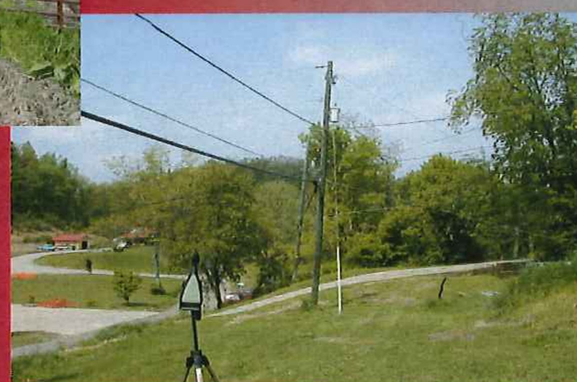
# Analysis of Traffic Noise Impact and Abatement Measures
# SCI-823-0.00
# (PID 19415)



*Prepared For:*

**Ohio Department of Transportation**
**1980 West Broad Street**
**Columbus, Ohio 43223**

*Prepared By:*

TranSystems

July 2006

**ANALYSIS OF TRAFFIC NOISE IMPACT AND ABATEMENT MEASURES**

**SCI-823-0.00**
**PID # 19415**
**Scioto County, Ohio**

**TABLE OF CONTENTS**




TranSystems
55 Public Square, Suite 1900
Cleveland, Ohio 44113-1901
(216) 861-1780

## LIST OF TABLES



## APPENDICES

## *Section 1.0*
## *INTRODUCTION*

### 1.1 Project Description

The proposed SCI-823-0.00 (PID 19415) project involves the construction of a limited access, four-lane divided highway on new location in central Scioto County, Ohio. The project is also referred to as the Portsmouth Bypass. The southern terminus of the project is located at United States Route (US) 52, approximately three quarters of a mile north of the Center Street exit in Wheelersburg, Ohio. From this point, the proposed corridor extends north through Sciotodale and Highland Bend and crossing over the Little Scioto River. The corridor continues north over undeveloped land to Shumway Hollow Road, just west of the Scioto County Airport, where a new interchange is proposed to be constructed. From this point the proposed roadway turns west continuing to Lucasville-Minford Road where a new interchange is also proposed. From this point the corridor continues west to the northern project terminus located on US 23 approximately 500 feet north of State Route (SR) 348 in Lucasville, Ohio. The total length of the proposed roadway is approximately 17 miles and is further referred to as the Hill Alternative. The project location is shown in Appendix A, Figure 1A-1C.

### 1.2 Project Scope

The concept of a highway bypass around the City of Portsmouth (Scioto County, Ohio) has been in existence since the creation of the Appalachian Development Highway System in 1964. The purpose of the proposed project is to alleviate roadway and capacity deficiencies with the existing roadway system. The preferred alternative for this project is referred to as the Hill Alternative. The Hill Alternative has been routed mostly along the hill tops or higher elevations of the project area which would utilize the lesser populated and more steeply-sloped ridgelines to make the trip from the US Route 52 near Sciotodale to US Route 23 just north of Portsmouth.

The purpose of this report is to detail the existing and the predicted future traffic noise levels associated with this proposed project and to consider noise abatement where applicable. This noise analysis report has been completed in compliance with the Federal Highway Administration (FHWA) noise criteria and the Ohio Department of Transportation (ODOT) highway noise policy.

## *Section 2.0*
## *NOISE ANALYSIS*

The noise analysis for this project was conducted in accordance with the Code of Federal Regulations (CFR), Title 23, Part 772, and the U.S. Department of Transportation, Federal Highway Administration (FHWA), *Highway Traffic Noise Analysis and Abatement Policy and Guidance* (FHWA, 1995). The project was further conducted in accordance with the ODOT noise policy pertaining to *Standard Procedure for Analysis and Abatement of Highway Traffic Noise* (ODOT, 2005). Existing year 2005 noise levels and noise levels for design year 2030 No Build and Build alternatives were modeled using the FHWA Traffic Noise Model (TNM) Version 2.5 (FHWA, 1998). Specific data and assumptions used in this analysis are described as follows.

### 2.1 Applicability

This noise barrier analysis has been performed in accordance with the policy that applies to Type I projects. A Type I project as described by the ODOT Standard Procedures for Analysis and Abatement of Highway Traffic Noise document is a federal aid highway project for the construction of highway on new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment or increases the number of through traffic lanes (ODOT, 2005).

### 2.2 Analysis Objectives

The objectives of the noise analysis include: (1) identification of existing and future noise sensitive areas in the vicinity of the proposed roadway improvement, (2) characterization of the existing ambient noise environment through computer modeling, (3) prediction of future noise levels and traffic noise impacts on land use activities for design year 2030 No Build and 2030 Build alternatives through computer modeling, (4) comparison of existing conditions against projected conditions to determine the projected impact on the surrounding area and, (5) evaluation of reasonable and feasible noise abatement measures for reducing noise where impacts are identified.

### 2.3 Noise Descriptors

Noise descriptors are used to describe the time varying nature of noise. Noise is defined as unwanted sound, which is produced by the vibration of sound pressure waves. Sound pressure levels are used to measure the intensity of sound and are described in terms of decibels (dB). Decibels are a logarithmic unit, which expresses the ratio of sound pressure level to a standard reference scale. The decibel scale has a range of 0-120 and is used to show the amount of sound pressure at a given location from the general environment of specific sources. An increase or decrease of 10 dB is perceived as a doubling or halving of the sound intensity since the decibel scale is logarithmic. In general, the average person cannot detect an increase or decrease in sound pressure level of less than 3 dB. However, a change in sound pressure level of 5 dB is readily perceptible by most people.

Sound is composed of various frequencies which are measured in cycles per second or Hertz (Hz). The human ear can detect a wide range of frequencies from 20 to 20,000 Hz, but is most sensitive to sounds over a frequency range of 200 to 5,000 Hz. The human ear does not respond in a uniform manner to different frequency sounds. A sound pressure level of 70 dB will be perceived as much louder at 1,000 Hz than at 100

Hz. To account for this, various weighting methods have been developed to reflect human sensitivity to noise. The purpose of a weighting method is to de-emphasize the frequency ranges in which the human ear is less sensitive. The most commonly used measure of noise level is the A-weighted sound level (dBA). The dBA sound level is widely used for transportation related noise measurements and specifications for community noise ordinances and standards. The dBA has been shown to be highly correlated to human response to noise.

In addition to noise fluctuating in frequency, environmental noise will fluctuate in intensity from moment to moment. Over a period of time there will be quiet moments and peak levels resulting from noisy, identifiable sources (trucks, aircraft, etc.). Because of these fluctuations, it is common practice to average these noise level fluctuations over a specified period of time. The equivalent sound level over a given period of time, $L_{eq}$, is widely accepted as a valid measure of community noise. The $L_{eq}$ is equal to the equivalent steady state noise level which, in a stated time period, would contain the same acoustical energy as the time varying noise levels that actually occurred during the same time period. The hourly value of $L_{eq}$, based upon the peak hour percentage of the annual average daily traffic, is referred to as $L_{eq(h)}$. Surveys have shown that $L_{eq}$ properly predicts annoyance. Therefore, this descriptor is commonly used for noise measurement, prediction, and impact assessment. In this report, noise levels will be described as hourly A weighted equivalent sound level in decibels, or dBA $L_{eq(h)}$.

## 2.4 Noise Sensitive Areas

A noise sensitive area (NSA) is a location consisting of land use sensitive to a potential increase in traffic noise level as a result of the proposed action. The FHWA has established five activity categories based on predominant land use where noise abatement must be considered for individual receptor sites where traffic noise levels meet, exceed or approach the level of noise described in the Noise Abatement Criteria (NAC). The NAC is shown in Table 1 on the following page of this report.

Noise sensitive areas identified within the study area were determined through a site visit and review of available mapping. Nine (9) locations, consisting primarily or residential properties, were identified along the proposed corridor that warranted the evaluation of a potential increase in noise levels. All of the identified NSAs fall into Activity Category B described in Table 1. The nine NSAs are described in greater detail in Table 2.

Land use along the Portsmouth Bypass corridor consists primarily of undeveloped woodland and agricultural land with isolated farms and residential structures where the proposed roadway would cross existing roads. The terrain is steep alternating between hilltops and hollows with elevations ranging from 800 to 900 feet on the steep hills to near 700 feet in the hollows. Development becomes somewhat dense near the south end of the corridor with areas of dense residential neighborhoods. It is assumed that persons living in residential structures within a distance of approximately 500 feet on either side of the proposed Portsmouth Bypass centerline could experience noise impacts as a result of the proposed project. For noise modeling purposes, potential noise sensitive receptors were identified in each of the NSAs and each area was modeled separately. The NSAs are described as follows and are shown in Appendix A, Figures 1A-1C and Figures 2A-2I.

Table 1.
Noise Abatement Criteria (NAC): Hourly A-Weighted Sound Level in Decibels(dBA)

| Activity Category | Leq(h) | L10(h) | Description of Activity Category |
|---|---|---|---|
| A | 57 (Exterior) | 60 (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) | 70 (Exterior) | Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals. |
| C | 72 (Exterior) | 75 (Exterior) | Developed lands, properties, or activities not included in Categories A or B above. |
| D | -- | -- | Undeveloped lands. |
| E | 52 (Interior) | 55 (Interior) | Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums. |

Table 2.
Noise Analysis Locations within the Study Area.

| NSA | Study Area Location | Total Study Length (ft) |
|---|---|---|
| 1 | The Riverview neighborhood south of Sciotodale on the east side of the corridor. | 2,100 |
| 2 East | The Highland Bend/Happy Hours Addition south of the Little Scioto River on the east side of the corridor. | 2,800 |
| 2 West | Highland Bend south of the Little Scioto River on the west side of the corridor. | 1,600 |
| 3 | Swauger Valley-Minford Road southwest of Minford on both sides of corridor. | 2,000 |
| 4 | State Route 139/Oliver Road area along the east side of the corridor. | 3,000 |
| 5 | Flowers Ison Road and Lucasville-Minford Road on the west side of the corridor. | 5,000 |
| 6 | Blue Run Road just north of Flowers Ison Road on the east side of the corridor. | 1,000 |
| 7 | Rose Hill Road northeast of Preston Addition on the east side of corridor. | 1,300 |
| 8 | Fairground Road and Thomas Hollow Road north of Lucasville on the south side of corridor. | 3,500 |

**NSA 1:** Land use within this NSA consists of a medium density residential neighborhood and one church facility. The NSA is comprised of eight residential dwelling units and one church.

NSA 2 is referred to as the Highland Bend area, a residential neighborhood south of the Little Scioto River. The proposed Hill Alignment would run the proposed roadway through the west side of this neighborhood, splitting the neighborhood in two. For modeling purposes, NSA 2 was divided into east and west sides of the proposed alignment. Each side was evaluated separately for future noise impact and noise abatement purposes.

**NSA 2 East:** Land use within this NSA consists of two residential neighborhoods, Highland Bend and Happy Hours Addition, which are separated by railroad tracks. The NSA consists primarily of single family residential structures and two church facilities. Some land parcels appear to be vacant and other parcels appear to have multiple dwelling units on the same parcel. The NSA is comprised of 82 residential dwelling units and two churches.

**NSA 2 West:** Land use in this NSA consists of single family dwelling units on the west end of Pershing Avenue. Similar to NSA East, some land parcels in this NSA appear to be vacant and other parcels have multiple dwelling units on the same parcel. The NSA is comprised of 13 residential dwelling units.

**NSA 3:** Land use within this NSA consists of isolated residential dwellings located on the west side of Swauger Valley Road. The NSA consists of four residential dwelling units.

**NSA 4:** Land use within this NSA consists of medium density single family residential dwelling units located on the north side of SR 139 and on both side of Oliver Road, a residential street running north off of SR 139. The NSA is comprised of 28 residential dwelling units.

**NSA 5:** Land use within this NSA consists of isolated residential dwelling units on the north side of Lucasville-Minford Road and on both sides of Flowers Ison Road a residential road running north off of Lucasville-Minford Road. The NSA is comprised of 15 residential dwelling units.

**NSA 6:** Land use within this NSA consists of isolated residential dwelling units on the north and south sides of Blue Run Road just north of the Flowers Ison Road intersection. The NSA consists of seven residential dwelling units.

**NSA 7:** Land use in this NSA is comprised of isolated residential dwelling units on Rose Hill Road. The NSA is comprised of 3 residential dwelling units.

**NSA 8:** Land use within this NSA is isolated residential dwellings on the north side of Thomas Hollow Road and on both sides of Fairground Road, a residential road running north/south. The NSA is comprised of six residential dwelling units.

### 2.5 Traffic

Since the proposed project is on new alignment there are no traffic data for the existing year condition. A design year of 2030 was used for future traffic volume. Projected traffic volume for the opening year 2010 and design year 2030 were provided by ODOT Office of Technical Services. A copy of the traffic volumes used in the analysis is presented in Appendix B.

Peak hour traffic volumes used in the noise analysis represent worst case conditions. Peak hour traffic volumes used in the noise model were obtained by multiplying the existing or design year Average Daily Traffic (ADT) by 10% to obtain the Design Hourly Volume (DHV). The DHV was multiplied by 55% to obtain the directional traffic volume. The high directional traffic volume (55% of the DHV) was always applied to the directional traffic lanes closest to the NSA. The low directional traffic volume (45% of the DHV) was always applied to the directional traffic lanes farthest from the NSA. As an example for NSA 1, located on the east side of proposed roadway, the high directional traffic volume was applied to the northbound lanes which are closest to the NSA and low directional traffic was applied to the southbound lanes which are further away from the NSA.

Three vehicle types were used in the noise model; automobiles, medium trucks and heavy trucks. A truck factor of 14% was applied to the peak hour traffic volumes to derive the peak hourly volume of truck traffic on the proposed roadway. The truck volume was further broken down to 70% heavy truck and 30% medium truck traffic.

### 2.6 Ambient Noise Measurements

A field visit was conducted in the project area to measure the existing noise environment at representative locations within each of the NSAs. Noise measurements were performed in accordance with the FHWA Report Number FHWA-PD-96-046, *Measurement of Highway Related Noise* May, 1996. Short-term ambient noise level measurements (15 minutes in duration) were conducted within the project area by CH2M Hill staff, with an ODOT observer, on December 19th and 20th, 2002. CH2M Hill staff further conducted subsequent short-term and ambient noise level measurements on January 8th, 9th and May 1st, 2003 in order to determine the existing traffic and ambient noise levels throughout the project area. Measurement equipment consisted of a Bruel & Kjaer (B&K) 2236 precision sound level meter equipped with a B&K Type 4188 half-inch condenser microphone. The instrumentation was calibrated in the field, prior to each measurement, using a B&K 4130 acoustical calibrator to ensure the accuracy of the measured noise levels. All instrumentation complies with the requirements of the American National Standards Institute (ANSI) and International Electrotechnical Commission (IEC) for Type I (precision) sound-level equipment. Short-term ambient noise level measurements were conducted at a total of 27 locations along the Hill Alternative. The monitoring locations are representative of the closest homes to the proposed roadway and were selected to provide full coverage and representation of homes within the noise study areas. The ambient noise monitoring locations are shown in Appendix A, Figure 3. A summary of the field measurement data is presented in Appendix B. Table 3 summarizes the results of the measured existing noise levels and compares them to the NAC.

Table 3.
Ambient Noise Measurements

| NSA | Location | Location Description | Measured Noise Level Leq |
|---|---|---|---|
| **1** | 39 | Section10/Hill + 9/Valley | 53 |
| **2East 2 West** | H8 | Section9/Hill | 54 |
| **2 East** | 42 | Section9/Hill | 52 |
| **2 East** | 43 | Section9/Hill | 50 |
| **3** | 41 | Section9/Hill | 54 |
| **4, 5** | 44 | Section8/Hill | 51 |
| **5** | N11 | Section3/Hill | 55.7 |
| **5** | N12 | Section4/Hill | 39.8 |
| **6** | N6 | Section2/Hill | 45.6 |
| **6** | H11 | Section2/Hill | 54.9 |
| **6** | H1 | Section1/Hill | 52.6 |
| **6, 7** | H2 | Section2/Hill | 54.9 |
| **8** | H1 | Section1/Hill | 52.6 |

From data presented in Table 3, it is apparent that existing noise levels throughout the project corridor are generally well below the NAC. The Ambient noise measurement locations, as recorded by CH2M Hill, are shown in Appendix A, Figure 3.

In order to assess existing peak-hour traffic noise levels at receiver locations near existing roadways, TNM input files were developed for such locations. Noise model predictions were validated by using the traffic counts obtained at subject noise monitoring locations in the TNM files, as described in Appendix C. Existing peak-hour traffic volumes were then input in the validated TNM files to predict existing peak-hour traffic noise levels at receiver locations in the vicinity of US-23, US-52, and Lucasville-Minford Road. Table 4 summarizes the peak-hour traffic noise levels at receivers in close proximity to existing traffic.

Table 4.
Measured Existing Year Peak Hour Traffic Noise Levels (Leq dBA)

| Location | Description | Peak-hour Noise Level | Approach/Exceed NAC? |
|---|---|---|---|
| 1 | 627 Fairgrounds Road | 61 | NO |
| 4 | Behind house at end of Indian Drive | 53 | NO |
| 6 | Next to 41 Joetta Road | 63 | NO |
| 9 | Next to 1054 Lucasville-Minford Road | 62 | NO |
| 11 | Front yard of the Chaney Residence | 61 | NO |
| 13 | Beside 2658 Lucasville-Minford Road | 62 | NO |
| 45 | At Alley Chiropractic Clinic on Ohio River Road | 72 | YES |

The only locations where existing noise levels exceed the NAC are the receivers at the south end of the corridor, where the proposed Portsmouth Bypass would meet US-52 (represented by receiver location 45).

## *Section 3.0*
## *NOISE MODELING*

### 3.1 Existing Conditions

Most of the noise within the project area is generated by traffic on the local roadway system. The existing year noise levels were established by field measurements at multiple locations within the nine NSAs.

### 3.2 Design Year 2030 Build Alternative

The Build alternative is described as construction of the proposed project. TNM was used to predict future noise levels for the Build 2030 alternative if the project was constructed. Noise levels for the Build alternative were modeled using the proposed roadway alignment and projected design year traffic volumes.

## *Section 4.0*
## *IMPACT ASSESSMENT*

To evaluate the significance of the changes in the predicted noise levels, FHWA has established NAC, as shown in Table 1, for various categories of land use which represent the upper limits of acceptable traffic generated noise emissions. According to FHWA guidance, a project may have a traffic noise impact if either or both of the following conditions exist:

- The predicted noise levels associated with the Build alternative approach, meet, or exceed the applicable NAC. According to ODOT, noise levels "approach" the NAC when they are within 1 dB of the applicable NAC.

- A substantial increase occurs in predicted noise levels between the future year Build alternative and existing noise levels, even though the applicable NAC may not be approached or exceeded. A substantial increase is considered to be a 10 dB or greater increase, representing a doubling or more of the perceived existing noise level.

All of the sensitive noise receptor sites in this analysis fall under the NAC Activity Category B with an applicable NAC of 67 dBA [$L_{eq(h)}$]. Therefore, under Activity Category B, a predicted noise level of 66 dBA approaches the NAC and is considered a noise impact.

### 4.1 Traffic Noise Impacts

The following tables assess the traffic noise impacts at each NSA.

Table 5.
Measured Existing year and Predicted Design Year Noise Levels – NSA 1

| Receptor | | Existing | 2030 Build | | Impact Criteria | | |
|---|---|---|---|---|---|---|---|
| Site | #DUs | Measured Noise Level | Calculated Noise Level | Increase Build over Existing | Substantial Increase | Sound Level Criterion | Type of Impact |
| | | dBA Leq(h) | dBA Leq(h) | dB | dB | dBA Leq(h) | |
| 72 | 1 | 53.0 | **68.1** | **15.1** | 10 | 66 | Both |
| 73 | 1 | 53.0 | 63.8 | **10.8** | 10 | 66 | Sub'l Inc |
| 74 | 1 | 53.0 | 56.6 | 3.6 | 10 | 66 | - - - - |
| 75 | 1 | 53.0 | 57.9 | 4.9 | 10 | 66 | - - - - |
| 76 | 1 | 53.0 | 58.6 | 5.6 | 10 | 66 | - - - - |
| 77 | 3 | 53.0 | 51.7 | -1.3 | 10 | 66 | - - - - |
| 78 | 5 | 53.0 | 53.2 | 0.2 | 10 | 66 | - - - - |
| 79 | 3 | 53.0 | 57.4 | 4.4 | 10 | 66 | - - - - |
| 80 | 1 | 53.0 | 51.7 | -1.3 | 10 | 66 | - - - - |
| 81 | 1 | 53.0 | 64.1 | **11.1** | 10 | 66 | Sub'l Inc |
| 82 | 3 | 53.0 | 61.8 | 8.8 | 10 | 66 | - - - - |

Three of the receptor sites (72,73, and 81) in NSA 1 were predicted to experience a substantial increase in noise level (>10 dB) as a result of the proposed project. One of the three sites (72) was also predicted to exceed the applicable NAC (67 dBA). Therefore, three of the receptor sites in NSA 1 are expected to experience a traffic noise impact as a result of the proposed project. The locations of the receptor sites in NSA 1 are shown in Appendix A, Figure 2A.

Table 6.
Measured Existing Year and Predicted Design Year Noise Levels - NSA 2 East Side

| **Receptor** | | **Existing** | **2030 Build** | | **Impact Criteria** | | |
|---|---|---|---|---|---|---|---|
| Site | #DUs | Measured Noise Level | Calculated Noise Level | Increase Build over Existing | Substantial Increase | Sound Level Criterion | Type of Impact |
| | | dBA Leq(h) | dBA Leq(h) | dB | dB | dBA Leq(h) | |
| 12 | 1 | 50.0 | 65.0 | **15.0** | 10 | 66 | Sub'l Inc |
| 13 | 1 | 50.0 | 62.4 | **12.4** | 10 | 66 | Sub'l Inc |
| 14 | 1 | 50.0 | 61.8 | **11.8** | 10 | 66 | Sub'l Inc |
| 15 | 1 | 50.0 | 61.3 | **11.3** | 10 | 66 | Sub'l Inc |
| 16 | 1 | 50.0 | 64.3 | **14.3** | 10 | 66 | Sub'l Inc |
| 17 | 1 | 50.0 | 63.3 | **13.3** | 10 | 66 | Sub'l Inc |
| 18 | 1 | 50.0 | 61.7 | **11.7** | 10 | 66 | Sub'l Inc |
| 19 | 1 | 50.0 | 60.3 | **10.3** | 10 | 66 | Sub'l Inc |
| 20 | 1 | 54.0 | 61.0 | 7.0 | 10 | 66 | ---- |
| 21 | 1 | 50.0 | 61.5 | **11.5** | 10 | 66 | Sub'l Inc |
| 22 | 1 | 54.0 | 61.2 | 7.2 | 10 | 66 | ---- |
| 23 | 1 | 50.0 | 61.2 | **11.2** | 10 | 66 | Sub'l Inc |
| 25 | 1 | 54.0 | 60.5 | 6.5 | 10 | 66 | ---- |
| 26 | 1 | 54.0 | 59.0 | 5.0 | 10 | 66 | ---- |
| 27 | 1 | 54.0 | 58.4 | 4.4 | 10 | 66 | ---- |
| 28 | 1 | 54.0 | 56.8 | 2.8 | 10 | 66 | ---- |
| 29 | 1 | 54.0 | 58.0 | 4.0 | 10 | 66 | ---- |
| 30 | 1 | 54.0 | 58.4 | 4.4 | 10 | 66 | ---- |
| 31 | 1 | 54.0 | 57.7 | 3.7 | 10 | 66 | ---- |
| 32 | 1 | 54.0 | 58.3 | 4.3 | 10 | 66 | ---- |
| 33 | 1 | 54.0 | 58.4 | 4.4 | 10 | 66 | ---- |
| 34 | 1 | 54.0 | 58.8 | 4.8 | 10 | 66 | ---- |
| 35 | 2 | 54.0 | 56.2 | 2.2 | 10 | 66 | ---- |
| 36 | 2 | 54.0 | 54.2 | 0.2 | 10 | 66 | ---- |
| 37 | 1 | 50.0 | 52.9 | 2.9 | 10 | 66 | ---- |
| 38 | 2 | 54.0 | 54.9 | 0.9 | 10 | 66 | ---- |
| 39 | 2 | 54.0 | 54.2 | 0.2 | 10 | 66 | ---- |
| 40 | 1 | 54.0 | 53.5 | -0.5 | 10 | 66 | ---- |

| Receptor | | Existing | 2030 Build | | Impact Criteria | | |
|---|---|---|---|---|---|---|---|
| Site | #DUs | Measured Noise Level | Calculated Noise Level | Increase Build over Existing | Substantial Increase | Sound Level Criterion | Type of Impact |
| | | dBA Leq(h) | dBA Leq(h) | dB | dB | dBA Leq(h) | |
| 41 | 1 | 50.0 | 59.7 | 9.7 | 10 | 66 | ---- |
| 42 | 1 | 50.0 | 58.3 | 8.3 | 10 | 66 | ---- |
| 43 | 1 | 50.0 | 57.7 | 7.7 | 10 | 66 | ---- |
| 44 | 1 | 50.0 | 57.6 | 7.6 | 10 | 66 | ---- |
| 45 | 1 | 50.0 | 57.1 | 7.1 | 10 | 66 | ---- |
| 46 | 1 | 50.0 | 57.0 | 7.0 | 10 | 66 | ---- |
| 47 | 1 | 50.0 | 56.5 | 6.5 | 10 | 66 | ---- |
| 48 | 2 | 50.0 | 59.6 | 9.6 | 10 | 66 | ---- |
| 49 | 1 | 50.0 | 59.9 | 9.9 | 10 | 66 | ---- |
| 50 | 1 | 50.0 | 59.1 | 9.1 | 10 | 66 | ---- |
| 51 | 1 | 54.0 | 58.6 | 4.6 | 10 | 66 | ---- |
| 52 | 1 | 54.0 | 58.0 | 4.0 | 10 | 66 | ---- |
| 53 | 1 | 54.0 | 58.0 | 4.0 | 10 | 66 | ---- |
| 54 | 1 | 54.0 | 57.1 | 3.1 | 10 | 66 | ---- |
| 55 | 1 | 54.0 | 56.2 | 2.2 | 10 | 66 | ---- |
| 56 | 1 | 54.0 | 55.8 | 1.8 | 10 | 66 | ---- |
| 57 | 1 | 54.0 | 55.1 | 1.1 | 10 | 66 | ---- |
| 58 | 1 | 54.0 | 58.4 | 4.4 | 10 | 66 | ---- |
| 59 | 1 | 54.0 | 58.0 | 4.0 | 10 | 66 | ---- |
| 60 | 1 | 54.0 | 53.0 | -1.0 | 10 | 66 | ---- |
| 61 | 1 | 54.0 | 54.6 | 0.6 | 10 | 66 | ---- |
| 62 | 1 | 54.0 | 55.6 | 1.6 | 10 | 66 | ---- |
| 63 | 1 | 54.0 | 57.0 | 3.0 | 10 | 66 | ---- |
| 64 | 1 | 54.0 | 56.4 | 2.4 | 10 | 66 | ---- |
| 65 | 1 | 52.0 | 55.7 | 3.7 | 10 | 66 | ---- |
| 66 | 5 | 52.0 | 57.0 | 5.0 | 10 | 66 | ---- |
| 67 | 5 | 52.0 | 55.6 | 3.6 | 10 | 66 | ---- |
| 68 | 1 | 52.0 | 56.5 | 3.5 | 10 | 66 | ---- |
| 69 | 1 | 52.0 | 55.8 | 3.8 | 10 | 66 | ---- |
| 70 | 1 | 52.0 | 55.3 | 3.3 | 10 | 66 | ---- |
| 71 | 1 | 52.0 | 54.6 | 2.6 | 10 | 66 | ---- |

Ten of the receptor sites (12-19, 21 and 23) in NSA 2 East were predicted to experience a substantial increase in noise level (>10 dB) as a result of the proposed project. None of the receptor sites were predicted to experience traffic noise levels that approach or exceed the applicable NAC (67 dBA). Therefore, a total of ten receptor sites in NSA 2 East Side are expected to experience a noise impact as a result of the proposed project. The locations of the receptor sites in NSA 2 East are shown in Appendix A, Figure 2C.

Table 7.
Measured Existing Year and Predicted Design Year Noise Levels – NSA 2 West Side

| Receptor | | Existing | 2030 Build | | Impact Criteria | | |
|---|---|---|---|---|---|---|---|
| Site | #DUs | Measured Noise Level | Calculated Noise Level | Increase Build over Existing | Substantial Increase | Sound Level Criterion | Type of Impact |
| | | dBA Leq(h) | dBA Leq(h) | dB | dB | dBA Leq(h) | |
| 1 | 1 | 54.0 | 63.5 | 9.5 | 10 | 66 | ---- |
| 2 | 1 | 54.0 | 51.3 | -2.7 | 10 | 66 | ---- |
| 3 | 1 | 54.0 | 56.8 | 2.8 | 10 | 66 | ---- |
| 4 | 1 | 54.0 | 57.3 | 3.3 | 10 | 66 | ---- |
| 5 | 1 | 54.0 | 57.5 | 3.5 | 10 | 66 | ---- |
| 6 | 1 | 54.0 | 57.7 | 3.7 | 10 | 66 | ---- |
| 7 | 1 | 54.0 | 57.3 | 3.3 | 10 | 66 | ---- |
| 8 | 1 | 54.0 | 57.4 | 3.4 | 10 | 66 | ---- |
| 9 | 1 | 54.0 | 58.3 | 4.3 | 10 | 66 | ---- |
| 10 | 2 | 54.0 | 58.0 | 4.0 | 10 | 66 | ---- |
| 11 | 2 | 54.0 | 57.7 | 3.7 | 10 | 66 | ---- |

None of the receptor sites in NSA 2 West Side were predicted to experience a substantial increase in noise level (>10 dB) as a result of the proposed project. None of the 13 receptor sites were predicted to experience a traffic noise level that would approach or exceed the applicable NAC (67 dBA). Therefore, there are no receptor sites in NSA 2 West Side that are predicted to experience traffic noise impacts as a result of the proposed project. The locations of the receptor sites in NSA West Side are shown in Appendix A, Figure 2B.

Table 8.
Measured Existing Year and Predicted Design Year Noise Levels – NSA 3

| Receptor | | Existing | 2030 Build | | Impact Criteria | | |
|---|---|---|---|---|---|---|---|
| Site | #DUs | Measured Noise Level | Calculated Noise Level | Increase Build over Existing | Substantial Increase | Sound Level Criterion | Type of Impact |
| | | dBA Leq(h) | dBA Leq(h) | dB | dB | dBA Leq(h) | |
| 1 | 1 | 54.0 | 59.2 | 5.2 | 10 | 66 | - - - - |
| 2 | 1 | 54.0 | 50.9 | -3.1 | 10 | 66 | - - - - |
| 3 | 1 | 54.0 | **66.2** | **12.2** | 10 | 66 | Both |
| 4 | 1 | 54.0 | 59.3 | 5.3 | 10 | 66 | - - - - |
| 5 | 1 | 54.0 | 57.7 | 3.7 | 10 | 66 | - - - - |

One of the receptor sites (3) in NSA 3 was predicted to experience a substantial increase in noise level (>10 dB) as a result of the proposed project. The same receptor site was also predicted to exceed the applicable NAC (67 dBA). Therefore, one receptor site in NSA 3 was predicted to experience a traffic noise impact as a result of the proposed project. The locations of the receptor sites in NSA 3 are shown in Appendix A, Figure 2D.

Table 9.
Measured Existing Year and Predicted Design Year Noise Levels – NSA 4

| Receptor | | Existing | 2030 Build | | Impact Criteria | | |
|---|---|---|---|---|---|---|---|
| Site | #DUs | Measured Noise Level | Calculated Noise Level | Increase Build over Existing | Substantial Increase | Sound Level Criterion | Type of Impact |
| | | dBA Leq(h) | dBA Leq(h) | dB | dB | dBA Leq(h) | |
| 11 | 1 | 51.0 | 60.8 | 9.8 | 10 | 66 | - - - - |
| 12 | 1 | 51.0 | 64.8 | **13.8** | 10 | 66 | Sub'l Inc |
| 13 | 1 | 51.0 | 62.3 | **11.3** | 10 | 66 | Sub'l Inc |

Two of the receptor sites (12 and 13) in NSA 4 were predicted to experience a substantial increase in noise level (>10 dB) as a result of the proposed project. None of the receptor sites were predicted to exceed the applicable NAC (67 dBA). Therefore, two receptor sites in NSA 4 were predicted to experience traffic noise impacts as a result of the proposed project. The locations of the receptor sites in NSA 4 are shown in Appendix A, Figure 2E.

Table 10.
Measured Existing Year and Predicted Design Year Noise Levels – NSA 5

| Receptor | | Existing | 2030 Build | | Impact Criteria | | |
|---|---|---|---|---|---|---|---|
| Site | #DUs | Measured Noise Level | Calculated Noise Level | Increase Build over Existing | Substantial Increase | Sound Level Criterion | Type of Impact |
| | | dBA Leq(h) | dBA Leq(h) | dB | dB | dBA Leq(h) | |
| 1 | 1 | 39.8 | 61.7 | **21.9** | 10 | 66 | Sub'l Inc |
| 2 | 3 | 39.8 | 61.9 | **22.1** | 10 | 66 | Sub'l Inc |
| 3 | 2 | 39.8 | 63.7 | **23.9** | 10 | 66 | Sub'l Inc |
| 4 | 2 | 55.7 | 65.1 | 9.4 | 10 | 66 | ---- |
| 5 | 1 | 55.7 | 63.6 | 7.9 | 10 | 66 | ---- |
| 6 | 1 | 55.7 | 63.3 | 7.6 | 10 | 66 | ---- |
| 7 | 2 | 55.7 | 61.8 | 6.1 | 10 | 66 | ---- |
| 8 | 2 | 55.7 | 60.7 | 5.0 | 10 | 66 | ---- |
| 9 | 1 | 61.6 | 62.9 | 1.3 | 10 | 66 | ---- |
| 13 | 1 | 51.0 | 62.3 | **11.3** | 10 | 66 | Sub'l Inc |
| 14 | 1 | 39.8 | 59.4 | **19.6** | 10 | 66 | Sub'l Inc |
| 15 | 1 | 39.8 | 62.3 | **22.5** | 10 | 66 | Sub'l Inc |
| 16 | 1 | 39.8 | 62.3 | **22.5** | 10 | 66 | Sub'l Inc |
| 17 | 2 | 39.8 | 60.0 | **20.2** | 10 | 66 | Sub'l Inc |
| 18 | 3 | 39.8 | 60.3 | **20.5** | 10 | 66 | Sub'l Inc |
| 19 | 2 | 39.8 | 61.4 | **21.6** | 10 | 66 | Sub'l Inc |
| 20 | 2 | 55.7 | 60.0 | 4.3 | 10 | 66 | ---- |

Ten of the receptor sites (1-3 and 13-19) in NSA 5 were predicted to experience a substantial increase in noise level (>10 dB) as a result of the proposed project. None of the residential dwelling units were predicted to experience a traffic noise level that would approach or exceed the applicable NAC (67 dBA). Therefore, ten receptor sites in NSA 5 are predicted to experience traffic noise impacts as a result of the proposed project. The locations of the receptor sites in NSA 5 are shown in Appendix A, Figure 2F.

Table 11
Measured Existing Year and Predicted Design Year Noise Levels – NSA 6

| **Receptor** | | **Existing** | **2030 Build** | | **Impact Criteria** | | |
|---|---|---|---|---|---|---|---|
| Site | #DUs | Measured Noise Level | Calculated Noise Level | Increase Build over Existing | Substantial Increase | Sound Level Criterion | Type of Impact |
| | | dBA Leq(h) | dBA Leq(h) | dB | dB | dBA Leq(h) | |
| 9 | 1 | 52.6 | **66.6** | **14.0** | 10 | 66 | Both |
| 10 | 1 | 52.6 | 63.0 | 9.4 | 10 | 66 | ---- |
| 11 | 1 | 52.6 | 56.7 | 3.9 | 10 | 66 | ---- |
| 12 | 1 | 52.6 | 52.9 | 0.3 | 10 | 66 | ---- |
| 13 | 2 | 54.9 | 55.3 | 0.4 | 10 | 66 | ---- |
| 14 | 1 | 54.9 | 60.6 | 5.7 | 10 | 66 | ---- |
| 15 | 1 | 54.9 | 59.7 | 4.8 | 10 | 66 | ---- |
| 16 | 2 | 54.9 | 59.5 | 4.6 | 10 | 66 | ---- |
| 17 | 1 | 52.6 | 54.1 | 1.5 | 10 | 66 | ---- |
| 18 | 1 | 54.9 | 64.3 | 9.4 | 10 | 66 | ---- |
| 25 | 1 | 55.7 | 65.8 | **10.1** | 10 | 66 | Sub'l Inc |
| 26 | 3 | 45.5 | 52.4 | 6.9 | 10 | 66 | ---- |
| 27 | 3 | 55.7 | 55.9 | 0.2 | 10 | 66 | ---- |
| 28 | 4 | 55.7 | 58.8 | 3.1 | 10 | 66 | ---- |
| 29 | 1 | 55.7 | 62.3 | 6.6 | 10 | 66 | ---- |
| 30 | 2 | 55.7 | 61.1 | 5.4 | 10 | 66 | ---- |
| 33 | 1 | 52.6 | 53.0 | 0.4 | 10 | 66 | ---- |

Two of the receptor sites(9 and 25) in NSA 6 were predicted to experience a substantial increase in noise level (>10 dB) as a result of the proposed project. One of the two receptor sites (9) was also predicted to experience a traffic noise level that would approach the applicable NAC (67 dBA). Therefore, a total of two receptor sites in NSA 6 are predicted to experience traffic noise impacts as a result of the proposed project. The locations of the receptor sites in NSA 6 are shown in Appendix A, Figure 2G.

Table 12.
Measured Existing Year and Predicted Design Year Noise Levels – NSA 7

| Receptor | | Existing | 2030 Build | | Impact Criteria | | |
|---|---|---|---|---|---|---|---|
| Site | #DUs | Measured Noise Level | Calculated Noise Level | Increase Build over Existing | Substantial Increase | Sound Level Criterion | Type of Impact |
| | | dBA Leq(h) | dBA Leq(h) | dB | dB | dBA Leq(h) | |
| 19 | 1 | 54.9 | 63.3 | 8.4 | 10 | 66 | ---- |
| 21 | 1 | 54.9 | 64.6 | 9.7 | 10 | 66 | ---- |
| 22 | 1 | 54.9 | 64.5 | 9.6 | 10 | 66 | ---- |
| 23 | 2 | 54.9 | 59.9 | 5.0 | 10 | 66 | ---- |
| 24 | 1 | 54.9 | 61.7 | 6.8 | 10 | 66 | ---- |
| 32 | 1 | 54.9 | 64.7 | 9.8 | 10 | 66 | ---- |

None of the receptor sites in NSA 7 were predicted to experience a substantial increase in noise level (>10 dB) as a result of the proposed project. None of the receptor sites were predicted to exceed the applicable NAC (67 dBA). Therefore, no receptor sites in NSA 7 were predicted to experience a traffic noise impact as a result of the proposed project. The locations of the receptor sites in NSA 7 are shown in Appendix A, Figure 2H.

Table 13.
Predicted Existing Year and Design Year Traffic Noise Levels - NSA 8

| Receptor | | Existing | 2030 Build | | Impact Criteria | | |
|---|---|---|---|---|---|---|---|
| Site | #DUs | Measured Noise Level | Calculated Noise Level | Increase Build over Existing | Substantial Increase | Sound Level Criterion | Type of Impact |
| | | dBA Leq(h) | dBA Leq(h) | dB | dB | dBA Leq(h) | |
| 1 | 1 | 52.6 | 57.6 | 5.0 | 10 | 66 | ---- |
| 2 | 1 | 52.6 | 57.7 | 5.1 | 10 | 66 | ---- |
| 3 | 1 | 52.6 | 56.2 | 4.2 | 10 | 66 | ---- |
| 4 | 1 | 52.6 | 57.5 | 4.9 | 10 | 66 | ---- |
| 5 | 1 | 52.6 | 58.0 | 5.4 | 10 | 66 | ---- |
| 31 | 1 | 52.6 | 56.2 | 3.6 | 10 | 66 | ---- |

None of the receptor sites in NSA 8 were predicted to experience a substantial increase in noise level (>10 dB) as a result of the proposed project. None of the receptor sites were predicted to exceed the applicable NAC (67 dBA). Therefore, no receptor sites in NSA 8 were predicted to experience a traffic noise impact as a result of the proposed project. The locations of the receptor sites in NSA 8 are shown in Appendix A, Figure 2I.

## 4.2 Impact Assessment Summary

Of the nine NSAs evaluated for noise impact as part of this investigation, NSAs one through six have noise sensitive receptor sites which are predicted to experience a substantial increase in traffic noise levels or experience traffic-related noise levels above the applicable NAC. ODOT noise policy requires the consideration of noise abatement measures when traffic noise impacts occur. When noise abatement measures are being considered, every reasonable effort should be made to obtain substantial noise reduction of at least 8 dB. Abatement must provide at least a 5 dB reduction in highway traffic noise levels in order to provide noticeable and effective attenuation. The ODOT noise policy further recommends that an attempt be made to achieve the greatest noise reduction possible while remaining cost reasonable.

## *Section 5.0*
## *EVALUATION OF NOISE ABATEMENT MEASURES*

In accordance with 23 CFR Part 772, noise abatement measures were evaluated for sites which were predicted to approach or exceed the applicable FHWA NAC. Abatement measures that were considered include traffic management, modifications to the vertical and horizontal roadway alignments, noise insulation, and construction of permanent noise barriers within or adjacent to the right-of-way. In order to be considered for implementation, a potential mitigation measure must be determined to be both feasible and reasonable. Feasibility includes such considerations as effectiveness of the measure in attaining specified reductions in predicted noise levels, the cost of the measure, and the number of receptors that will benefit. Reasonableness considerations can include overall environmental effects, community desirability, the degree that future Build noise levels exceed existing noise levels.

**Traffic management measures:** Traffic management measures, which can include restrictions on access to specific motor vehicle types, travel speed, traffic volumes, and/or time of operation, are sometimes used as noise abatement measures. A reduction in speed limit, while possibly generating some beneficial effects on noise level reduction, would affect the ability of the roadway to accommodate anticipated traffic volumes and reduce the capacity of the proposed facility. Limiting truck traffic and/or time of truck traffic operation is not a feasible option to reduce noise impacts due to the lack of nearby routes capable of handling the existing capacity. Limiting truck traffic may further result in economic impact that time use limitations may have on commercial traffic and businesses both within and beyond the project locale. Traffic management measures would not be feasible, therefore, it is not considered as an option for this project.

**Alteration of horizontal and vertical alignments:** Alignment modifications generally involve orienting and/or siting the roadway a sufficient distance from noise sensitive areas to minimize noise impact. The horizontal and vertical alignment of the proposed roadway improvement is greatly dictated by the extreme vertical topography of the project area. The Conceptual Alternative Study prepared for the project, identified the hill alignment as the alignment that would have the least impact on existing structures. Shifting the horizontal alignment away from sensitive receptor sites to reduce noise impacts will only result in shifting the impacts on to other sensitive receptor sites. Vertical and/or horizontal alignment modifications to the proposed alignment were evaluated but are not considered to be feasible or reasonable abatement measures.

**Acquisition of real property or interests therein to serve as a buffer zone:** Buffer zones are undeveloped, open spaces which border a highway and are created when a highway agency purchases land or development rights, in addition to the normal right-of-way, so that future dwellings cannot be constructed next to the highway. Following ODOT guidelines, the amount of public funds considered reasonable for noise abatement purposes is $25,000 per benefited noise sensitive receptor. A property acquisition program to provide a noise buffer zone adjacent to the proposed roadway is not considered a reasonable noise abatement measure due to the tremendous amount of land that would be required for acquisition would not be considered a reasonable noise abatement measure.

**Noise insulation of public use or non profit institutional structures:** This mitigation measure applies only to public use structures and therefore was not considered for the predominantly residential structures impacted by the proposed project.

**Noise Barrier Construction:** Noise barriers are generally the abatement measure most often associated with noise abatement on new roadway construction projects. Noise barriers reduce noise levels by blocking the sound path between the noise source and noise sensitive receptors. To be effective, noise barriers must be long, continuous, and sufficiently high to break the line of sight from the highway to the receptor. When designing a noise barrier wall, every attempt should be made to obtain a substantial noise reduction (8 dB or higher) wherever possible. Noise barriers are generally designed to provide a minimum reduction of 5 dB for receptor sites closest to the roadway (front row receptors) and a minimum of 3 dB for other receptor sites to be considered effective. Noise levels must be reduced by a minimum of 3 dB at any sensitive receptor site for that site to be considered a benefited receptor. The construction of a noise barrier is considered a feasible mitigation measure if a 5 dB noise reduction can be achieved. The construction of a noise barrier is considered a reasonable mitigation measure if the construction cost is less than $25,000 per benefited receptor. The cost per square foot of reflective barrier wall construction, provided by ODOT is $17.50. Reasonableness also includes the desires of the affected property owners to have a noise barrier constructed adjacent to their property.

Noise barrier design was facilitated through use of TNM Version 2.5. TNM is an interactive computer program with the fundamental purpose of enabling the designer to develop an optimum noise barrier design, one that provides the desired noise reduction at the least cost. Site specific variables used in the computer model include barrier length, the geometry of the roadway to the receptor, barrier height, barrier design material (concrete), and the number of dwelling units benefited by the barrier. Based on the height and length of the modeled barrier, TNM calculates noise barrier effectiveness (noise reduction) and cost. The model can quickly change barrier heights to improve (optimize) the cost efficiency of the barrier system. The effectiveness of a barrier relates to the reduction in noise level the barrier provides and the number of people benefited by the barrier system.

The following subsections present a summary of the noise barrier wall analyses performed for the impacted NSAs. TNM spreadsheets detailing the level of noise reduction at each receptor site and a description of the evaluated noise barriers and costs are provided for each NSA in Appendix D.

### 5.1 Barrier Wall Analysis - NSA 1

A noise barrier analysis was performed for NSA 1 to determine if the construction of a noise barrier wall would be a reasonable and feasible measure in abating design year Build traffic noise levels at the 19 residential structures and two church facilities in this NSA. The sensitive receptors in this NSA are situated at a much higher elevation than the proposed roadway. Noise barrier wall NSA 1 was modeled approximately six feet west of the paved shoulder on the northbound traffic lanes. The barrier wall would begin at approximate roadway station 40+50 and extend north 3,387 feet. The noise barrier wall was modeled at a maximum height of 17 feet with an average height of 16.03 feet. In this configuration the noise barrier wall would provide a substantial noise reduction of 9.7 dB at receptor site 81 and a reduction of 8.9 dB at receptor site 76. In this configuration, the noise barrier wall would also provide a minimum noise reduction of greater than 3.0 dB at 19 other receptor sites. With the level of noise reduction that this barrier would provide, the noise barrier wall would meet the ODOT feasibility criterion.

Using an average cost of $17.50 per square foot for noise barrier construction, the total cost of the noise barrier is estimated at $950,122. With a total of 21 benefited receptor sites, the average cost per benefited receptor would be $45,243. With an average cost of greater than $25,000 per benefited receptor, noise barrier wall NSA 1 would not meet the ODOT reasonable cost criterion. Attempts were made to further optimize the height and length of the wall to reduce the cost per benefited receptor site. However, as the noise barrier wall was shortened in height or length, receptor sites no longer met the minimum 3.0 dB noise reduction. The configuration of the modeled noise barrier wall described above presents the best benefit to cost ratio. Having not met the ODOT criteria as a cost reasonable abatement measure, noise barrier wall NSA 1 is not recommended for construction.

### 5.2 Barrier Wall Analysis - NSA 2 East (East Side of Roadway)

A noise barrier analysis was performed for NSA 2 East to determine if the construction of a noise barrier would be reasonable and feasible in abating design year 2030 traffic noise levels at the noise sensitive receptor sites. Noise barrier wall NSA 2 East was modeled approximately 6 feet east of the northbound paved shoulder. A noise barrier wall was not evaluated along the east right-of-way line because this section of roadway would be constructed on fill and is situated at a higher elevation than the receptor sites. Noise barrier wall NSA East begins at approximate roadway station 110+00 and extends north a distance of 2,681 feet with a maximum height of 14 feet and an average height of 12.33 feet.

At a length of 2,681 feet and an average height of 12.33 feet, noise barrier wall NSA 2 East would provide a maximum noise reduction of 9.0 dB at residential receptor site 12 and would further provides a reduction in noise level of 5 dB or greater at 26 other front row receptor sites. The noise barrier wall would also provide a reduction of 3 dB or more at a total of 32 additional receptor sites. The 13 benefited receptor sites are representative of 67 individual residential dwelling units. With the level of noise reduction that this barrier provides, the noise barrier wall would meet the ODOT feasibility criterion.

Using an average cost of $17.50 per square foot for noise barrier construction, the total cost of the noise barrier is estimated at $578,532. With a total of 67 benefited residential dwelling units, the average cost per benefited receptor would be $8,634. With an average cost of less than $25,000 per benefited receptor, noise barrier wall NSA 2 East would meet the ODOT reasonable cost criterion. Noise barrier wall NSA 2 East would meet the ODOT criteria for a feasible and reasonable noise abatement measure and is recommended for construction as part of the proposed project.

### 5.3 Barrier Wall Analysis - NSA 2 West (West Side of Roadway)

A noise barrier analysis was performed for NSA 2 West to determine if the construction of a noise barrier would be reasonable and feasible in abating design year 2030 traffic noise levels at the noise sensitive receptor sites. Noise barrier wall NSA 2 West was modeled approximately 6 feet east of the northbound paved shoulder. A noise barrier wall was not evaluated along the west right-of-way line because this section of roadway would be constructed on fill and is situated at a higher elevation than the receptor sites. Noise barrier wall NSA 2 West begins at approximate roadway station 110+80 and extends north a distance of 1,261 feet with a maximum height of 17 feet and an average height of 15.05 feet. In this configuration, noise barrier wall NSA 2 West would provide a maximum noise reduction of 5.0 dB at residential receptor site 8 and would further provide a reduction in noise level of 3 dB or greater at 10 other receptor sites. A total of 11 residential receptor sites would be considered benefited with this noise barrier wall. With the level of noise reduction that this barrier wall would provide, the noise barrier wall would meet the ODOT feasibility criterion.

Using an average cost of $17.50 per square foot for noise barrier construction, the total cost of the noise barrier is estimated at $332,066. With a total of 13 benefited receptor sites, the average cost per benefited receptor would be $30,188. With an average cost of greater than $25,000 per benefited receptor, noise barrier wall NSA 2 West would not meet the ODOT reasonable cost criterion. Attempts were made to further optimize the height and length of the wall to reduce the cost per benefited receptor site. However, as the noise barrier wall was shortened in height or length, the barrier wall no longer met the substantial noise reduction criterion. The configuration of the modeled noise barrier wall described above presents the best benefit to cost ratio. Having not met the ODOT criteria as a cost reasonable abatement measure, noise barrier wall NSA 2 West is not recommended for construction.

### 5.4 Barrier Wall Analysis - NSA 3

A noise barrier analysis was performed for NSA 3 to determine if the construction of a noise barrier would be reasonable and feasible in abating design year 2030 traffic noise levels at the noise sensitive receptor sites. A noise barrier wall was modeled approximately 6 feet off the southbound edge of pavement. Barrier wall NSA 3 would begin at approximate roadway station 435+00, just south of Swauger Valley Road, and continue south approximately 657 feet. The sensitive receptors in this NSA are situated at elevations higher and lower than the proposed roadway. In this configuration the noise barrier wall could not provide a substantial noise reduction of 8.0 dB. The greatest noise reduction that could be achieved by this noise barrier wall was 2.6 dB at receptor site 12. A substantial noise reduction could not be obtained by the maximum ODOT recommended barrier wall height of 20 feet. Therefore, noise barrier wall NSA 3 would not meet the ODOT feasible criterion and is not a recommended noise abatement measure.

### 5.5 Barrier Wall Analysis - NSA 4

A noise barrier analysis was performed for NSA 4 to determine if the construction of a noise barrier would be reasonable and feasible in abating design year 2030 traffic noise levels at the noise sensitive receptor sites. Noise barrier wall NSA 4 was modeled approximately 6 feet east of the northbound paved shoulder. A noise barrier wall was not evaluated along the east right-of-way line because this section of roadway would be constructed on fill and is situated at a higher elevation than the receptor sites. Noise barrier wall NSA 4 begins at approximate roadway station 480+00 and extends north a distance of 3,073 feet with a maximum height of 14 feet and an average height of 11.84 feet.

At a length of 3,073 feet and an average height of 11.84 feet, noise barrier wall NSA 4 would provide a maximum noise reduction of 8.0 dB at residential receptor site 4 and would further provides a reduction in noise level of 3 dB or greater at 26 additional receptor sites. With the level of noise reduction that this barrier provides, the noise barrier wall would meet the ODOT feasibility criterion.

Using an average cost of $17.50 per square foot for noise barrier construction, the total cost of the noise barrier is estimated at $636,553. With a total of 27 benefited residential dwelling units, the average cost per benefited receptor would be $23,576. With an average cost of less than $25,000 per benefited receptor, noise barrier wall NSA 4 would meet the ODOT reasonable cost criterion. Noise barrier wall NSA 4 would meet the ODOT criteria for a feasible and reasonable noise abatement measure and is recommended for construction as part of the project.

### 5.6 Barrier Wall Analysis - NSA 5

A noise barrier analysis was performed for NSA 5 to determine if the construction of a noise barrier wall would be reasonable and feasible in abating design year 2030 traffic noise levels at the noise sensitive receptor sites. A noise barrier wall was modeled approximately 6 feet off the southbound edge of pavement. Barrier wall NSA 5 would begin at approximate roadway station 540+20 and continue south approximately 1,709 feet. Barrier wall NSA 5 was modeled at a maximum height of 17 feet and an average height of 13.34 feet. At a length of 1,709 feet and an average height of 13.34 feet, noise barrier wall NSA 5 would provide a maximum noise reduction of 6.7 dB at receptor site 9 and would further provide a noise reduction of 3 dB or greater at an additional 4 receptor sites. With the level of noise reduction that this noise barrier wall would provide, the noise barrier wall would meet the ODOT feasibility criterion.

Using an average cost of $17.50 per square foot for noise barrier construction, the total cost of the noise barrier is estimated at $399,038. With a total of 5 benefited residential dwelling units, the average cost per benefited receptor would be $79,807. With an average cost of greater than $25,000 per benefited receptor, noise barrier wall NSA 5 does not meet the ODOT reasonable cost criterion. Without meeting the ODOT cost reasonable criterion, the noise barrier wall is not recommended as a noise abatement measure.

### 5.7 Barrier Wall Analysis - NSA 6

A noise barrier analysis was performed for NSA 6 to determine if the construction of a noise barrier wall would be reasonable and feasible in abating design year 2030 traffic noise levels at the noise sensitive receptor sites. A noise barrier wall was modeled approximately 6 feet off the northbound edge of pavement. Barrier wall NSA 6 would begin at approximate roadway station 573+00 and continue north approximately 1,108 feet. Barrier wall NSA 6 was modeled at a maximum height of 12 feet and an average height of 11.10 feet. At a length of 1,108 feet and an average height of 11.10 feet, noise barrier wall NSA 6 would provide a maximum noise reduction of 8.0 dB at receptor site 19 and would further provide a noise reduction of 3 dB or greater at an additional 6 receptor sites. With the level of noise reduction that this noise barrier wall would provide, the noise barrier wall would meet the ODOT feasibility criterion.

Using an average cost of $17.50 per square foot for noise barrier construction, the total cost of the noise barrier is estimated at $215,258. With a total of 7 benefited residential dwelling units, the average cost per benefited receptor would be $30,751. With an average cost of greater than $25,000 per benefited receptor, noise barrier wall NSA 6 does not meet the ODOT reasonable cost criterion. Without meeting the ODOT cost reasonable criterion, the noise barrier wall is not recommended as a noise abatement measure.

**5.8 Barrier Wall Analysis - NSA 7**

No noise impacts were identified in NSA 7. Any further consideration of noise abatement measures is not necessary for receptors at this NSA.

**5.9 Barrier Wall Analysis - NSA 8**

No noise impacts were identified in NSA 8. Any further consideration of noise abatement measures is not necessary for receptors at this NSA.

## Section 6.0
## CONSTRUCTION NOISE

Noise sensitive receptors will also be subjected to noise impacts associated with the construction phase of the proposed project. Construction noise will generate temporary adverse impacts on adjacent and nearby properties, particularly those in residential land use. Construction noise will be emitted intermittently by a range of construction equipment at varying levels of intensity based on the types of operations being performed and the number of pieces of equipment in operation at any given time. Depending on project circumstances, options are available to minimize the temporary adverse noise impacts, including the proper maintenance of equipment, most notably adequate lubrication, and non leaking mufflers, equipment restriction modifications to reduce noise emissions and restrict the use of certain equipment by location and time of day, controlling non construction traffic by limiting heavy truck movements on residential streets, maximizing the distance between equipment and receptors where possible, and enclosing or screening noisy activities or stationary equipment.

## Section 7.0
## *CONCLUSION AND RECOMMENDATIONS*

Traffic generated noise levels were predicted using the FHWA TNM Version 2.5 for nine noise sensitive areas for the existing year 2005 and the design year 2030 Build alternative. TNM predicted traffic noise impacts at 6 of the 8 noise sensitive areas with implementation of the proposed project. Multiple receptor sites were predicted to experience peak hour traffic noise levels in excess of the Category B NAC of 67 dBA. All of the impacted NSAs were predicted to experience a substantial noise impact (increase > 10 dBA) as a result of the proposed action.

In accordance with 23 CFR Part 772, when noise impacts are identified as a result of a proposed action, noise abatement measures must be considered for impacted sites predicted to approach or exceed the applicable FHWA NAC. As described in Section 5.0, the only reasonable and feasible noise abatement measure identified for impacted sensitive receptor sites is the construction of noise barrier walls.

A summary of the noise abatement analyses for the eight evaluated NSAs is presented in Table 14. According to ODOT guidance, the criteria to determine the feasibility and reasonableness of noise barrier walls should consider the following items:

> <u>The amount of noise reduction provided:</u> When considering noise abatement measures, every reasonable effort should be made to obtain a substantial noise reduction at sensitive receptor sites. In Ohio, a substantial reduction is 8 dB or more.
>
> <u>The number of dwelling units benefited:</u> The threshold of noise reduction, which establishes a benefited property, is at least 3 dB. This reduction is determined at an exterior point where frequent human use occurs and a lowered noise level would be of benefit regardless of whether or not the property was identified as impacted.
>
> <u>The cost of the abatement:</u> A reasonable cost for noise barrier walls is determined using a cost index based on total cost per dwelling unit benefited, as well as the unit cost per square foot of the noise barrier material installed for the walls. For a unit cost of $17.50 per square foot of barrier wall a cost index of $25,000 per benefited unit should be used.
>
> <u>The views of the impacted residents:</u> The Views and desires of the impacted residents play a major consideration in determining the reasonableness of the noise abatement measure. The residents of the impacted properties have not been contacted to solicit their concerns/comments regarding noise barrier walls. It is assumed that their views will be determined at a future project public meeting.

A noise barrier wall is generally considered to be a reasonable mitigation measure if the overall abatement benefits outweigh the overall adverse social, economic and environmental effects. As shown on Table 14, the noise barrier walls evaluated at NSA 2 East and NSA 4 meet the minimum ODOT criteria of providing reasonable and feasible noise abatement to residents in the vicinity of the proposed project. The noise barrier walls appear to be a reasonable and feasible noise mitigation measure and should be incorporated into the proposed project. There is no apparent noise abatement solution to the traffic noise impacts at the remaining NSAs.

Table 14
Noise Abatement Summary Table

| Barrier | Maximum Insertion Loss[a] (dB) | Barrier Length (feet) | Average Barrier Height (feet) | Estimated Barrier Cost[b] | Benefitted Property[c] | Cost Per Benefitted Property | Effectiveness | | Barrier Recommended[f] |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Feasible[d] | Reasonable[e] | |
| **NSA 1** | 9.7 | 3,387 | 16.03 | $950,112 | 21 | $445,243 | Yes | No | No |
| **NSA 2 East** | 9.0 | 2,681 | 12.33 | $578,532 | 67 | $ 8,634 | Yes | Yes | Yes |
| **NSA 2 West** | 5.0 | 1,261 | 15.05 | $332,066 | 13 | $30,188 | Yes | No | No |
| **NSA 3** | 2.6 | 657 | 20.00 | $229,950 | 0 | N/A | No | No | No |
| **NSA 4** | 8.0 | 3,073 | 11.84 | $636,553 | 27 | $23,576 | Yes | Yes | Yes |
| **NSA 5** | 6.7 | 1,709 | 13.34 | $399,038 | 5 | $79,807 | Yes | No | No |
| **NSA 6** | 8.0 | 1,108 | 11.10 | $215,258 | 7 | $30,751 | Yes | No | No |
| **NSA 7** | No noise impacts identified in this NSA | | | | | | | | |
| **NSA 8** | No noise impacts identified in this NSA | | | | | | | | |

Notes:
[a] Insertion Loss (IL) for each barrier is the maximum noise reduction of all residences protected by the barrier.
[b] Cost per noise barrier is assumed to be $17.50 per square foot.
[c] A receptor is considered benefited by the noise barrier if the IL at the receptor site is 3 dB or greater.
[d] A noise barrier is considered acoustically feasible if the barrier can provide a noise reduction of at least 5 dB at one receptor site.
[e] A noise barrier is considered cost reasonable if the cost per benefited receptor is less than $25,000.
[f] Recommendation is made if the noise barrier is cost-reasonable and acoustically-feasible.

## *Section 8.0*
## *REFERENCES*

Code of Federal Regulations (CFR) Title 23, Part 772, U.S. Department of Transportation, Federal Highway Administration (FHWA), *Procedures for Abatement of Highway Traffic Noise and Construction Noise.* Washington, D.C.

Ohio Department of Transportation, Office of Environmental Services. June, 2005. *Standard Procedure for Analysis and Abatement of Highway Traffic Noise.* Columbus, Ohio.

U.S. Department of Transportation, Federal Highway Administration (FHWA). January, 1998. *FHWA Traffic Noise Model (TNM).* Report No. FHWA-PD-96-009. Washington, D.C.

U.S. Department of Transportation, Federal Highway Administration. May, 1996. *Measurement of Highway-Related* Report No. FHWA-PD-96-046. Washington, D.C.

U.S. Department of Transportation, Federal Highway Administration. June, 1995. *Highway Traffic Noise Analysis and Abatement - Policy and Guidance.* Washington, D.C.

## PREPARED BY

**Tracy Engle, MS** is TranSystems' Ecological Team Leader and offers experience in completing environmental documents and conducting various field studies involving the identification of wetlands, threatened and endangered species and terrestrial and aquatic resources and their habitats. Mr. Engle has conducted and managed ecological evaluations, wetland delineations, permit applications, and environmental site assessment projects throughout Ohio and the eastern US, many for a statewide ODOT Task Order Contract. He served as the Project Manager for ODOT's Statewide Ecological Services/ESA Task Order Contract from 1999 to 2003, in which he managed projects in most ODOT Districts.

**Craig M. Cox, BS** is TransSystems' Senior Noise Analyst with over eight years experience preparing noise analysis and abatement design for projects in the state of Ohio. Mr. Cox has completed the Bowlby & Associates, Inc. FHWA Transportation Noise Model (TNM) training course (1999) and is qualified in conducting noise analysis and abatement design using TNM v2.5.

**Jennifer Arp, MS** is TranSystems' Junior Noise Analysis and Noise Abatement specialist. Ms. Arp has completed the Bowlby & Associates, Inc. FWHA TNM v2.5 training course (2004) and is qualified in conducting noise analysis and abatement using the FHWA Traffic Noise Model v2.5. She has experience in both modeling and derived noise analysis procedures. Her noise analysis experience also includes involvement in Federal Aviation Administration projects. Ms. Arp is also a biologist with experience in aquatic ecology, wetland identification and delineation, as well as terrestrial and aquatic habitat evaluation.

# APPENDIX A

Figures

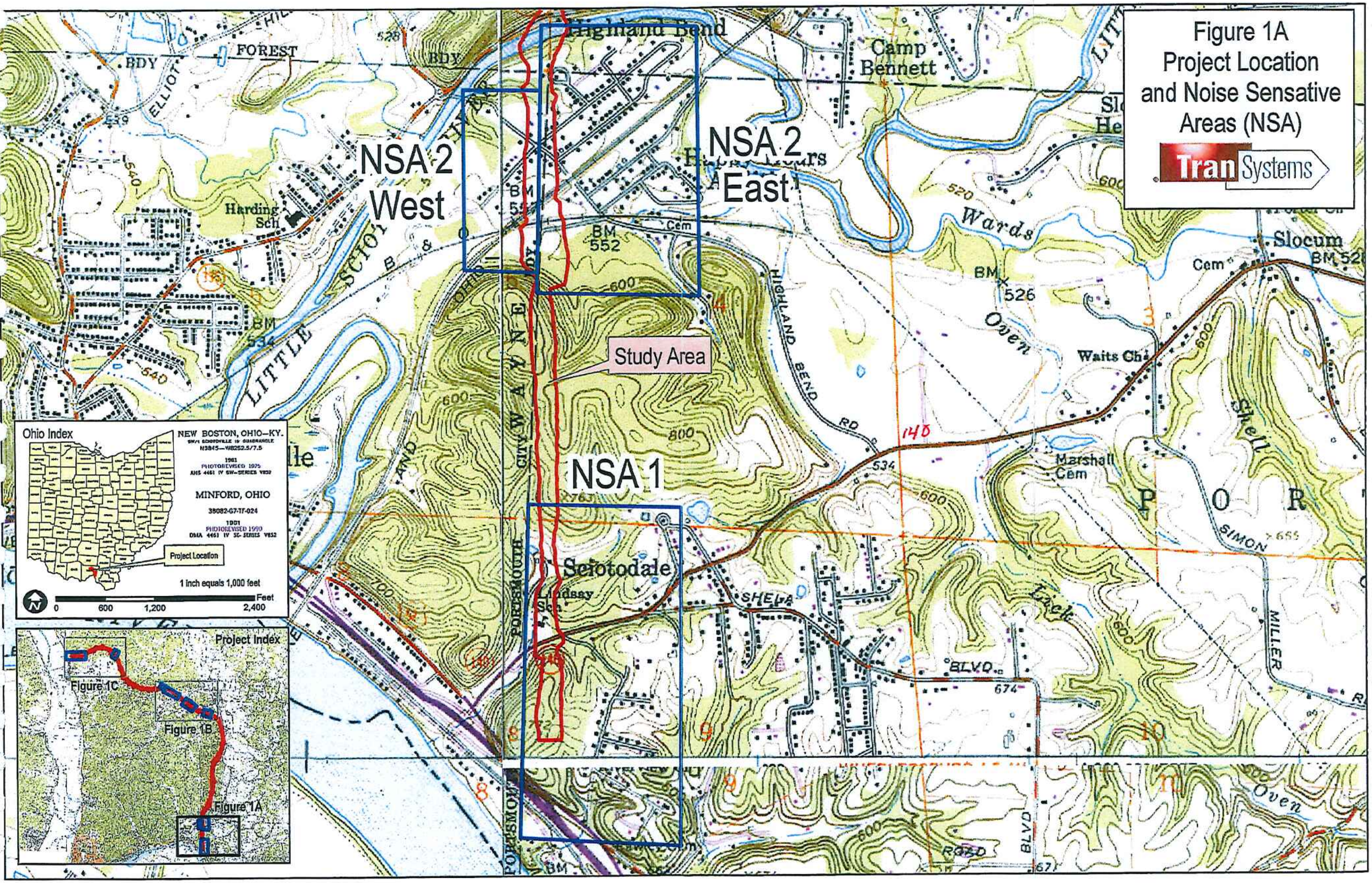


Figure 1A
Project Location
and Noise Sensative
Areas (NSA)
TranSystems
NSA 2
West
NSA 2
East
NSA 1
Study Area
Highland Bend
Camp Bennett
Wards
Oven
Slocum
Waits Ch
Marshall Cem
Sciotodale
Harding Sch
LITTLE SCIOTO
HIGHLAND BEND RD
SIMON
MILLER
BLVD
Ohio Index
NEW BOSTON, OHIO–KY.
MINFORD, OHIO
Project Location
1 inch equals 1,000 feet
0
600
1,200
2,400
Feet
Project Index
Figure 1C
Figure 1B
Figure 1A

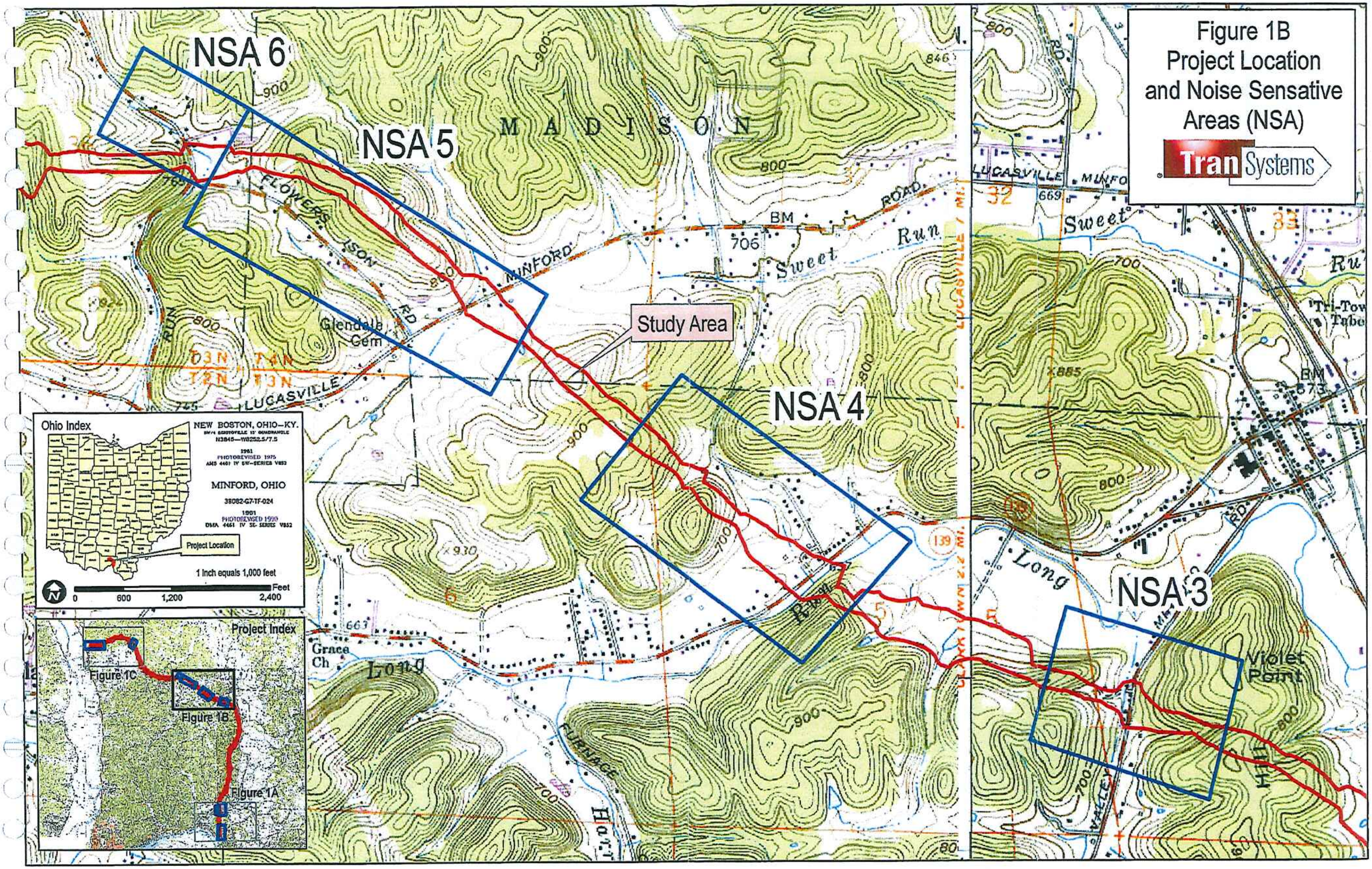


Figure 1B
Project Location
and Noise Sensative
Areas (NSA)
TranSystems
NSA 6
NSA 5
NSA 4
NSA 3
Study Area
MADISON
Violet Point
Ohio Index
NEW BOSTON, OHIO–KY.
MINFORD, OHIO
Project Location
1 inch equals 1,000 feet
0 600 1,200 2,400 Feet
Project Index
Figure 1C
Figure 1B
Figure 1A

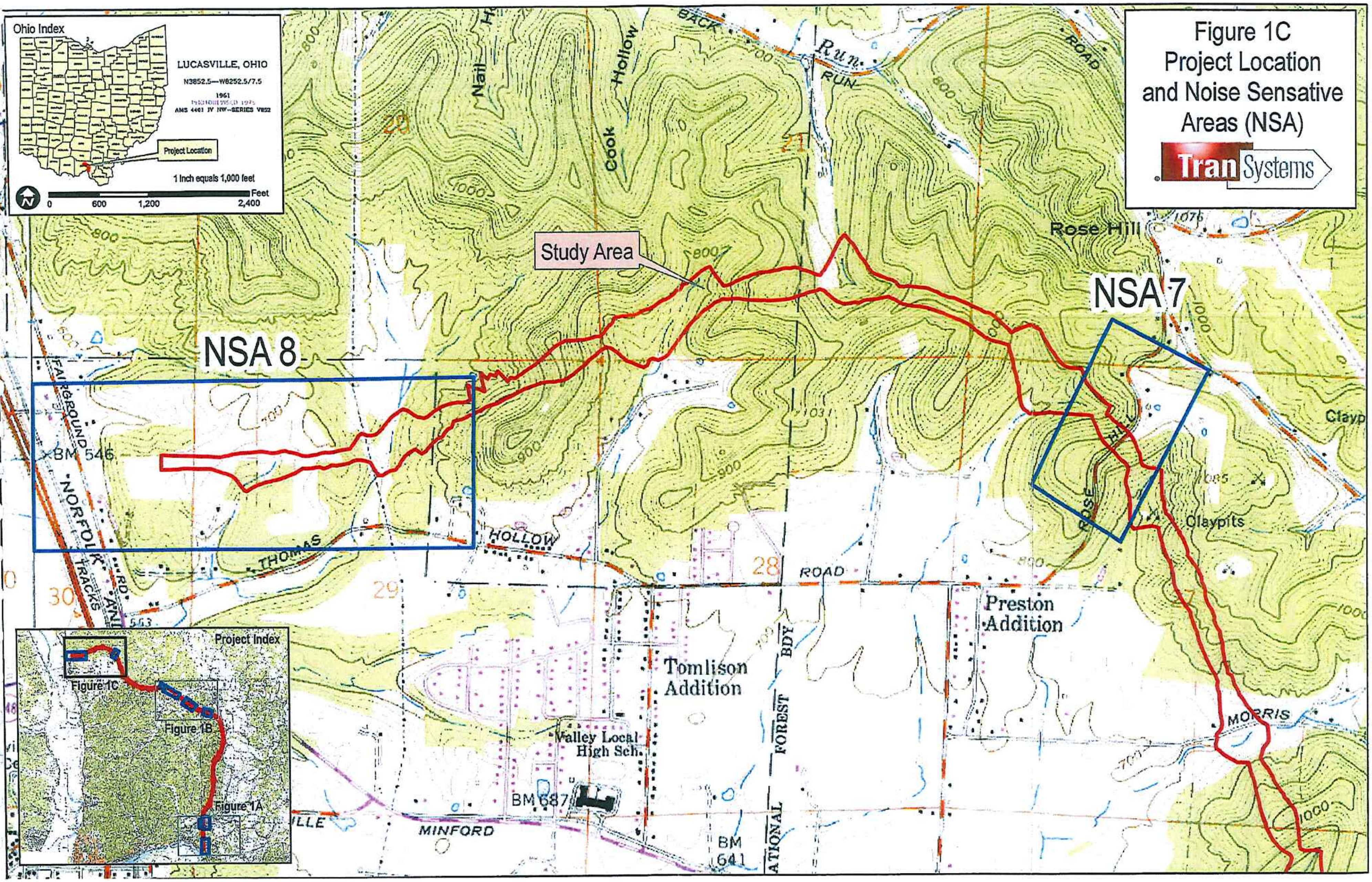


Figure 1C
Project Location
and Noise Sensative
Areas (NSA)
TranSystems
Ohio Index
LUCASVILLE, OHIO
N3852.5—W8252.5/7.5
1961
Project Location
1 inch equals 1,000 feet
0
600
1,200
2,400
Feet
Study Area
NSA 8
NSA 7
Rose Hill
Claypits
Preston Addition
Tomlison Addition
Valley Local High Sch.
BM 687
BM 546
BM 641
FAIRGROUND RD
NORFOLK AND TRACKS
THOMAS HOLLOW ROAD
MINFORD
MORRIS
BACK RUN ROAD
Cook Hollow
Project Index
Figure 1C
Figure 1B
Figure 1A

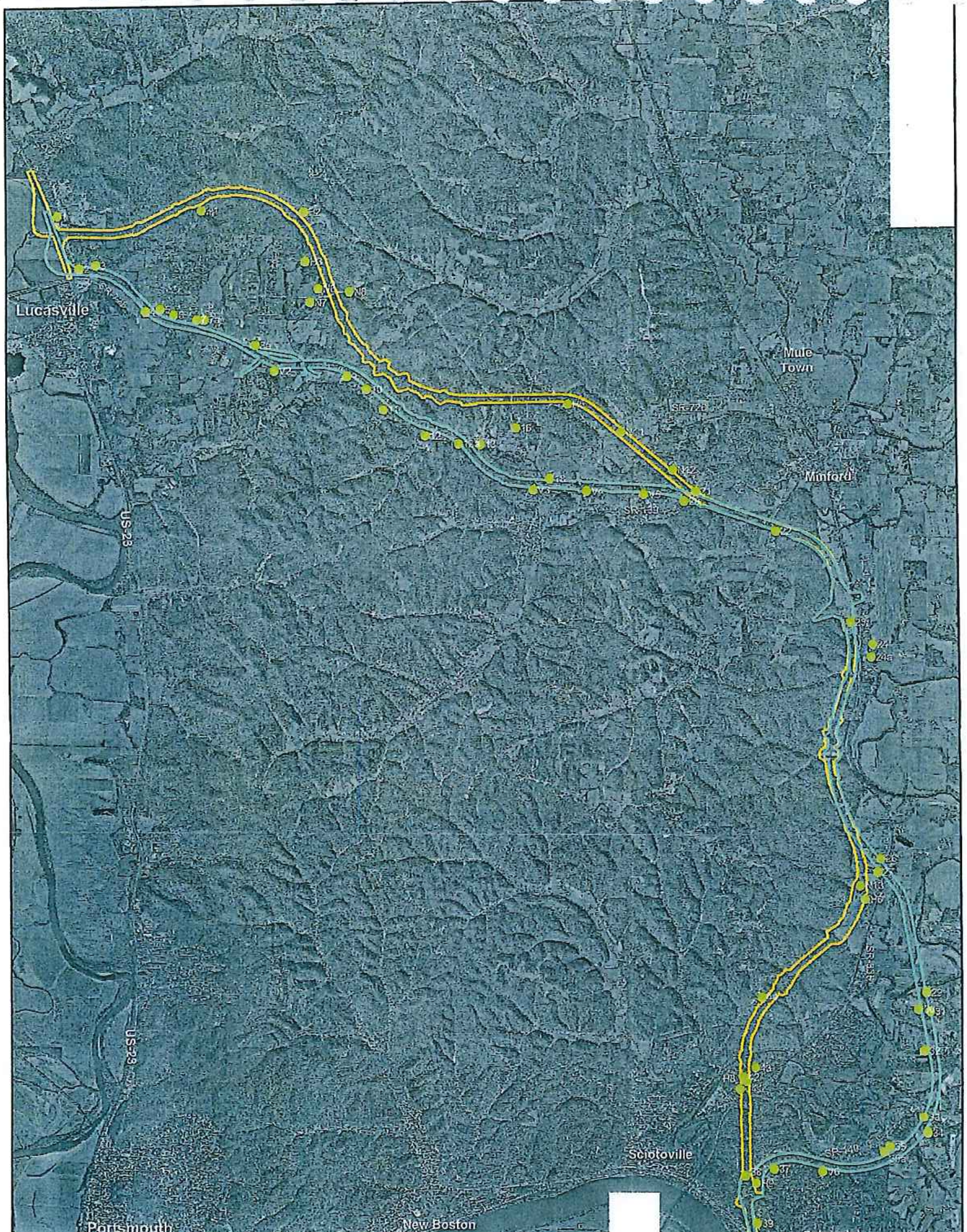



**Figure 3: Monitoring Locations**

Valley Alternative

Hill Alternative

Monitored locations

0 0.5 1 2 Miles

N

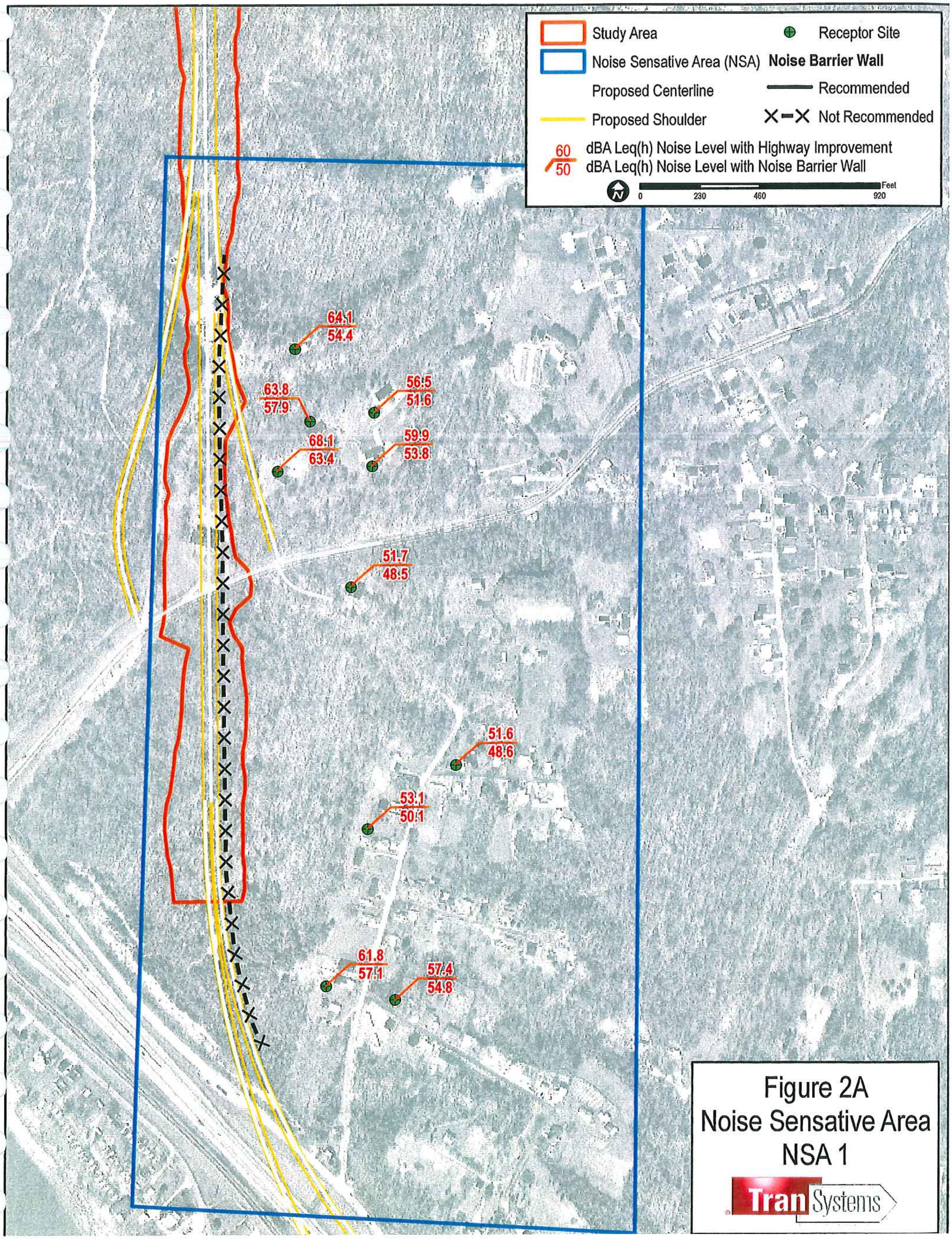



Figure 2A
Noise Sensative Area
NSA 1

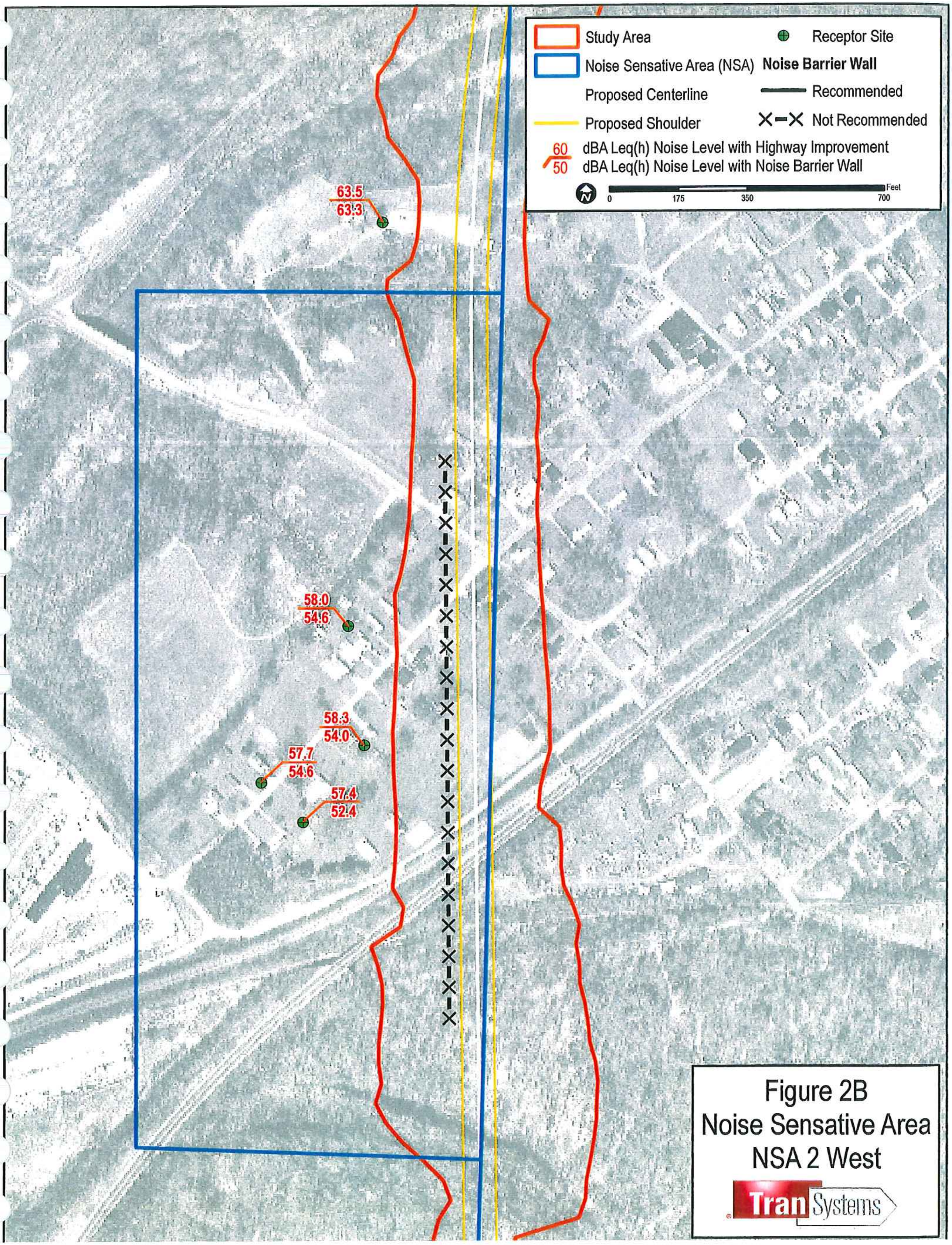
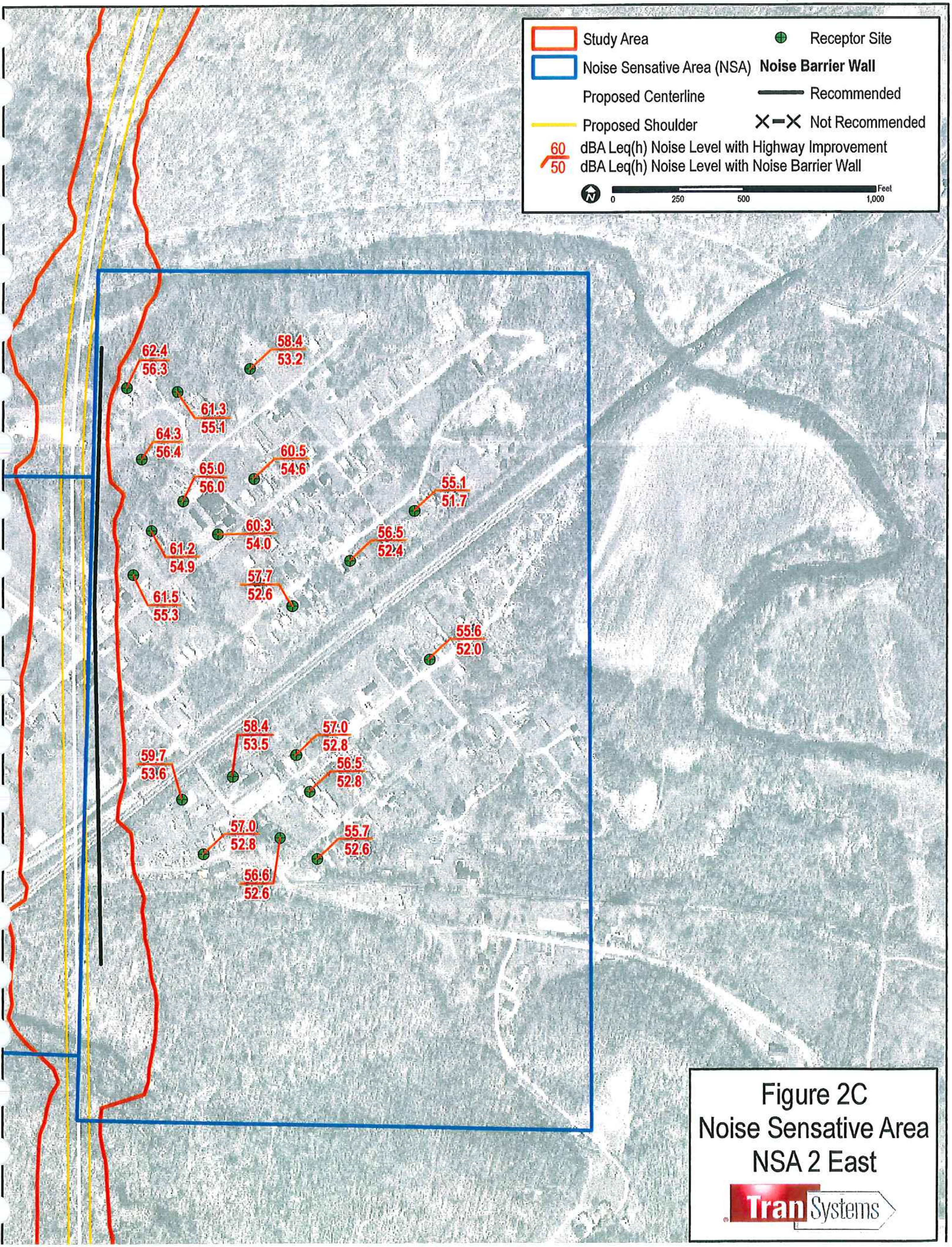



Figure 2B
Noise Sensative Area
NSA 2 West

TranSystems


Study Area
Receptor Site
Noise Sensative Area (NSA)
Noise Barrier Wall
Proposed Centerline
Recommended
Proposed Shoulder
Not Recommended
60 dBA Leq(h) Noise Level with Highway Improvement
50 dBA Leq(h) Noise Level with Noise Barrier Wall
Feet
0
250
500
1,000
62.4 / 56.3
58.4 / 53.2
61.3 / 55.1
64.3 / 56.4
60.5 / 54.6
65.0 / 56.0
55.1 / 51.7
60.3 / 54.0
56.5 / 52.4
61.2 / 54.9
57.7 / 52.6
61.5 / 55.3
55.6 / 52.0
58.4 / 53.5
57.0 / 52.8
59.7 / 53.6
56.5 / 52.8
57.0 / 52.8
55.7 / 52.6
56.6 / 52.6
Figure 2C
Noise Sensative Area
NSA 2 East
TranSystems

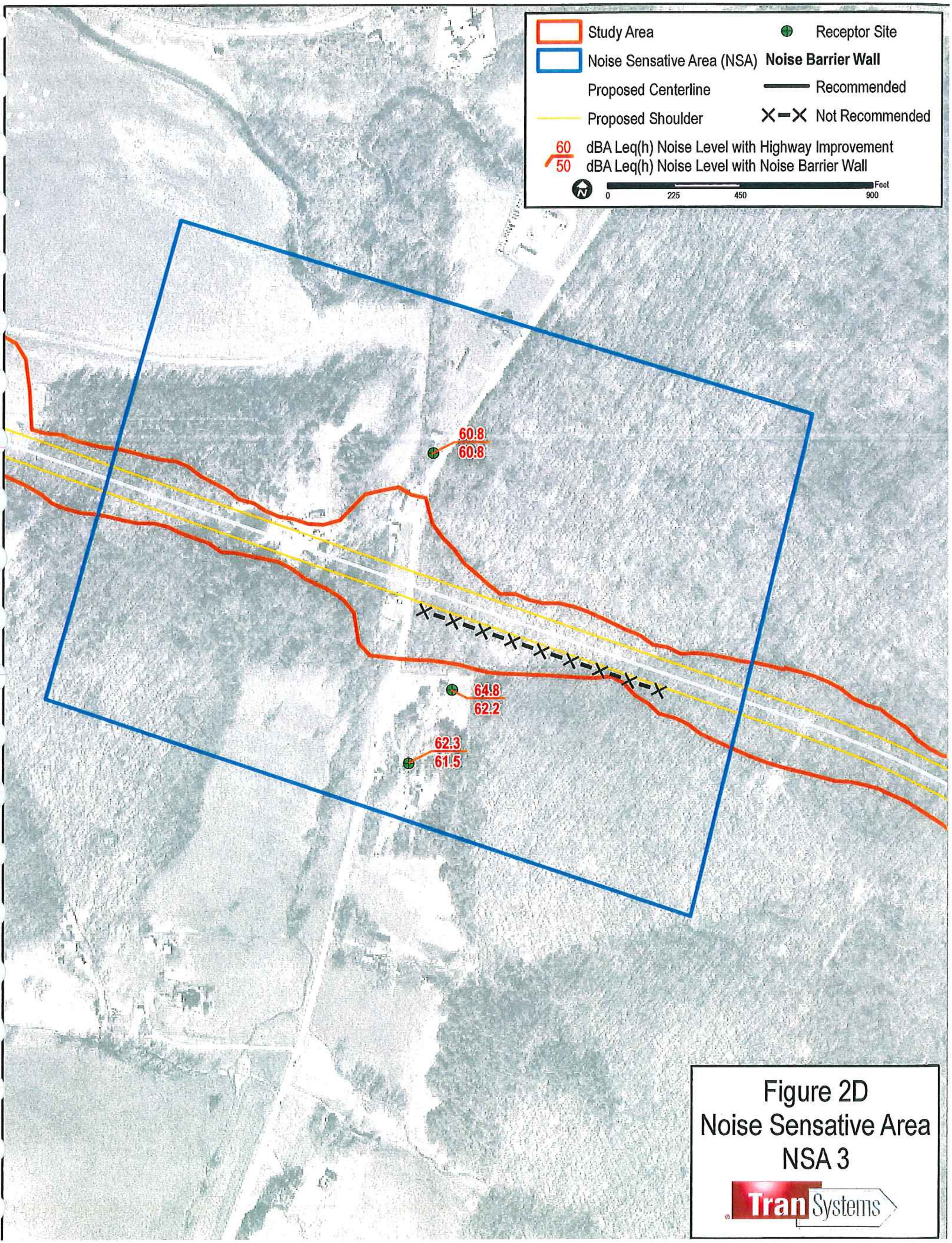
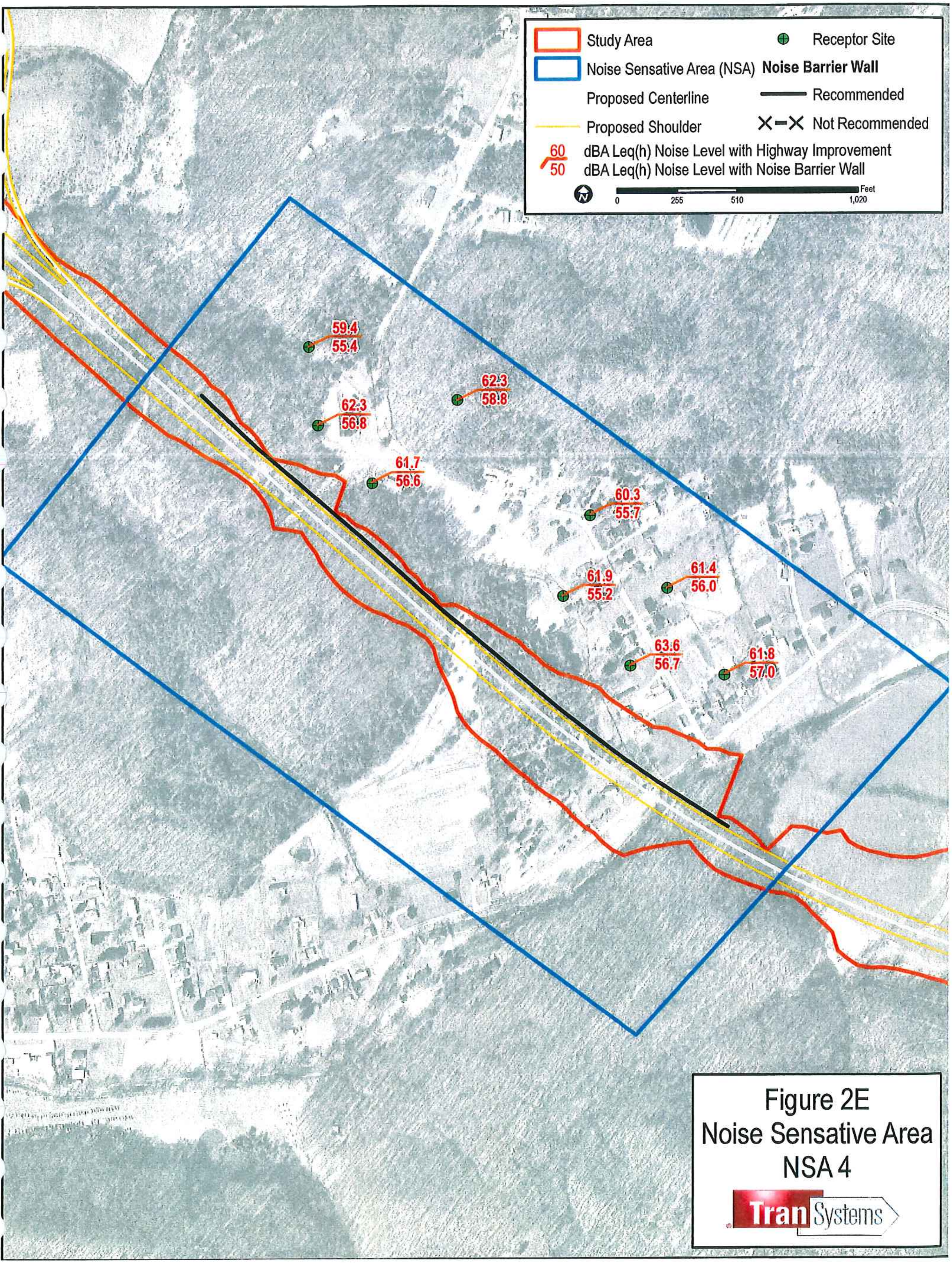



Figure 2D
Noise Sensative Area
NSA 3


Study Area
Receptor Site
Noise Sensative Area (NSA)
Noise Barrier Wall
Proposed Centerline
Recommended
Proposed Shoulder
Not Recommended
60 dBA Leq(h) Noise Level with Highway Improvement
50 dBA Leq(h) Noise Level with Noise Barrier Wall
Feet
0
255
510
1,020
59.4
55.4
62.3
58.8
62.3
56.8
61.7
56.6
60.3
55.7
61.9
55.2
61.4
56.0
63.6
56.7
61.8
57.0
Figure 2E
Noise Sensative Area
NSA 4
TranSystems

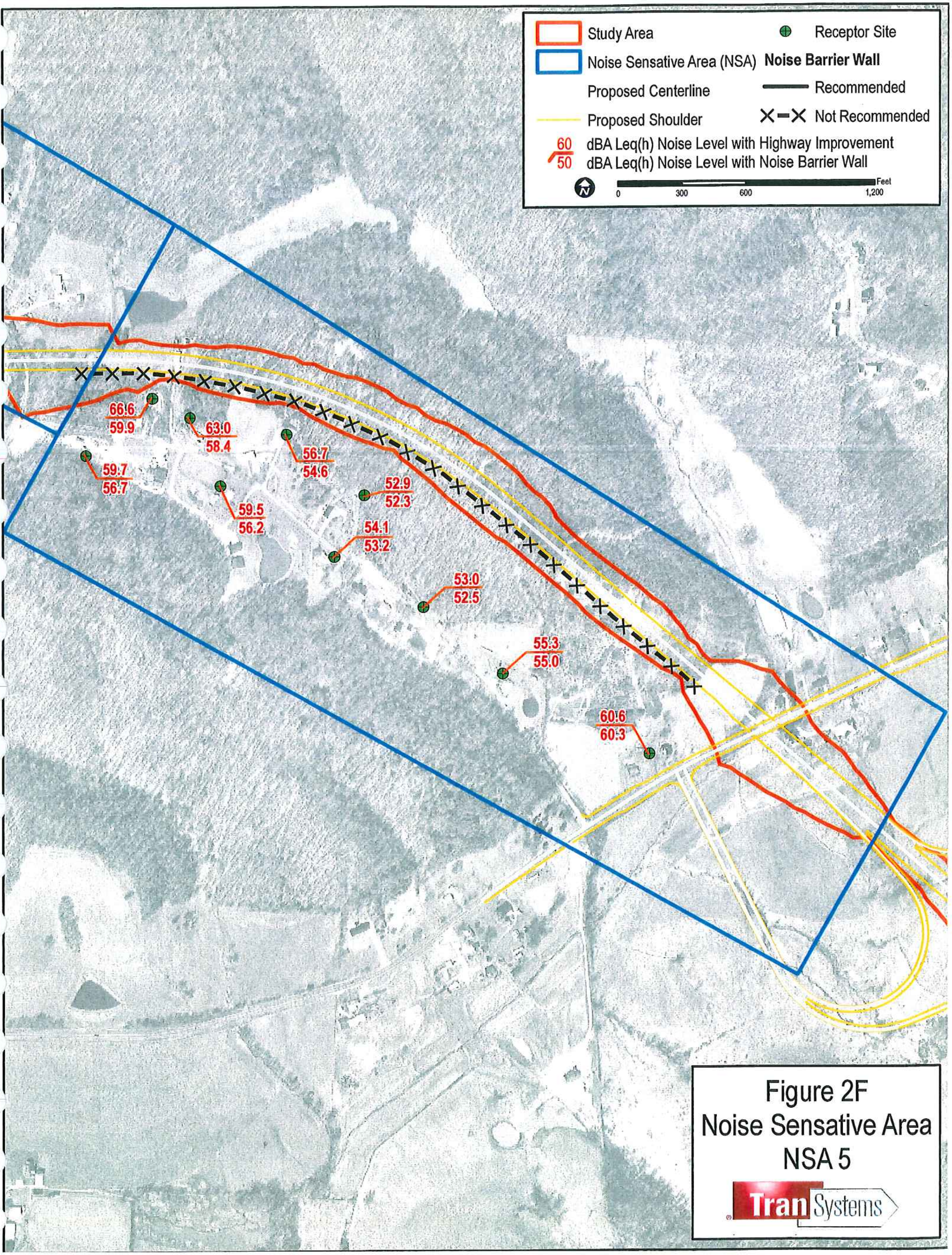
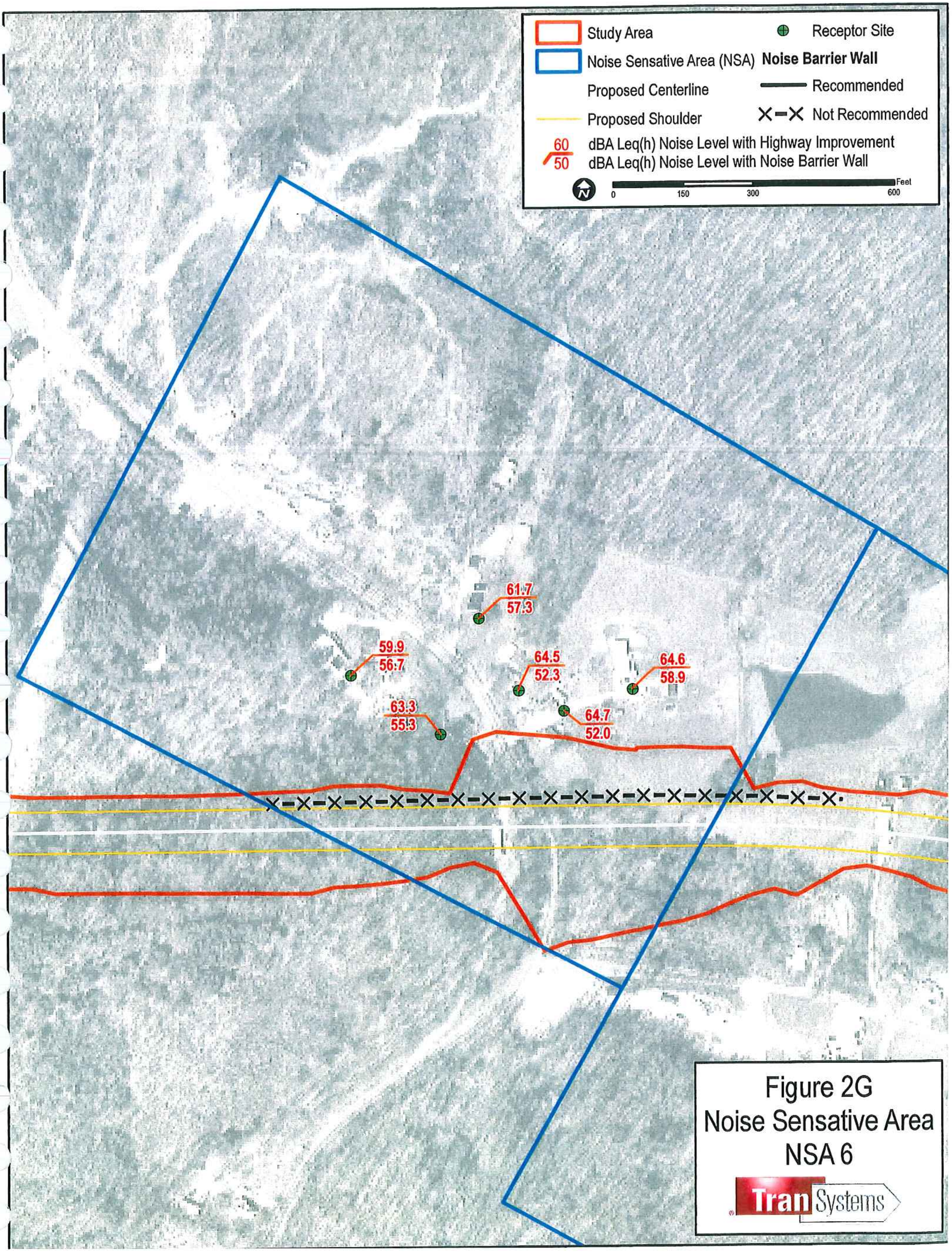



Figure 2F
Noise Sensative Area
NSA 5

TranSystems



Study Area
Receptor Site
Noise Sensative Area (NSA)
Noise Barrier Wall
Proposed Centerline
Recommended
Proposed Shoulder
Not Recommended
60
50
dBA Leq(h) Noise Level with Highway Improvement
dBA Leq(h) Noise Level with Noise Barrier Wall
0
150
300
600
Feet
61.7
57.3
59.9
56.7
64.5
52.3
64.6
58.9
63.3
55.3
64.7
52.0
Figure 2G
Noise Sensative Area
NSA 6
TranSystems

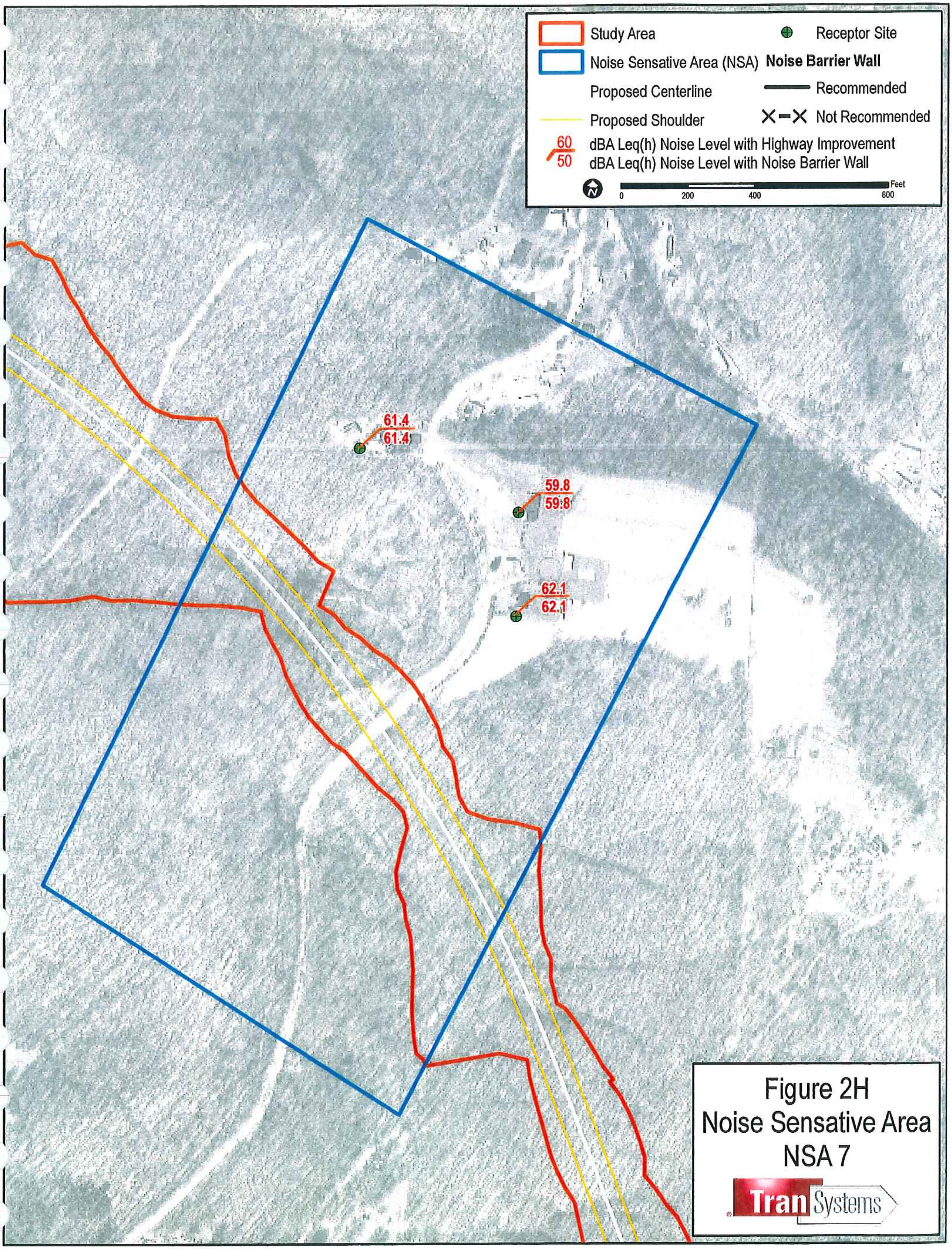



Figure 2H
Noise Sensative Area
NSA 7

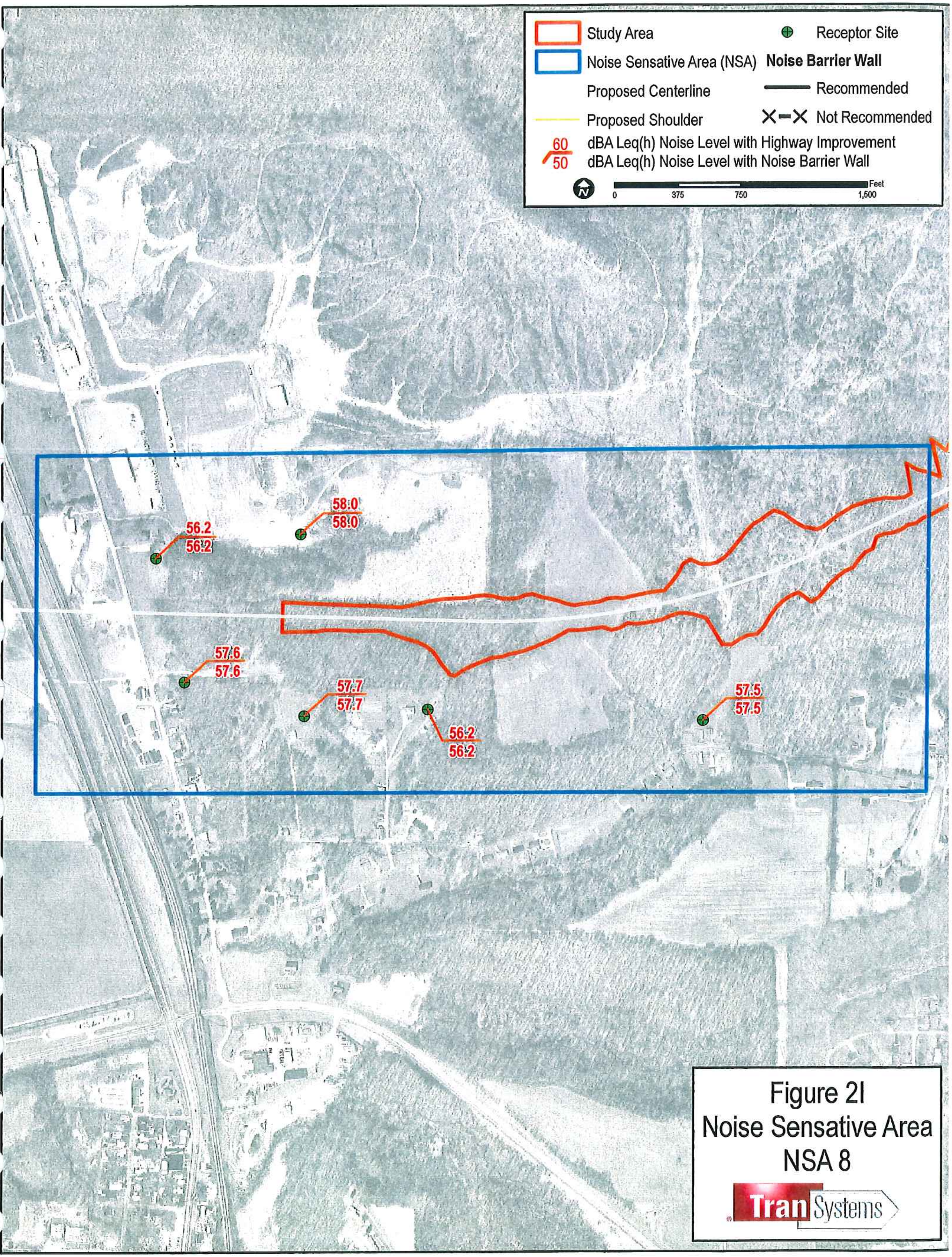



Figure 2I
Noise Sensative Area
NSA 8

# APPENDIX B

Traffic Data and
Field Noise Measurement Results

OHIO DEPARTMENT OF TRANSPORTATION
CENTRAL OFFICE, P.O. BOX 899, COLUMBUS, OHIO 43216-0899

June 2, 2005

Mr. Aaron G. Grilliot, P.E.
TranSystems Corporation of Ohio
5747 Perimeter Drive Suite 240
Dublin OH 43017

RE: SCI-823-0.00 Portsmouth Bypass PID 19415 (Design Designations)

Dear Mr. Grilliot:

In reply to a letter dated May 31, 2005, please use the following design designations for the subject project:

PID 19415
SCI-823-0.00
S.R. 823

| | US52-SR140 Ramps | SR140 Ramps to Shumway Hollow S Ramps | Shumway Hollow S Ramps - U.S. 23 |
|---|---|---|---|
| 2010 ADT | 13400 | 21200 | 19800 |
| 2030 ADT | 21000 | 31200 | 26000 |
| DHV | 2100 | 3120 | 2600 |
| D | .55 | .55 | .55 |
| T24 | .14 | .14 | .14 |

| | US 23 | Lucasville-Minford | SR 335 | Shumway Hollow | SR 140 | US 52 |
|---|---|---|---|---|---|---|
| 2010 ADT | 16200 | 3000 | 4500 | 3800 | 16400 | 28400 |
| 2030 ADT | 23400 | 6000 | 6600 | 7800 | 20600 | 39400 |
| DHV | 2100 | 600 | 660 | 780 | 2060 | 3940 |
| D | .55 | .55 | .55 | .55 | .55 | .55 |
| T24 | .14 | .06 | .14 | .06 | .05 | .10 |

This office does not approve legal or design speed. Except for S.R. 823, the design designations shown are intended for the cover sheet. Specific volumes from the plates should be used with the above design values for pavement design.

If you have any questions, please contact me at (614) 644-8195.

Respectfully,

Robert A. Burgett
Project Analyses Administrator
Office of Technical Services

RAB:rb

c: J. McQuirt, OTS–L. Oesterling, OTS–T. Long, D9–D. Norris, D9–File

**Table B1**

Summary of Background Noise Level Measurement Data

| Location | Date | Leq | Lmin | Lmax | L90 | Source(s) of Noise |
|---|---|---|---|---|---|---|
| 1 | 19-Dec-02 | 58.3 | 43.1 | 67.5 | * | Wind |
| H1 | 01-May-03 | 43.6 | 37 | 67.5 | 38.5 | Birds |
| 3 | 19-Dec-02 | 45.5 | 40.2 | 55.9 | 41.9 | |
| H2 | 01-May-03 | 47.1 | 39.3 | 60.5 | 42.5 | Birds, 2 train horns |
| H3 | 01-May-03 | 44.3 | 38.0 | 65.1 | 39.5 | Dogs, birds |
| N6 | 08-Jan-03 | 42.6 | 35.1 | 62.8 | 37.0 | |
| N7 | 08-Jan-03 | 52.4 | 36.2 | 72.8 | 37.5 | Noisy neighbor, cars, wind |
| N8 | 08-Jan-03 | 59.1 | 32.6 | 73.3 | 34.0 | Dogs, light traffic |
| H5 | 01-May-03 | 54.9 | 36.8 | 78.8 | 41.0 | Lawn mower, birds, car horn, dogs |
| N11 | 09-Jan-03 | 55.7 | 34.5 | 67.6 | 43.5 | Wind, heavy traffic |
| 16 | 01-May-03 | 44.8 | 36.0 | 67.7 | 38.5 | Dogs, wind |
| N12 | 09-Jan-03 | 39.8 | 29.7 | 58.7 | 31.0 | 1 car passes |
| N13 | 09-Jan-03 | 40.7 | 32.1 | 56.4 | 33.5 | |
| H6 | 01-May-03 | 63.8 | 40.1 | 75.5 | 45.0 | Wind, train goes by, birds |
| 44 | 20-Dec-02 | 49.4 | 39.6 | 65.9 | 43.0 | Wind, leaves |
| 41 | 20-Dec-02 | 54.4 | 40.8 | 69.7 | 42.0 | train goes by, wind |
| 42 | 20-Dec-02 | 52.0 | 41.9 | 64.7 | 46.0 | Wind |
| 43 | 20-Dec-02 | 50.4 | 37.1 | 67.1 | 41.0 | Wind |
| H8 | 01-May-03 | 53.7 | 41.7 | 72.7 | 43.0 | Wind, plane, birds, construction |
| H9 | 01-May-03 | 47.2 | 41.2 | 61.2 | 43.0 | Wind, lawn mower |
| 2 | 19-Dec-02 | 58.0 | 48.2 | 77.4 | * | Wind |
| 3 | 19-Dec-02 | 45.5 | 40.2 | 55.9 | 41.9 | |
| 4 | 08-Jan-03 | 51.2 | 37.1 | 61 | 44.0 | Church music, wind |
| 5 | 08-Jan-03 | 50.9 | 41.1 | 62.3 | 43.5 | Wind |
| 6 | 08-Jan-03 | 60.0 | 42.2 | 74.6 | 48.0 | train horn, helicopter |
| 7 | 08-Jan-03 | 59.1 | 44.4 | 70.6 | 49.0 | |
| 7a | 08-Jan-03 | 56.8 | 41.9 | 64 | 51.5 | Wind |
| 8a | 08-Jan-03 | 51.7 | 40.2 | 62.9 | 45.5 | train horn, wind |
| V2 | 01-May-03 | 46.4 | 33.7 | 65.6 | 36.0 | Birds, Heavy trucks braking hard |
| 9 | 08-Jan-03 | 60.5 | 41.6 | 72.6 | 49.5 | Muffler less vehicles, wind |
| 10 | 08-Jan-03 | 62.2 | 44.0 | 74.9 | 48.5 | car started |
| 11 | 19-Dec-02 | 59.9 | 41.5 | 72.5 | * | Traffic, wind |
| 12 | 08-Jan-03 | 53.1 | 38.1 | 72.3 | 43.5 | Wind, train horn, heavy traffic |
| 12A | 09-Jan-03 | 53.1 | 31.5 | 64.8 | 38.0 | Heavy traffic |

**Table B1**

Summary of Background Noise Level Measurement Data

| Location | Date | Leq | Lmin | Lmax | L90 | Source(s) of Noise |
|---|---|---|---|---|---|---|
| 13 | 01-May-03 | 58.2 | 34.7 | 74.2 | 38.0 | Dogs, road construction, mowing |
| V3 | 01-May-03 | 46.4 | 33.5 | 68.7 | 35.5 | Wind, birds, construction |
| V4 | 01-May-03 | 46.6 | 35.0 | 66.7 | 40.0 | Wind, birds, loud truck |
| V5 | 01-May-03 | 43.7 | 32.6 | 63.3 | 37.0 | Wind, birds, lawn mower |
| 18 | 01-May-03 | 49.4 | 38.3 | 60.8 | 42.0 | Wind, birds, electrical lines |
| 20 | 09-Jan-03 | 61.6 | 38.9 | 73.9 | 44.5 | Wind, airplane |
| 21 | 09-Jan-03 | 55.7 | 36.4 | 68.9 | 42.5 | Wind, dogs |
| 22 | 09-Jan-03 | 50.8 | 36.1 | 70.7 | 39.0 | Wind, leaves, truck, school bus |
| 23 | 09-Jan-03 | 48.4 | 32.0 | 62.3 | 36.0 | Airplanes, helicopter, roof work |
| 24 | 09-Jan-03 | 47.6 | 31.0 | 67.6 | 33.5 | Leaves, brush hog, plane taking off |
| 24a | 09-Jan-03 | 58.0 | 40.9 | 81.0 | 43.0 | brush hog, airplane taking off |
| 26 | 09-Jan-03 | 55.8 | 33.2 | 69.8 | 38.5 | Dogs, trucks, train horn, leaves |
| 27 | 09-Jan-03 | 58.2 | 34.8 | 74.1 | 42.0 | Wind, leaves, heavy trucks, car |
| 29 | 20-Dec-02 | 43.1 | 38.9 | 52.3 | 41.0 | |
| 30 | 20-Dec-02 | 56.0 | 40.6 | 69.3 | 44.0 | |
| 31 | 20-Dec-02 | 56.0 | 40.6 | 69.3 | 44.0 | |
| 32 | 20-Dec-02 | 52.4 | 40.2 | 73.2 | 42.0 | Wind |
| 33 | 20-Dec-02 | 55.8 | 40.4 | 71.0 | 45.0 | Single plane, many cars, heavy trucks |
| 34 | 20-Dec-02 | 55.8 | 40.4 | 71.0 | 45.0 | Single plane, many cars, heavy trucks |
| 35 | 20-Dec-02 | 48.1 | 39.1 | 56.5 | 42.0 | |
| 35A | 20-Dec-02 | 42.7 | 42.7 | 59.2 | 45.5 | |
| V6 | 01-May-03 | 43.2 | 37.8 | 52.3 | 39.5 | Water splash, train horn, birds |
| 37 | 20-Dec-02 | 47.7 | 42.2 | 57.6 | 43.5 | Wind |
| 38 | 20-Dec-02 | 44.7 | 42.3 | 53.0 | 43.0 | Water spilling on rocks |
| 39 | 20-Dec-02 | 53.3 | 44.9 | 61.0 | 48.0 | train goes by, wind |
| 45 | 20-Dec-02 | 69.7 | 54.7 | 78.3 | * | Train pass by, traffic |

TNM input files for receiver locations where existing roadways dictate the noise conditions were developed using the existing roadway geometry, and surrounding terrain. Measured traffic noise levels, concurrent traffic counts, and observed vehicle speeds obtained during the noise monitoring effort were used to evaluate the accuracy of the TNM program in estimating traffic noise exposure at such locations. The summary of onsite traffic counts for each 15-minute measurement period at the receiver locations near existing traffic is included in **Table C1.**

**TABLE C1**
Onsite Traffic Counts

| Location | Description | Autos | Medium Trucks | Heavy Trucks |
|---|---|---|---|---|
| 1 | Behind 627 Fairgrounds Road – Walters Residence – Monitoring Route 23 | 146 | 9 | 18 |
| 4 | Behind Page Residence on Indian Drive – Lucasville-Minford Road | 91 | 4 | 5 |
| 6 | In front of 41 JoEtta Road – Gahm Residence – Monitoring Lucasville – Minford Road | 71 | 3 | 5 |
| 7 | In front of 28 Pleasant Drive | 86 | 5 | 2 |
| 9 | Next to 1054 Lucasville-Minford Road – Monitoring Lucasville-Minford Road | 117 | 3 | 1 |
| 11 | Front yard of the Chaney Residence – Monitoring Lucasville-Minford Road | 115 | 2 | 2 |
| 13 | Beside 2658 Lucasville-Minford Road – King Residence – Monitoring Lucasville-Minford Road | 55 | 5 | 2 |
| 45 | At Alley Chiropractic Clinic and 7142 Egbert Rd. | | | |
| | US Route 52 | 250 | 7 | 22 |
| | Ohio River Road | 99 | 4 | 1 |

**Table C2** summarizes the noise levels obtained during the traffic noise measurements and their comparison to levels predicted by the TNM program. From the data in **Table C2**, it is apparent that differences between noise levels predicted by TNM and those measured in the field were generally within the acceptable range of ±3 dB. At locations where there were great discrepancies between the model results and the measured noise levels (Sites 4 and 13), site-specific shielding factors are the main reason for the large differences.

TABLE C2
Comparison of Measured and Predicted Traffic Noise Levels

| Location | Description | Measured $L_{eq}$ (dBA) | Predicted $L_{eq}$ (dBA) | Difference (dBA) |
|---|---|---|---|---|
| 1 | 627 Fairgrounds Road | 58.3 | 58.3 | 0.0 |
| 4 | Behind house at end of Indian Drive | 51.2 | 61.0 | +9.8 |
| 6 | Next to 41 JoEtta Road | 60.0 | 62.4 | +2.4 |
| 7 | 28 Pleasant Drive | 59.1 | 61.3 | +2.2 |
| 9 | Next to 1054 Lucasville-Minford Rd. | 60.5 | 59.7 | -0.8 |
| 11 | Front Yard of the Chaney Residence | 59.9 | 62.3 | +2.4 |
| 13 | Beside 2658 Lucasville-Minford Rd. | 58.2 | 68.7 | +10.5 |
| 45 | At Alley Chiropractic Clinic on Ohio River Rd. | 69.7 | 67.2 | -2.5 |

Note: At locations where the noise model results vary from measurement results by more than 1 dBA, a K factor equal to the difference between predicted and measured noise levels is used for calculation of noise levels throughout the remainder of this analysis.

H2 receptor behind house.

House used for receptor H2.

H3 in front yard of home.

V5 near abandoned home.

V3 receptor in front yard of House.

House used for Receptor V3.

V4 receptor in Front yard of House.

House used for Receptor V4.

Receptor 18 behind barn and open field.

Receptor 18 behind barn.

H5 receptor in front yard.

House used for receptor H5

# APPENDIX C

TNM Validation Data

TNM input files for receiver locations where existing roadways dictate the noise conditions were developed using the existing roadway geometry, and surrounding terrain. Measured traffic noise levels, concurrent traffic counts, and observed vehicle speeds obtained during the noise monitoring effort were used to evaluate the accuracy of the TNM program in estimating traffic noise exposure at such locations. The summary of onsite traffic counts for each 15-minute measurement period at the receiver locations near existing traffic is included in **Table C1.**

**TABLE C1**
Onsite Traffic Counts

| Location | Description | Autos | Medium Trucks | Heavy Trucks |
|---|---|---|---|---|
| 1 | Behind 627 Fairgrounds Road – Walters Residence – Monitoring Route 23 | 146 | 9 | 18 |
| 4 | Behind Page Residence on Indian Drive – Lucasville-Minford Road | 91 | 4 | 5 |
| 6 | In front of 41 JoEtta Road – Gahm Residence – Monitoring Lucasville – Minford Road | 71 | 3 | 5 |
| 7 | In front of 28 Pleasant Drive | 86 | 5 | 2 |
| 9 | Next to 1054 Lucasville-Minford Road – Monitoring Lucasville-Minford Road | 117 | 3 | 1 |
| 11 | Front yard of the Chaney Residence – Monitoring Lucasville-Minford Road | 115 | 2 | 2 |
| 13 | Beside 2658 Lucasville-Minford Road – King Residence – Monitoring Lucasville-Minford Road | 55 | 5 | 2 |
| 45 | At Alley Chiropractic Clinic and 7142 Egbert Rd. | | | |
| | US Route 52 | 250 | 7 | 22 |
| | Ohio River Road | 99 | 4 | 1 |

**Table C2** summarizes the noise levels obtained during the traffic noise measurements and their comparison to levels predicted by the TNM program. From the data in **Table C2,** it is apparent that differences between noise levels predicted by TNM and those measured in the field were generally within the acceptable range of ±3 dB. At locations where there were great discrepancies between the model results and the measured noise levels (Sites 4 and 13), site-specific shielding factors are the main reason for the large differences.

**TABLE C2**
Comparison of Measured and Predicted Traffic Noise Levels

| Location | Description | Measured $L_{eq}$ (dBA) | Predicted $L_{eq}$ (dBA) | Difference (dBA) |
|---|---|---|---|---|
| 1 | 627 Fairgrounds Road | 58.3 | 58.3 | 0.0 |
| 4 | Behind house at end of Indian Drive | 51.2 | 61.0 | +9.8 |
| 6 | Next to 41 JoEtta Road | 60.0 | 62.4 | +2.4 |
| 7 | 28 Pleasant Drive | 59.1 | 61.3 | +2.2 |
| 9 | Next to 1054 Lucasville-Minford Rd. | 60.5 | 59.7 | -0.8 |
| 11 | Front Yard of the Chaney Residence | 59.9 | 62.3 | +2.4 |
| 13 | Beside 2658 Lucasville-Minford Rd. | 58.2 | 68.7 | +10.5 |
| 45 | At Alley Chiropractic Clinic on Ohio River Rd. | 69.7 | 67.2 | -2.5 |

Note: At locations where the noise model results vary from measurement results by more than 1 dBA, a K factor equal to the difference between predicted and measured noise levels is used for calculation of noise levels throughout the remainder of this analysis.

# APPENDIX D

TNM Data – Sound Level Spreadsheets

TranSystems
CM Cox

2 June 2006
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 1 South End Final Run
BARRIER DESIGN: NSA 1 Final Run

ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

| Receiver | | | | No Barrier | | | | | With Barrier | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | No. | #DUs | Existing LAeq1h | LAeq1h | | Increase over existing | | Type Impact | Calculated LAeq1h | Noise Reduction | | |
| | | | | Calculated | Crit'n | Calculated | Crit'n Sub'l Inc | | | Calculated | Goal | Calculated minus Goal |
| | | | dBA | dBA | dBA | dB | dB | | dBA | dB | dB | dB |
| 72 | 82 | 1 | 53.0 | 68.1 | 66 | 15.1 | 10 | Both | 63.4 | 4.7 | 8 | -3.3 |
| 73 | 83 | 1 | 53.0 | 63.8 | 66 | 10.8 | 10 | Sub'l Inc | 57.9 | 5.9 | 8 | -2.1 |
| 74 | 84 | 1 | 53.0 | 56.5 | 66 | 3.5 | 10 | ---- | 51.6 | 4.9 | 8 | -3.1 |
| 75 | 85 | 1 | 53.0 | 57.9 | 66 | 4.9 | 10 | ---- | 53.8 | 4.1 | 8 | -3.9 |
| 76 | 86 | 1 | 53.0 | 58.6 | 66 | 5.6 | 10 | ---- | 49.7 | 8.9 | 8 | 0.9 |
| 77 | 87 | 3 | 53.0 | 51.7 | 66 | -1.3 | 10 | ---- | 48.5 | 3.2 | 8 | -4.8 |
| 78 | 88 | 5 | 53.0 | 53.1 | 66 | 0.1 | 10 | ---- | 50.1 | 3.0 | 8 | -5.0 |
| 79 | 90 | 3 | 53.0 | 57.4 | 66 | 4.4 | 10 | ---- | 54.8 | 2.6 | 8 | -5.4 |
| 80 | 91 | 1 | 53.0 | 51.6 | 66 | -1.4 | 10 | ---- | 48.6 | 3.0 | 8 | -5.0 |
| 81 | 92 | 1 | 53.0 | 64.1 | 66 | 11.1 | 10 | Sub'l Inc | 54.4 | 9.7 | 8 | 1.7 |
| 82 | 89 | 3 | 53.0 | 61.8 | 66 | 8.8 | 10 | ---- | 57.1 | 4.7 | 8 | -3.3 |

| Dwelling Units | # DUs | Noise Reduction | | |
|---|---|---|---|---|
| | | Min | Avg | Max |
| | | dB | dB | dB |
| All Selected | 21 | 2.6 | 5.0 | 9.7 |
| All Impacted | 3 | 4.7 | 6.8 | 9.7 |
| All that meet NR Goal | 2 | 8.9 | 9.3 | 9.7 |

TranSystems
CM Cox

2 June 2006
TNM 2.5

RESULTS: BARRIER DESCRIPTIONS
PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 1 South End Final Run
BARRIER DESIGN: NSA 1 Final Run

| Barriers | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Type | Heights along Barrier | | | Length | If Wall | If Berm | | | Cost |
| | | Min | Avg | Max | | Area | Volume | Top Width | Run:Rise | |
| | | ft | ft | ft | ft | sq ft | cu yd | ft | ft:ft | $ |
| H10-1 | W | 13.00 | 16.03 | 17.00 | 3387 | 54293 | | | | 950122 |
| | | | | | | | | | Total Cost: | 950122 |

RESULTS: SOUND LEVELS

SCI-823 Portsmouth Bypass

TranSystems
CM Cox

2 June 2006
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS

PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 2 West Barrier Final Run
BARRIER DESIGN: NSA 2 West Side Final Run

ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

| Receiver | | | | No Barrier | | | | | | With Barrier | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | No. | #DUs | Existing LAeq1h | LAeq1h | | Increase over existing | | Type Impact | | Calculated LAeq1h | Noise Reduction | | |
| | | | | Calculated | Crit'n | Calculated | Crit'n Sub'l Inc | | | | Calculated | Goal | Calculated minus Goal |
| | | | dBA | dBA | dBA | dB | dB | | | dBA | dB | dB | dB |
| 1 | 1 | 1 | 54.0 | 63.5 | 66 | 9.5 | 10 | ---- | | 63.3 | 0.2 | 8 | -7.8 |
| 2 | 2 | 1 | 54.0 | 51.3 | 66 | -2.7 | 10 | ---- | | 50.2 | 1.1 | 8 | -6.9 |
| 3 | 3 | 1 | 54.0 | 56.8 | 66 | 2.8 | 10 | ---- | | 52.5 | 4.3 | 8 | -3.7 |
| 4 | 4 | 1 | 54.0 | 57.3 | 66 | 3.3 | 10 | ---- | | 53.1 | 4.2 | 8 | -3.8 |
| 5 | 5 | 1 | 54.0 | 57.5 | 66 | 3.5 | 10 | ---- | | 54.5 | 3.0 | 8 | -5.0 |
| 6 | 6 | 1 | 54.0 | 57.7 | 66 | 3.7 | 10 | ---- | | 54.6 | 3.1 | 8 | -4.9 |
| 7 | 7 | 1 | 54.0 | 57.3 | 66 | 3.3 | 10 | ---- | | 54.3 | 3.0 | 8 | -5.0 |
| 8 | 8 | 1 | 54.0 | 57.4 | 66 | 3.4 | 10 | ---- | | 52.4 | 5.0 | 8 | -3.0 |
| 9 | 9 | 1 | 54.0 | 58.3 | 66 | 4.3 | 10 | ---- | | 54.0 | 4.3 | 8 | -3.7 |
| 10 | 10 | 2 | 54.0 | 58.0 | 66 | 4.0 | 10 | ---- | | 54.6 | 3.4 | 8 | -4.6 |
| 11 | 11 | 2 | 54.0 | 57.7 | 66 | 3.7 | 10 | ---- | | 54.3 | 3.4 | 8 | -4.6 |

| Dwelling Units | # DUs | Noise Reduction | | |
|---|---|---|---|---|
| | | Min | Avg | Max |
| | | dB | dB | dB |
| All Selected | 13 | 0.2 | 3.2 | 5.0 |
| All Impacted | 0 | 0.0 | 0.0 | 0.0 |
| All that meet NR Goal | 0 | 0.0 | 0.0 | 0.0 |

TranSystems
CM Cox

2 June 2006
TNM 2.5

RESULTS: BARRIER DESCRIPTIONS

PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 2 West Barrier Final Run
BARRIER DESIGN: NSA 2 West Side Final Run

| Barriers | Type | Heights along Barrier | | | Length | If Wall | If Berm | | | Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | | Min | Avg | Max | | Area | Volume | Top Width | Run:Rise | |
| | | ft | ft | ft | ft | sq ft | cu yd | ft | ft:ft | $ |
| | | | | | | | | | | 332066 |
| NSA 2 West | W | 10.00 | 15.05 | 17.00 | 1261 | 18975 | | | Total Cost: | 332066 |

TranSystems
CM Cox

6 June 2006
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 2 West Barrier Final Run
BARRIER DESIGN: NSA 2 East Side Final Run

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

ATMOSPHERICS: 68 deg F, 50% RH

| Receiver | | | | No Barrier | | | | | | With Barrier | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | No. | #DUs | Existing LAeq1h | LAeq1h | | Increase over existing | | Type | | Calculated LAeq1h | Noise Reduction | | |
| | | | | Calculated | Crit'n | Calculated | Crit'n Sub'l Inc | Impact | | | Calculated | Goal | Calculated minus Goal |
| | | | dBA | dBA | dBA | dB | dB | | | dBA | dB | dB | dB |
| 12 | 12 | 1 | 50.0 | 65.0 | 66 | 15.0 | 10 | Sub'l Inc | | 56.0 | 9.0 | 8 | 1.0 |
| 13 | 13 | 1 | 50.0 | 62.4 | 66 | 12.4 | 10 | Sub'l Inc | | 56.3 | 6.1 | 8 | -1.9 |
| 14 | 14 | 1 | 50.0 | 61.8 | 66 | 11.8 | 10 | Sub'l Inc | | 55.8 | 6.0 | 8 | -2.0 |
| 15 | 15 | 1 | 50.0 | 61.3 | 66 | 11.3 | 10 | Sub'l Inc | | 55.1 | 6.2 | 8 | -1.8 |
| 16 | 16 | 1 | 50.0 | 64.3 | 66 | 14.3 | 10 | Sub'l Inc | | 56.4 | 7.9 | 8 | -0.1 |
| 17 | 17 | 1 | 50.0 | 63.3 | 66 | 13.3 | 10 | Sub'l Inc | | 55.6 | 7.7 | 8 | -0.3 |
| 18 | 18 | 1 | 50.0 | 61.7 | 66 | 11.7 | 10 | Sub'l Inc | | 54.9 | 6.8 | 8 | -1.2 |
| 19 | 19 | 1 | 50.0 | 60.3 | 66 | 10.3 | 10 | Sub'l Inc | | 54.0 | 6.3 | 8 | -1.7 |
| 20 | 20 | 1 | 54.0 | 61.0 | 66 | 7.0 | 10 | ---- | | 54.8 | 6.2 | 8 | -1.8 |
| 21 | 21 | 1 | 50.0 | 61.5 | 66 | 11.5 | 10 | Sub'l Inc | | 55.3 | 6.2 | 8 | -1.8 |
| 22 | 22 | 1 | 54.0 | 61.2 | 66 | 7.2 | 10 | ---- | | 55.3 | 5.9 | 8 | -2.1 |
| 23 | 23 | 1 | 50.0 | 61.2 | 66 | 11.2 | 10 | Sub'l Inc | | 54.9 | 6.3 | 8 | -1.7 |
| 25 | 25 | 1 | 54.0 | 60.5 | 66 | 6.5 | 10 | ---- | | 54.6 | 5.9 | 8 | -2.1 |
| 26 | 26 | 1 | 54.0 | 59.0 | 66 | 5.0 | 10 | ---- | | 53.8 | 5.2 | 8 | -2.8 |
| 27 | 28 | 1 | 54.0 | 58.4 | 66 | 4.4 | 10 | ---- | | 53.2 | 5.2 | 8 | -2.8 |
| 28 | 29 | 1 | 54.0 | 56.8 | 66 | 2.8 | 10 | ---- | | 52.6 | 4.2 | 8 | -3.8 |
| 29 | 30 | 1 | 54.0 | 58.0 | 66 | 4.0 | 10 | ---- | | 53.6 | 4.4 | 8 | -3.6 |
| 30 | 31 | 1 | 54.0 | 58.4 | 66 | 4.4 | 10 | ---- | | 53.8 | 4.6 | 8 | -3.4 |
| 31 | 32 | 1 | 54.0 | 57.7 | 66 | 3.7 | 10 | ---- | | 53.1 | 4.6 | 8 | -3.4 |
| 32 | 33 | 1 | 54.0 | 58.3 | 66 | 4.3 | 10 | ---- | | 53.4 | 4.9 | 8 | -3.1 |
| 33 | 34 | 1 | 54.0 | 58.4 | 66 | 4.4 | 10 | ---- | | 53.4 | 5.0 | 8 | -3.0 |
| 34 | 35 | 1 | 54.0 | 58.8 | 66 | 4.8 | 10 | ---- | | 53.6 | 5.2 | 8 | -2.8 |
| 35 | 37 | 2 | 54.0 | 56.2 | 66 | 2.2 | 10 | ---- | | 52.4 | 3.8 | 8 | -4.2 |

RESULTS: SOUND LEVELS

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 38 | 2 | 54.0 | 54.2 | 66 | 0.2 | 10 | ---- | 50.6 | 3.6 | 8 | -4.4 |
| 37 | 39 | 1 | 50.0 | 52.9 | 66 | 2.9 | 10 | ---- | 49.9 | 3.0 | 8 | -5.0 |
| 38 | 40 | 2 | 54.0 | 54.9 | 66 | 0.9 | 10 | ---- | 51.7 | 3.2 | 8 | -4.8 |
| 39 | 41 | 2 | 54.0 | 54.2 | 66 | 0.2 | 10 | ---- | 51.3 | 2.9 | 8 | -5.1 |
| 40 | 42 | 1 | 54.0 | 53.5 | 66 | -0.5 | 10 | ---- | 50.9 | 2.6 | 8 | -5.4 |
| 41 | 44 | 1 | 50.0 | 59.7 | 66 | 9.7 | 10 | ---- | 53.6 | 6.1 | 8 | -1.9 |
| 42 | 45 | 1 | 50.0 | 58.3 | 66 | 8.3 | 10 | ---- | 52.9 | 5.4 | 8 | -2.6 |
| 43 | 46 | 1 | 50.0 | 57.7 | 66 | 7.7 | 10 | ---- | 52.6 | 5.1 | 8 | -2.9 |
| 44 | 47 | 1 | 50.0 | 57.6 | 66 | 7.6 | 10 | ---- | 52.6 | 5.0 | 8 | -3.0 |
| 45 | 48 | 1 | 50.0 | 57.1 | 66 | 7.1 | 10 | ---- | 52.5 | 4.6 | 8 | -3.4 |
| 46 | 49 | 1 | 50.0 | 57.0 | 66 | 7.0 | 10 | ---- | 52.5 | 4.5 | 8 | -3.5 |
| 47 | 50 | 1 | 50.0 | 56.5 | 66 | 6.5 | 10 | ---- | 52.4 | 4.1 | 8 | -3.9 |
| 48 | 52 | 2 | 50.0 | 59.6 | 66 | 9.6 | 10 | ---- | 54.4 | 5.2 | 8 | -2.8 |
| 49 | 53 | 1 | 50.0 | 59.9 | 66 | 9.9 | 10 | ---- | 54.2 | 5.7 | 8 | -2.3 |
| 50 | 54 | 1 | 50.0 | 59.1 | 66 | 9.1 | 10 | ---- | 53.8 | 5.3 | 8 | -2.7 |
| 51 | 55 | 1 | 54.0 | 58.6 | 66 | 4.6 | 10 | ---- | 53.4 | 5.2 | 8 | -2.8 |
| 52 | 56 | 1 | 54.0 | 58.0 | 66 | 4.0 | 10 | ---- | 53.1 | 4.9 | 8 | -3.1 |
| 53 | 57 | 1 | 54.0 | 58.0 | 66 | 4.0 | 10 | ---- | 52.8 | 5.2 | 8 | -2.8 |
| 54 | 58 | 1 | 54.0 | 57.1 | 66 | 3.1 | 10 | ---- | 52.5 | 4.6 | 8 | -3.4 |
| 55 | 59 | 1 | 54.0 | 56.2 | 66 | 2.2 | 10 | ---- | 52.3 | 3.9 | 8 | -4.1 |
| 56 | 60 | 1 | 54.0 | 55.8 | 66 | 1.8 | 10 | ---- | 52.1 | 3.7 | 8 | -4.3 |
| 57 | 61 | 1 | 54.0 | 55.1 | 66 | 1.1 | 10 | ---- | 51.7 | 3.4 | 8 | -4.6 |
| 58 | 63 | 1 | 54.0 | 58.4 | 66 | 4.4 | 10 | ---- | 53.5 | 4.9 | 8 | -3.1 |
| 59 | 64 | 1 | 52.0 | 58.0 | 66 | 6.0 | 10 | ---- | 53.6 | 4.4 | 8 | -3.6 |
| 60 | 66 | 1 | 54.0 | 53.0 | 66 | -1.0 | 10 | ---- | 52.1 | 0.9 | 8 | -7.1 |
| 61 | 67 | 1 | 54.0 | 54.6 | 66 | 0.6 | 10 | ---- | 52.2 | 2.4 | 8 | -5.6 |
| 62 | 68 | 1 | 54.0 | 55.6 | 66 | 1.6 | 10 | ---- | 52.6 | 3.0 | 8 | -5.0 |
| 63 | 70 | 1 | 54.0 | 57.0 | 66 | 3.0 | 10 | ---- | 52.8 | 4.2 | 8 | -3.8 |
| 64 | 71 | 1 | 54.0 | 56.4 | 66 | 2.4 | 10 | ---- | 52.9 | 3.5 | 8 | -4.5 |
| 65 | 72 | 1 | 52.0 | 55.7 | 66 | 3.7 | 10 | ---- | 52.6 | 3.1 | 8 | -4.9 |
| 66 | 74 | 5 | 52.0 | 57.0 | 66 | 5.0 | 10 | ---- | 52.8 | 4.2 | 8 | -3.8 |
| 67 | 75 | 5 | 52.0 | 55.6 | 66 | 3.6 | 10 | ---- | 52.0 | 3.6 | 8 | -4.4 |
| 68 | 77 | 1 | 52.0 | 56.5 | 66 | 4.5 | 10 | ---- | 52.8 | 3.7 | 8 | -4.3 |
| 69 | 78 | 1 | 52.0 | 55.8 | 66 | 3.8 | 10 | ---- | 52.6 | 3.2 | 8 | -4.8 |
| 70 | 79 | 1 | 52.0 | 55.3 | 66 | 3.3 | 10 | ---- | 52.3 | 3.0 | 8 | -5.0 |
| 71 | 80 | 1 | 52.0 | 54.6 | 66 | 2.6 | 10 | ---- | 51.7 | 2.9 | 8 | -5.1 |

| Dwelling Units | # DUs | Noise Reduction | | |
|---|---|---|---|---|
| | | Min | Avg | Max |
| | | dB | dB | dB |
| All Selected | 72 | 0.9 | 4.7 | 9.0 |

**RESULTS: SOUND LEVELS**

| | | | | |
|---|---|---|---|---|
| All Impacted | 10 | 6.0 | 6.8 | 9.0 |
| All that meet NR Goal | 1 | 9.0 | 9.0 | 9.0 |

TranSystems
CM Cox

6 June 2006
TNM 2.5

RESULTS: BARRIER DESCRIPTIONS
PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 2 West Barrier Final Run
BARRIER DESIGN: NSA 2 East Side Final Run

| Barriers | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Type | Heights along Barrier | | | Length | If Wall | If Berm | | | Cost |
| | | Min | Avg | Max | | Area | Volume | Top Width | Run:Rise | |
| | | ft | ft | ft | ft | sq ft | cu yd | ft | ft:ft | $ |
| NSA 2 East | W | 10.00 | 12.33 | 14.00 | 2681 | 33059 | | | | 578532 |
| | | | | | | | | | Total Cost: | 578532 |

RESULTS: SOUND LEVELS

SCI-823 Portsmouth Bypass

TranSystems
CM Cox

6 June 2006
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS

PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 3
BARRIER DESIGN: NSA 3 Final Run

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

ATMOSPHERICS: 68 deg F, 50% RH

| Receiver | | | | | | | | | With Barrier | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | No. | #DUs | Existing LAeq1h | No Barrier LAeq1h Calculated | Crit'n | Increase over existing Calculated | Crit'n Sub'l Inc | Type Impact | Calculated LAeq1h | Noise Reduction Calculated | Goal | Calculated minus Goal |
| | | | dBA | dBA | dBA | dB | dB | | dBA | dB | dB | dB |
| 12 | 12 | 1 | 51.0 | 64.8 | 66 | 13.8 | 10 | Sub'l Inc | 62.2 | 2.6 | 8 | -5.4 |
| 13 | 13 | 1 | 51.0 | 62.3 | 66 | 11.3 | 10 | Sub'l Inc | 61.5 | 0.8 | 8 | -7.2 |

| Dwelling Units | # DUs | Noise Reduction Min | Avg | Max |
|---|---|---|---|---|
| | | dB | dB | dB |
| All Selected | 2 | 0.8 | 1.7 | 2.6 |
| All Impacted | 2 | 0.8 | 1.7 | 2.6 |
| All that meet NR Goal | 0 | 0.0 | 0.0 | 0.0 |

TranSystems
CM Cox

6 June 2006
TNM 2.5

RESULTS: BARRIER DESCRIPTIONS

PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 3
BARRIER DESIGN: NSA 3 Final Run

| Barriers | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Type | Heights along Barrier | | | Length | If Wall | If Berm | | | Cost |
| | | Min | Avg | Max | | Area | Volume | Top Width | Run:Rise | |
| | | ft | ft | ft | ft | sq ft | cu yd | ft | ft:ft | $ |
| barrier 1 | W | 20.00 | 20.00 | 20.00 | 657 | 13143 | | | | 229996 |
| | | | | | | | | | Total Cost: | 229996 |

## RESULTS: SOUND LEVELS



TranSystems
CM Cox

6 June 2006
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 4
BARRIER DESIGN: NSA 4 Final Run

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

ATMOSPHERICS: 68 deg F, 50% RH

| Receiver Name | No. | #DUs | Existing LAeq1h | No Barrier LAeq1h Calculated | No Barrier LAeq1h Crit'n | Increase over existing Calculated | Increase over existing Crit'n Sub'l Inc | Type Impact | With Barrier Calculated LAeq1h | Noise Reduction Calculated | Noise Reduction Goal | Calculated minus Goal |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | dBA | dBA | dBA | dB | dB | | dBA | dB | dB | dB |
| 1 | 1 | 1 | 39.8 | 61.7 | 66 | 21.9 | 10 | Sub'l Inc | 56.6 | 5.1 | 8 | -2.9 |
| 3 | 3 | 2 | 39.8 | 63.7 | 66 | 23.9 | 10 | Sub'l Inc | 56.8 | 6.9 | 8 | -1.1 |
| 4 | 4 | 2 | 55.7 | 65.1 | 66 | 9.4 | 10 | ---- | 57.1 | 8.0 | 8 | 0.0 |
| 5 | 5 | 1 | 55.7 | 63.6 | 66 | 7.9 | 10 | ---- | 56.7 | 6.9 | 8 | -1.1 |
| 6 | 6 | 1 | 55.7 | 63.3 | 66 | 7.6 | 10 | ---- | 57.4 | 5.9 | 8 | -2.1 |
| 9 | 9 | 1 | 61.6 | 62.9 | 66 | 1.3 | 10 | ---- | 62.9 | 0.0 | 8 | -8.0 |
| 2 | 2 | 3 | 39.8 | 61.9 | 66 | 22.1 | 10 | Sub'l Inc | 55.8 | 6.1 | 8 | -1.9 |
| 8 | 8 | 2 | 55.7 | 60.7 | 66 | 5.0 | 10 | ---- | 57.2 | 3.5 | 8 | -4.5 |
| 7 | 7 | 2 | 55.7 | 61.8 | 66 | 6.1 | 10 | ---- | 57.0 | 4.8 | 8 | -3.2 |
| 14 | 15 | 1 | 39.8 | 59.4 | 66 | 19.6 | 10 | Sub'l Inc | 55.4 | 4.0 | 8 | -4.0 |
| 15 | 16 | 1 | 39.8 | 62.3 | 66 | 22.5 | 10 | Sub'l Inc | 56.8 | 5.5 | 8 | -2.5 |
| 16 | 17 | 1 | 39.8 | 62.3 | 66 | 22.5 | 10 | Sub'l Inc | 58.8 | 3.5 | 8 | -4.5 |
| 17 | 18 | 2 | 39.8 | 60.0 | 66 | 20.2 | 10 | Sub'l Inc | 55.7 | 4.3 | 8 | -3.7 |
| 18 | 19 | 3 | 39.8 | 60.3 | 66 | 20.5 | 10 | Sub'l Inc | 55.7 | 4.6 | 8 | -3.4 |
| 19 | 20 | 2 | 39.8 | 61.4 | 66 | 21.6 | 10 | Sub'l Inc | 56.0 | 5.4 | 8 | -2.6 |
| 20 | 21 | 2 | 55.7 | 60.0 | 66 | 4.3 | 10 | ---- | 57.0 | 3.0 | 8 | -5.0 |

| Dwelling Units | # DUs | Noise Reduction Min | Noise Reduction Avg | Noise Reduction Max |
|---|---|---|---|---|
| | | dB | dB | dB |
| All Selected | 27 | 0.0 | 4.8 | 8.0 |
| All Impacted | 16 | 3.5 | 5.0 | 6.9 |
| All that meet NR Goal | 2 | 8.0 | 8.0 | 8.0 |

RESULTS: BARRIER DESCRIPTIONS

SCI-823 Portsmouth Bypass

TranSystems
CM Cox

6 June 2006
TNM 2.5

RESULTS: BARRIER DESCRIPTIONS

| | |
|---|---|
| PROJECT/CONTRACT: | SCI-823 Portsmouth Bypass |
| RUN: | NSA 4 |
| BARRIER DESIGN: | NSA 4 Final Run |

| Barriers | | | | | | If Wall | If Berm | | | Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Type | Heights along Barrier | | | Length | Area | Volume | Top Width | Run:Rise | |
| | | Min | Avg | Max | | | | | | |
| | | ft | ft | ft | ft | sq ft | cu yd | ft | ft:ft | $ |
| H4-1 | W | 9.00 | 11.84 | 14.00 | 3073 | 36374 | | | | 636553 |
| | | | | | | | | | Total Cost: | 636553 |

TranSystems
CM Cox

6 June 2006
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 5
BARRIER DESIGN: NSA 5 Final Run

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

ATMOSPHERICS: 68 deg F, 50% RH

| Receiver | | | | No Barrier | | | | | | With Barrier | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | No. | #DUs | Existing LAeq1h | LAeq1h | | Increase over existing | | Type Impact | | Calculated LAeq1h | Noise Reduction | | |
| | | | | Calculated | Crit'n | Calculated | Crit'n Sub'l Inc | | | | Calculated | Goal | Calculated minus Goal |
| | | | dBA | dBA | dBA | dB | dB | | | dBA | dB | dB | dB |
| 9 | 9 | 1 | 52.6 | 66.6 | 66 | 14.0 | 10 | Both | | 59.9 | 6.7 | 8 | -1.3 |
| 10 | 10 | 1 | 52.6 | 63.0 | 66 | 10.4 | 10 | Sub'l Inc | | 58.4 | 4.6 | 8 | -3.4 |
| 11 | 11 | 1 | 52.6 | 56.7 | 66 | 4.1 | 10 | ---- | | 54.6 | 2.1 | 8 | -5.9 |
| 12 | 12 | 1 | 52.6 | 52.9 | 66 | 0.3 | 10 | ---- | | 52.3 | 0.6 | 8 | -7.4 |
| 13 | 13 | 2 | 54.9 | 55.3 | 66 | 0.4 | 10 | ---- | | 55.0 | 0.3 | 8 | -7.7 |
| 14 | 14 | 1 | 54.9 | 60.6 | 66 | 5.7 | 10 | ---- | | 60.3 | 0.3 | 8 | -7.7 |
| 15 | 15 | 1 | 54.9 | 59.7 | 66 | 4.8 | 10 | ---- | | 56.7 | 3.0 | 8 | -5.0 |
| 16 | 16 | 2 | 54.9 | 59.5 | 66 | 4.6 | 10 | ---- | | 56.2 | 3.3 | 8 | -4.7 |
| 17 | 17 | 1 | 52.6 | 54.1 | 66 | 1.5 | 10 | ---- | | 53.2 | 0.9 | 8 | -7.1 |
| 33 | 35 | 1 | 52.6 | 53.0 | 66 | 0.4 | 10 | ---- | | 52.5 | 0.5 | 8 | -7.5 |

| Dwelling Units | # DUs | Noise Reduction | | |
|---|---|---|---|---|
| | | Min | Avg | Max |
| | | dB | dB | dB |
| All Selected | 12 | 0.3 | 2.2 | 6.7 |
| All Impacted | 2 | 4.6 | 5.6 | 6.7 |
| All that meet NR Goal | 0 | 0.0 | 0.0 | 0.0 |

TranSystems
CM Cox

6 June 2006
TNM 2.5

RESULTS: BARRIER DESCRIPTIONS
PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 5
BARRIER DESIGN: NSA 5 Final Run

Barriers

| Name | Type | Heights along Barrier | | | Length | If Wall | If Berm | | | Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Avg | Max | | Area | Volume | Top Width | Run:Rise | |
| | | ft | ft | ft | ft | sq ft | cu yd | ft | ft:ft | $ |
| H3-2 | W | 10.00 | 13.34 | 17.00 | 1709 | 22802 | | | | 399038 |
| | | | | | | | | | Total Cost: | 399038 |

TranSystems
CM Cox

6 June 2006
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 6
BARRIER DESIGN: NSA 6 Final Run

ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

| Receiver Name | No. | #DUs | Existing LAeq1h | No Barrier LAeq1h Calculated | No Barrier LAeq1h Crit'n | Increase over existing Calculated | Increase over existing Crit'n Sub'l Inc | Type Impact | With Barrier Calculated LAeq1h | Noise Reduction Calculated | Noise Reduction Goal | Calculated minus Goal |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | dBA | dBA | dBA | dB | dB | | dBA | dB | dB | dB |
| 19 | 19 | 1 | 54.9 | 63.3 | 66 | 8.4 | 10 | ---- | 55.3 | 8.0 | 8 | 0.0 |
| 21 | 21 | 1 | 54.9 | 64.6 | 66 | 9.7 | 10 | ---- | 58.9 | 5.7 | 8 | -2.3 |
| 22 | 22 | 1 | 54.9 | 64.5 | 66 | 9.6 | 10 | ---- | 57.3 | 7.2 | 8 | -0.8 |
| 23 | 23 | 2 | 54.9 | 59.9 | 66 | 5.0 | 10 | ---- | 56.7 | 3.2 | 8 | -4.8 |
| 24 | 24 | 1 | 54.9 | 61.7 | 66 | 6.8 | 10 | ---- | 57.3 | 4.4 | 8 | -3.6 |
| 32 | 33 | 1 | 52.6 | 64.7 | 66 | 12.1 | 10 | Sub'l Inc | 57.0 | 7.7 | 8 | -0.3 |

| Dwelling Units | # DUs | Noise Reduction Min | Noise Reduction Avg | Noise Reduction Max |
|---|---|---|---|---|
| | | dB | dB | dB |
| All Selected | 7 | 3.2 | 6.0 | 8.0 |
| All Impacted | 1 | 7.7 | 7.7 | 7.7 |
| All that meet NR Goal | 1 | 8.0 | 8.0 | 8.0 |

TranSystems
CM Cox

6 June 2006
TNM 2.5

RESULTS: BARRIER DESCRIPTIONS
PROJECT/CONTRACT: SCI-823 Portsmouth Bypass
RUN: NSA 6
BARRIER DESIGN: NSA 6 Final Run

| Barriers | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Type | Heights along Barrier | | | Length | If Wall | If Berm | | | | Cost |
| | | Min | Avg | Max | | Area | Volume | Top Width | Run:Rise | | |
| | | ft | ft | ft | ft | sq ft | cu yd | ft | ft:ft | | $ |
| H3-1 | W | 10.00 | 11.10 | 12.00 | 1108 | 12300 | | | | | 215258 |
| | | | | | | | | | | Total Cost: | 215258 |