# P | Noise Discipline Report

This page intentionally left blank.

SR 502 CORRIDOR WIDENING

IMPROVING SAFETY • INCREASING CAPACITY • REDUCING CONGESTION

I-5 TO BATTLE GROUND

# FINAL
# Noise Discipline Report

*Prepared for:*

**Washington State Department of Transportation**
Southwest Region
11018 NE 51st Circle
Vancouver, WA 98682-6686

*Prepared by:*


**Parsons Brinckerhoff**
400 SW Sixth Avenue, Suite 802
Portland, OR 97204



**June 2008**

**Revised February 2009**


*This project is also referred to as “SR 502/I-5 to Battle Ground – Add Lanes”.*

This page left blank intentionally.

# Errata Sheet

## Noise Discipline Report

| | |
|---|---|
| November 2009 | Throughout: The “Mill Creek North potential mitigation site” was selected as a mitigation site and purchased by Washington State Department of Transportation (WSDOT) in 2009, therefore the name of this site is now the “Mill Creek North mitigation site.” |

This page intentionally left blank.

# Executive Summary

The purpose of this Executive Summary is to summarize the findings of the Final Noise Discipline Report for the SR 502 Corridor Widening Project.

Sensitive sites are those sites represented by activity categories A, B and E in the FHWA Noise Abatement Criteria (NAC). Some examples include schools, parks, residences, churches, libraries, and hospitals.

## What studies, methods and coordination were used to identify existing noise conditions in the study area?

Many studies were used as background information for this noise study. The Final Noise Discipline Report shows details about these studies. For this evaluation, sensitive sites within 500 feet of the Build Alternative right-of-way were included in the study area. The Washington State Department of Transportation (WSDOT) uses the Federal Highway Administration (FHWA) Noise Abatement Criteria (NAC) to evaluate noise effects at sensitive sites. These criteria area explained in Exhibit 1.

Study area: 500 feet outside of project footprint

The NAC are noise level standards at which noise reducing actions should be considered.

The equivalent steady-state sound level (Leq) in A-weighted decibels (dBA) for a stated period of time, in this case hourly (h).

**Exhibit 1 FHWA NAC**

| Activity Category | Leq (h) (dBA) | Description of Activity Category* |
|---|---|---|
| A | 57 (exterior) | Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. |
| B | 67 (exterior) | Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals. |
| C | 72 (exterior) | Developed lands, properties, or activities not included in Categories A or B above. |
| D | — | Undeveloped lands. |
| E | 52 (interior) | Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums. |

*Source: U.S. Department of Transportation, 1982.*

** Leq is a symbol that represents "Equivalent Continuous Noise Level". dBA is a unit for relative sound intensity. For highway traffic noise, an adjustment, or weighting, of the high and low-pitched sounds is made to approximate the way that an average person hears sounds. The adjusted sounds are called "A-weighted levels" or dBA.*

The analysis of noise effects in the study area is based on a comparison of future noise levels with existing levels. Future and existing noise levels are based off of the loudest hour of vehicle traffic during the day in both the existing year, 2006, and the future year 2033. The traffic during this time represents the loudest traffic hour because the largest numbers of vehicles are able to move at posted speeds without being delayed by a high level of vehicle traffic. These traffic levels were created as part of the project's transportation analysis. For more information on how the traffic levels are determined refer to the SR 502 Traffic Discipline Report.

WSDOT considers noise affects as occurring when noise levels are within 1 dBA of the FHWA NAC

dBA is the sound metric that is most similar to how people perceive sounds and is the commonly used sound frequency weighting for environmental noise.

### How were effects to noise conditions determined?

Construction noise effects are described based on maximum noise levels of construction equipment published by the FHWA. Traffic noise levels are predicted at noise sensitive sites based on the existing and projected future traffic levels using the FHWA Traffic Noise Model (TNM).

The loudest hour of vehicle traffic is represented by the time during the day where vehicle traffic levels are highest while being able to move at the posted speeds

WSDOT considers an increase in roadway noise at a site an effect when the increase is within 1 dBA of the FHWA NAC. For example, the FHWA NAC for activity category B is 67 dBA. WSDOT would consider an increase in roadway noise over the existing conditions an affect if that increase resulted in a noise level of 66 dBA or greater. WSDOT also considers an increase in roadway noise over the existing conditions of 10 dBA or greater an effect. Therefore, a 10 dBA or greater increase in roadway noise over the existing conditions at a site where the dBA is less than 66 dBA is still considered an effect. WSDOT only considers abatement measures in situations where there is a noise effect as described above.

### What are the existing noise conditions in the study area?

Existing noise levels were measured in the field at 10 locations. The field measurements were used to help create a model of the existing noise environment (or the existing conditions) near the project. Fifty-one additional sites were added to the model to represent other sensitive sites that were not fully represented by the 10 measured sites. Therefore, a total of 61 sites were modeled. The locations of these sites can be found on exhibits 7 and 8 in the Methods section of the Final Noise Discipline Report.

Noise levels in the study area ranged from 46 dBA to 66 dBA. Noise levels at one of the 61 sites, which represent one residence, exceeded the Noise Abatement Criteria for the corresponding activity category.

Noise levels ranged from 46 dBA to 66 dBA. The noise level at one of the 61 sites (Exhibit 3), which represents one residence, exceeded the NAC for the corresponding activity category (Exhibits 3, 4).

**Exhibit 2 Noise Levels at Affected Sites per FHWA NAC and WSDOT Guidance**

| Site | Land Use Activity Category | Total Residences Represented | Closest Existing Road (feet) | Existing Noise Level (dBA) | NO BUILD ALTERNATIVE (2033) | | BUILD ALTERNATIVE (2033) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Noise Level (dBA) | Change from Existing | Noise Level (dBA) | Change from Existing |
| A | B | 1 | 170 | 59 | 64 | 5 | 69 | 10 |
| B | B | 3 | 70 | 65 | 69 | 4 | 72 | 7 |
| C | B | 4 | 235 | 57 | 61 | 5 | 66 | 9 |
| D | B | 4 | 140 | 60 | 64 | 4 | 69 | 10 |
| F | B | 2 | 80 | 60 | 64 | 4 | 67 | 7 |
| G | B | 3 | 35 | 63 | 67 | 4 | 69 | 6 |
| H | B | 4 | 70 | 57 | 61 | 4 | 67 | 10 |
| I | B | 5 | 115 | 60 | 64 | 4 | 68 | 8 |
| 1 | B | 3 | 150 | 62 | 66 | 4 | 69 | 7 |
| 3 | B | 3 | 65 | 62 | 66 | 4 | 69 | 7 |
| 5 | B | 1 | 140 | 63 | 67 | 4 | 69 | 6 |
| 6 | B | 2 | 135 | 63 | 67 | 4 | 69 | 5 |
| 7 | B | 4 | 50 | 63 | 67 | 4 | 68 | 5 |
| 9 | B | 3 | 125 | 63 | 67 | 4 | 71 | 8 |
| 10 | B | 1 | 120 | 63 | 67 | 4 | 70 | 7 |
| 12 | B | 2 | 85 | 60 | 63 | 3 | 67 | 7 |
| 28 | B | 1 | 135 | 61 | 66 | 5 | 70 | 9 |
| 29 | B | 1 | 65 | 59 | 63 | 4 | 66 | 7 |
| 31 | B | 5 | 160 | 59 | 63 | 4 | 68 | 9 |
| 32 | B | 3 | 170 | 60 | 64 | 4 | 68 | 8 |
| 33 | B | 1 | 30 | 50 | 54 | 4 | 60 | 10 |
| 36 | B | 2 | 120 | 63 | 67 | 4 | 70 | 7 |
| 37 | B | 2 | 170 | 60 | 64 | 4 | 69 | 9 |
| 38 | B | 2 | 140 | 63 | 67 | 4 | 71 | 8 |
| 39 | B | 2 | 135 | 49 | 54 | 5 | 59 | 10 |
| 41 | B | 5 | 260 | 50 | 54 | 4 | 61 | 11 |
| 43 | B | 3 | 95 | 63 | 68 | 5 | 71 | 8 |
| 44 | B | 5 | 180 | 59 | 63 | 4 | 69 | 10 |
| 46 | B | 3 | 40 | 50 | 55 | 5 | 61 | 11 |
| 47 | B | 2 | 100 | 62 | 66 | 4 | 71 | 9 |
| 48 | B | 6 | 185 | 58 | 63 | 5 | 68 | 10 |
| 49 | B | 9 | 60 | 57 | 62 | 5 | 68 | 11 |
| 50 | B | 1 | 35 | 49 | 54 | 5 | 59 | 10 |
| 51 | B | 1 | 65 | 66 | 70 | 4 | 73 | 7 |

*Note: At all sites in this table, under the Build Alternative, noise is within 1 dBA of the FHWA NAC (per land use category) and/ or noise increases by 10 dBA or more. Therefore, WSDOT would consider noise abatement for all these sites.*

**Exhibit 3 Location of Sites Affected by Noise**

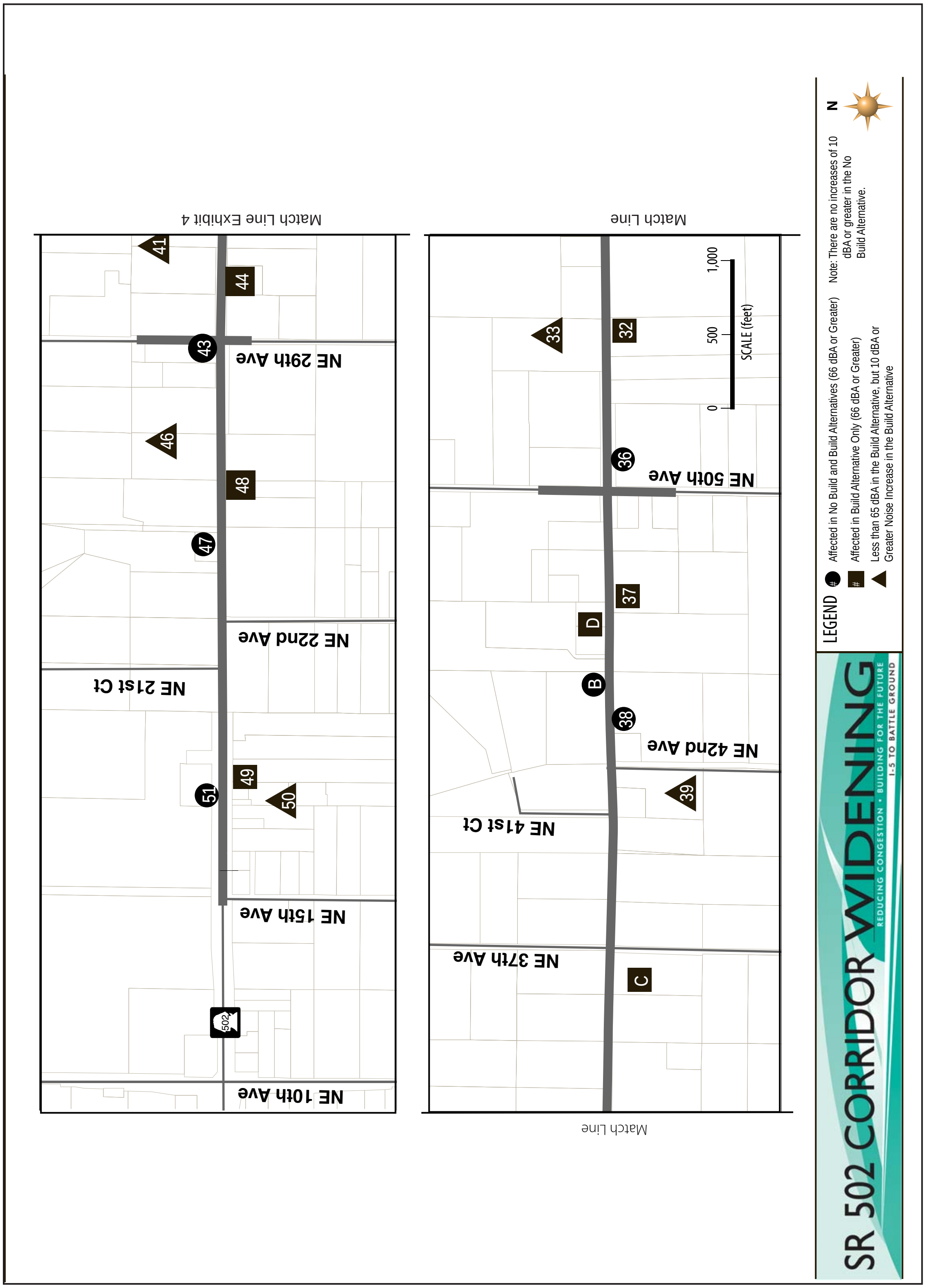
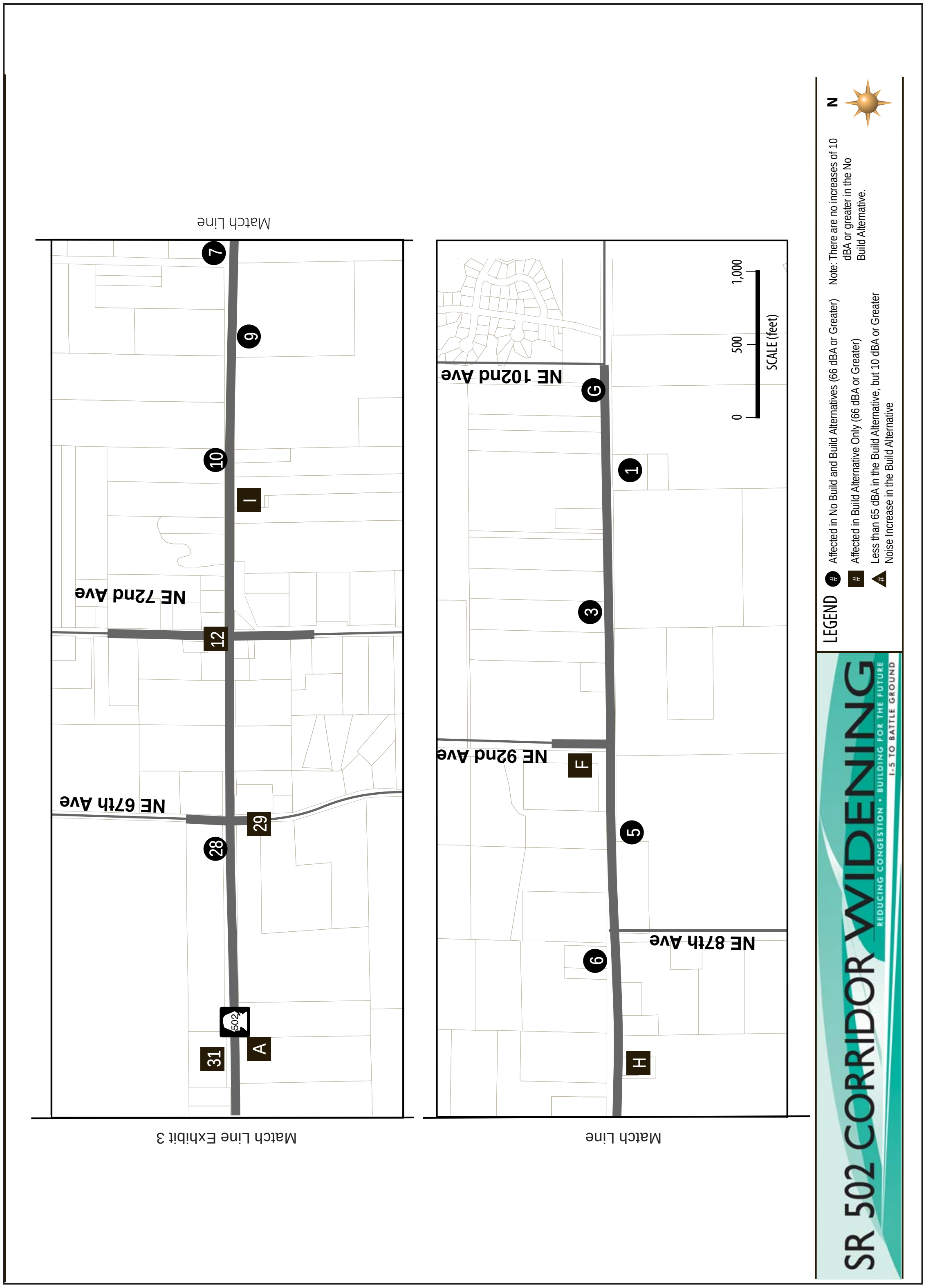


**Exhibit 4 Location of Sites Affected by Noise**



## What temporary effects to noise conditions would occur?

Temporary effects are those associated with construction activities.

### No Build Alternative

The No Build Alternative includes WSDOT's continued routine maintenance, which consists of the short-term minor construction necessary for continued operation of the existing SR 502 corridor. This minor construction would generate temporary increases in noise.

### Build Alternative

The Build Alternative would include construction activities that would generate noise during the construction period of the project. Nearby sites would experience temporary increases in noise. The main source of construction noise would be generated from the combustion engines on construction equipment.

## What long-term effects to noise conditions would occur?

Long-term effects are those associated with the operation and maintenance of the facility or permanent changes resulting from the project.

### No Build Alternative

Noise levels for the No Build Alternative are predicted to increase by 0 to 5 dBA due to increases in vehicle traffic levels (Exhibit 2). Noise levels would approach or exceed the Noise Abatement Criteria B at 15 out of 61 sites (Exhibit 2), representing 34 residences and one church. The locations of these sites affected by roadway noise are shown on Exhibits 3, 4.

### Build Alternative

Noise levels for the Build Alternative are predicted to increase by 1 to 11 dBA relative to existing modeled noise levels (Exhibit 2) due to being closer to the facility and the increases in vehicle traffic in the design year (2033). Noise levels would approach or exceed the Noise Abatement Criteria at 34 out of 61 sites (Exhibit 2), representing 96 residences and 3 churches (Exhibits 3, 4). Twenty to thirty of the affected residences would be displaced under the build alternative. The locations of these sites affected by roadway noise are shown on Exhibits 3, 4). While increases in roadway noise occur at commercial sites in the study area, none of these increases exceed the NAC (Exhibit 1) under the Build Alternative.

## What measures are proposed to minimize or avoid negative effects to noise conditions?

This section discusses potential abatement measures that could be used to avoid or minimize noise effects. Potential abatement measures are discussed for the temporary effects and the long-term effects of the Build Alternative only.

### Abatement of Temporary Effects

Several construction noise abatement methods can be implemented to limit the temporary effects on the noise environment. The below list of standard noise control specifications may be incorporated into construction contracts to abate the effects of construction noise.

Several construction noise abatement methods can be implemented to limit the temporary effects on the noise environment.

- Limiting noisier construction activities, such as pile-driving and jack-hammering to between 7 a.m. and 10 p.m. to reduce construction noise levels during sensitive nighttime hours;
- Equipping and maintaining construction equipment engines with adequate mufflers to reduce their noise by 5 to 10 dBA (U.S. EPA, 1971);
- Turning off construction equipment during prolonged periods of nonuse to eliminate noise;;
- Locating stationary equipment such as compressors or generators away from noise-sensitive receptors to decrease noise.

### Abatement of Long-Term Effects

Noise produced from vehicles on roadways can be abated in a variety of ways. WSDOT considers the following techniques to abate long-term noise effects on transportation projects like the SR 502 Corridor Widening project:

- Implementing traffic management measures
- Acquiring land as buffer zones or for constructing noise barriers or berms
- Realigning the roadway
- Sound insulating public use or nonprofit institutional structures
- Constructing noise barriers or berms.

Each of these techniques was evaluated to determine if it was feasible and reasonable to apply to this project. However, none of the potential abatement measures were found to be reasonable or feasible (see sidebar). For a more detailed discussion of the abatement determinations see the Abatement section of this Final Noise Discipline Report.

**Abatement Methods for Long-Term Effects**

Determinations of Feasibility or Reasonableness

**Traffic Management Measures**
Not reasonable (Counter to the purpose of the SR 502 facility)

**Land acquisition for noise buffers and barriers**
Not reasonable (Too costly)

**Realigning the Roadway**
Not reasonable (Too costly)

**Noise Insulation of Buildings**
Not reasonable (Interior noise levels are not high enough to warrant)

**Noise Barriers**
Not reasonable (Too costly)

# Table of Contents

## List of Exhibits



## List of Appendices

## 1.0 Introduction

The SR 502 Corridor Widening Project is located in north Clark County, Washington along SR 502 (NE 219th Street) between NE 15th Avenue and NE 102nd Avenue (mile post 2.3 to mile post 6.5) (Exhibit 1). The western terminus of the project area is approximately one mile east of Interstate 5 (I-5) and the eastern terminus is NE 102nd Avenue. The project would widen an approximate five mile segment of SR 502 from two travel lanes to four travel lanes and upgrade several intersections to improve mobility and safety. Currently, SR 502 is a rural, two-lane highway. There is one signalized intersection at SR 502 and NE 72nd Avenue.

Residences and business have direct access to SR 502 from their driveways and access at the intersections is controlled by both signs and signals in the corridor. Residences and businesses with direct access to the SR 502 facility from their driveways would continue to have reasonable access to the transportation system; however, the project would result in a limited access facility.

The purpose of this document is to describe the existing noise conditions, discuss effects and benefits the project would have on noise conditions, and identify abatement measures to address adverse effects as needed. The information contained in this discipline report will be used to support the project's Environmental Impact Statement (EIS).

Exhibit 1. Vicinity Map

# 2.0 Studies, Coordination, and Methods

## 2.1 Studies and Coordination

Sound is created when objects vibrate, resulting in a minute variation in surrounding atmospheric pressure called sound pressure. The human response to sound depends on the magnitude of a sound as a function of its frequency and time pattern (EPA, 1974). Magnitude measures the physical sound energy in the air. The range of magnitude from the faintest to the loudest sound the ear can hear is so large that sound pressure is expressed on a logarithmic scale in units called decibels (dB). Loudness, compared to physical sound measurement, refers to how people subjectively judge a sound and varies from person to person. Magnitudes of typical noise levels are presented in Exhibit 2.

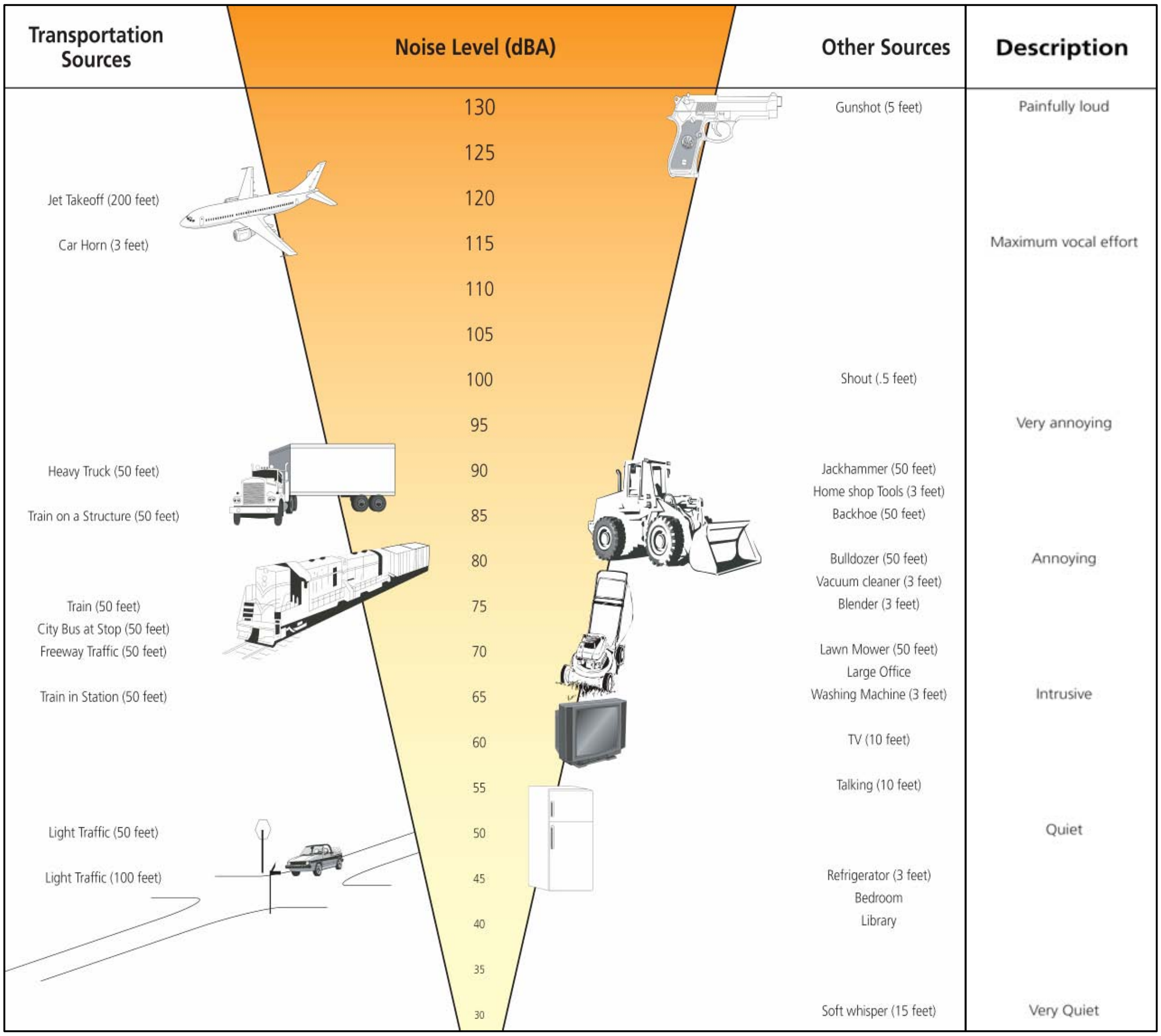
Humans respond to a sound's frequency or pitch. The human ear is very effective at perceiving sounds with a frequency between approximately 1,000 and 5,000 hertz (Hz), with the efficiency decreasing outside this range. Environmental noise is composed of many frequencies, each occurring simultaneously at its own sound pressure level. Frequency weighting, which is applied electronically by a sound level meter, combines the overall sound frequency into one sound level that simulates how an average person hears sounds. The commonly used frequency weighting for environmental noise is A-weighting (dBA), which is most similar to how humans perceive sounds of low to moderate magnitude.

Because of the logarithmic decibel scale, a doubling of the number of sound sources, such as the number of cars operating on a roadway, increases noise levels by 3 dBA. A tenfold increase in the number of sound sources will add 10 dBA. As a result, a sound source emitting a sound level of 60 dBA combined with another sound source of 60 dBA yields a combined sound level of 63 dBA, not 120 dBA. The human ear can barely perceive a 3 dBA increase, while a 5 or 6 dBA increase is readily noticeable and appears as if the sound is about one and one-half times as loud. A 10 dBA increase appears to be a doubling in sound level to most listeners.

Noise levels from traffic sources depend on volume, speed, and the type of vehicle. Generally, an increase in volume, speed, or vehicle size increases traffic noise levels. Vehicular noise is a combination of noises from the engine, exhaust, and tires. Other conditions affecting traffic noise include defective mufflers, steep grades, terrain, vegetation, distance from the roadway, and shielding by barriers and buildings.

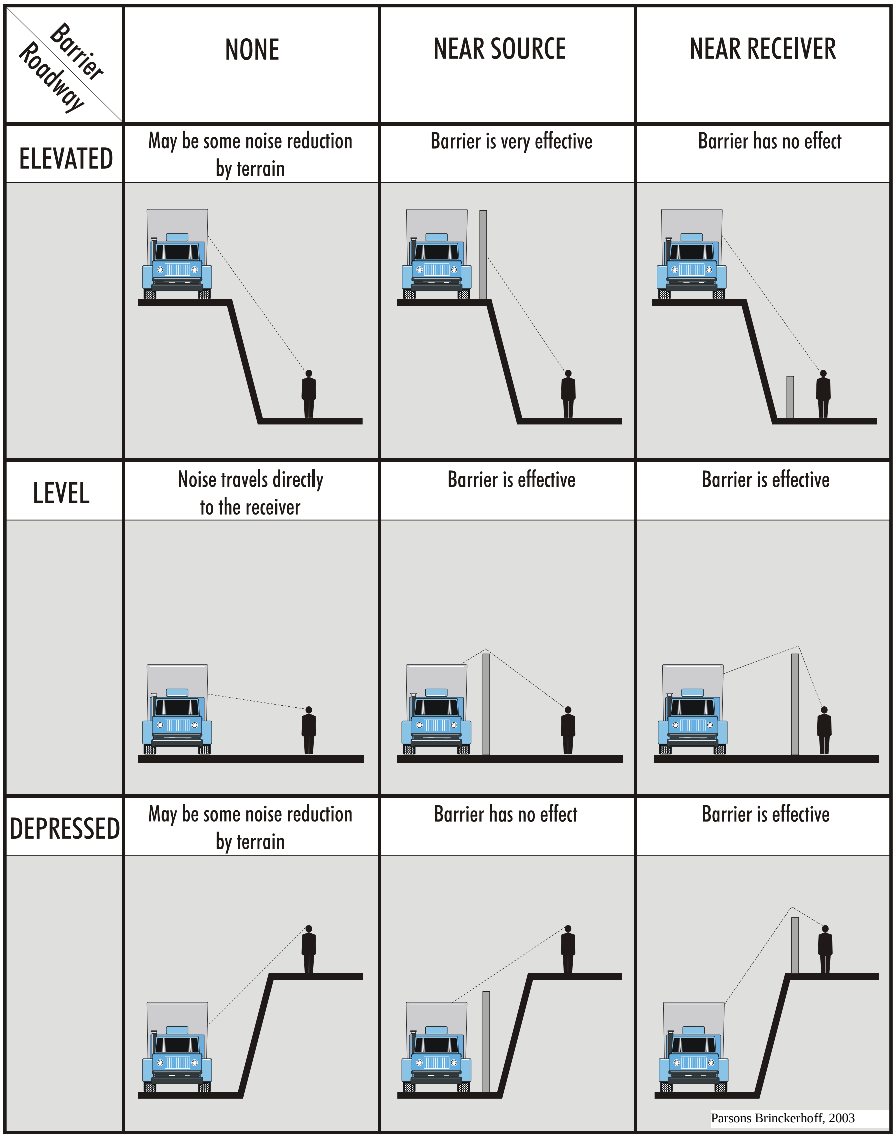
Sound levels decrease with distance from the source. For a line source such as a roadway, sound levels decrease 3 dBA over hard ground (concrete, pavement) or 4.5 dBA over soft ground (grass) for every doubling of distance between the source and the site. For a point source such as construction sources, sound levels will decrease between 6 and 7.5 dBA for every doubling of distance from the source.

Exhibit 2. Typical Noise Levels




The propagation of sound can be greatly affected by terrain and the elevation of the receiver relative to the sound source (Exhibit 3). Level ground is the simplest scenario. Sound travels in a straight line-of-sight path between the source and receiver. If the sound source is depressed or the receiver is elevated, sound generally travels directly to the receiver. Sound levels may be reduced because the terrain crests between the source and receiver, resulting in a partial sound barrier near the receiver. If the sound source is elevated or the receiver is depressed, sound often is reduced at the receiver. The edge of the roadway can act as a partial sound barrier, blocking some sound transmission between the source and receiver. Even a short barrier, such as a solid concrete jersey-type safety barrier, can be effective at further reducing traffic noise levels. Breaking the line of sight between the receiver and the highest sound source results in a noise reduction of approximately 5 dBA.

Exhibit 3. Noise Barrier Effectiveness




## 2.2 Sound Level Descriptors

A widely used descriptor for environmental noise is the equivalent sound level (Leq). The Leq can be considered a measure of the average sound energy during a specified period of time. It places more emphasis on occasional high sound levels that accompany general background noise levels. Leq is defined as the constant level that, over a given period of time, transmits to the receiver the same amount of acoustical energy as the actual time-varying sound. For example, if a person heard two sounds and the first sound had twice as much energy as the second but only lasted half as long, both would have the same Leq. Leq measured over a one-hour period is the hourly Leq [Leq(h)], which is used for highway noise impact and abatement analyses.

The day/night level (Ldn), a daily averaged noise level that ranks noise that occurs during the evening or night more heavily, is often reported. The Ldn adds 10 dBA to noise levels that occur between 10 p.m. and 7 a.m. Ldn is used for transit noise impact and abatement analyses to residential areas.

Short-term sound levels, such as those from a single truck pass-by, can be described by either the total sound energy or the highest instantaneous sound level that occurs during the event. The sound exposure level (SEL) is a measure of total sound energy from an event, and is useful in determining what the Leq would be over a period in time when several sound events occur. The maximum sound level (Lmax) is the greatest short-duration sound level that occurs during a single event. Lmax is related to impacts on speech interference and sleep disruption. In comparison, Lmin is the minimum sound level during a period of time.

People generally find a moderately high, constant sound level more tolerable than a quiet background level interrupted by frequent high-level noise intrusions. An individual's response to sound depends greatly on the range that the sound varies in a given environment. For example, steady traffic noise from a highway is normally less bothersome than occasional aircraft flyovers in a relatively quiet area. In light of this subjective response, it is often useful to look at a statistical distribution of sound levels over a given time period in addition to the average sound level. Such distributions identify the sound level exceeded and the percentage of time exceeded. It therefore allows for a more thorough description of the range of sound levels during the given measurement period. These distributions are identified with an Ln where n is the percentage of time that the levels are exceeded. For example, the L10 level is the noise level that is exceeded 10 percent of the time.

## 2.3 Effects of Noise

Environmental noise at high intensities directly affects human health by causing hearing loss. Prolonged exposure to very high levels of environmental noise can cause hearing loss. The EPA has established a protective level of 70 dBA Leq (24), below which hearing is conserved for exposure over a 40-year period (U.S. EPA, 1974). Leq (24) is an average of the sound level over a 24-hour period. Although scientific evidence is not currently conclusive, noise is suspected of causing or aggravating other diseases. Environmental noise indirectly affects human welfare by interfering with sleep, thought, and conversation. The Federal Highway Administration (FHWA) noise abatement criteria are based on speech interference, which is a well documented impact that is relatively reproducible in human response studies.

## 2.4 Noise Regulations and Impact Criteria

Applicable noise regulations and guidelines provide a basis for evaluating potential noise impacts. For federally funded highway projects, traffic noise impacts occur when predicted Leq(h) noise levels approach or exceed the noise abatement criteria (NAC) established by the FHWA, or substantially exceed existing noise levels (U.S. Department of Transportation, 1982, Noise Abatement Council). Although "substantially exceed" is not defined, WSDOT considers an increase of 10 dBA or more to be a substantial increase. WSDOT defines severe noise impacts as traffic noise levels that exceed 75 dBA outdoors in Category B areas, such as picnic or recreation areas, or 60 dBA indoors at Category E uses, such as residences or motels. Severe noise impacts also occur if predicted future noise levels exceed existing levels by 15 dBA or more in noise-sensitive locations as the result of a project.

The FHWA noise abatement criteria (NAC) exterior Leq(h) noise levels for various land activity categories (Exhibit 4). For sites where serenity and quiet are of extraordinary significance, the noise criterion is 57 dBA. For residences, parks, schools, churches, and similar areas, the noise criterion is 67 dBA. For developed lands, the noise criterion is 72 dBA. WSDOT considers a noise impact to occur if predicted Leq(h) noise levels approach within 1 dBA of the noise abatement criteria in Exhibit 4; thus, if a noise level were 66 dBA or higher, it would approach or exceed the FHWA noise abatement criterion of 67 dBA for residences.

Exhibit 4. FHWA Noise Abatement Criteria (NAC)

| Activity Category | $L_{eq}$ (h) (dBA) | Description of Activity Category |
|---|---|---|
| A | 57 (exterior) | Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. |
| B | 67 (exterior) | Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals. |
| C | 72 (exterior) | Developed lands, properties, or activities not included in Categories A or B above. |
| D | -- | Undeveloped lands. |
| E | 52 (interior) | Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums. |

*Source: U.S. Department of Transportation, 1982.*

The Washington State Department of Ecology (Ecology) regulates noise levels at property lines of neighboring properties (WAC Chapter 173-60-040). Traffic noise is exempt from the property line noise limits, but the limits apply to construction noise during certain hours. The maximum permissible noise levels depend on the land uses of both the source noise and receiving property (Exhibit 5). Clark County has adopted the State of Washington's property line standards with Clark County Code 9.14.010.

The City of Battle Ground has adopted a qualitative noise standard with Battle Ground Municipal Code Chapter 9.42.010. The standard limits any noise, sound or signal which unreasonably disturbs the comfort, peace, or repose of another person or persons. Construction noise is exempt from this qualitative standard between the hours of 9 p.m. and 7 a.m.

Exhibit 5. Maximum Permissible Noise Levels

| **EDNA of Noise Source** | **EDNA of Receiving Property** | | | |
|---|---|---|---|---|
| | **Class A** | | **Class B** | **Class C** |
| | **Daytime (7 a.m. to 10 p.m.)** | **Nighttime (10 p.m. to 7 a.m.)** | | |
| Class A | 55 dBA | 45 dBA | 57 dBA | 60 dBA |
| Class B | 57 dBA | 47 dBA | 60 dBA | 65 dBA |
| Class C | 60 dBA | 50 dBA | 65 dBA | 70 dBA |

*Source: WAC 173-60-040*

*EDNA = Environmental Designation for Noise Abatement*

The maximum permissible environmental noise level at residential receiving properties is reduced by 10 dBA between 10 pm and 7 am. Short-term exceedences above the permissible sound level are allowed. The maximum level may be exceeded by 5 dBA for a total of 15 minutes, by 10 dBA for a total of 5 minutes, or by 15 dBA for a total of 1.5 minutes during any 1 hour period (Exhibit 6).

Exhibit 6: Allowed Exceedences of the Maximum Permissible Noise

| **Duration of Exceedence** | **Allowed Exceedence** | **Statistical Descriptor** | **Equivalent Leq(h) Increase** |
|---|---|---|---|
| 15 minutes | 5 dBA | $L_{25}$ | 2 dBA |
| 5 minutes | 10 dBA | $L_{8}$ | 2 dBA |
| 1.5 minutes | 15 dBA | $L_{2.5}$ | 2 dBA |

*Source: WAC 173-60-040.*

Considering the allowed short-term exceedences (Exhibit 5), the permissible hourly $L_{eq}$ is approximately 2 dBA higher than the values in Exhibit 4. For example, a noise level of 57 dBA for 45 minutes and 62 dBA for 15 minutes (57 dBA + 5 dBA exceedence) is permissible for noise from a commercial activity received by a residential property; this sound pattern has an $L_{eq}$ (h) of 59 dBA.

Construction noise from projects within the State of Washington is exempt from Ecology property line regulations during daytime hours, but must meet the regulations during nighttime hours (10 p.m. to 7 a.m. on weekdays and 10 p.m. to 8 a.m. on weekends). Performance of construction activities during nighttime hours would require a noise variance from the City of Battle Creek or Clark County, depending on the location of the activity.

## 2.5 Methods

The study area used for this noise discipline report includes any noise sensitive sites within an area 500 feet from the future right of way for the proposed SR 502 Build Alternative.

Ambient noise levels were measured for 15-minute periods at 10 locations near the study area to describe the existing noise environment, identify major noise sources in the study area, validate the noise model, and characterize the weekday background environmental noise levels. Measurement locations will represent a variety of noise conditions and represent other sensitive sites near the proposed project. Existing and future noise levels for the No Build scenario and Build Alternative were modeled at the measurement locations and at additional locations that could potentially be affected by the project.

FHWA's Traffic Noise Model (TNM) Version 2.5 computer model (FHWA, 2004) was used to predict Leq(h) traffic noise levels. The TNM input and output files are part of the project file with WSDOT. TNM is used to obtain precise estimates of noise levels at discrete points, by considering interactions between different noise sources and the effects of topographical features on the noise level. The model estimates the acoustic intensity at a receiver location calculated from a series of straight-line roadway segments. Noise emissions from free-flowing traffic depend on the number of automobiles, medium trucks, and heavy trucks per hour; vehicular speed; and reference noise emission levels of an individual vehicle. TNM also considers effects of intervening barriers, topography, trees, and atmospheric absorption. Noise from sources other than traffic is not included. Therefore, when non-traffic noise such as aircraft is considerable in an area, TNM under-predicts the actual noise level. Noise measurements were used to validate the existing conditions TNM model.

Base maps and design files were exported from Microstation as DXF files and imported into the TNM package. Major roadways, topographical features, and sensitive sites were digitized into the model. Elevations were added from 5-foot and 2-foot contour data. Elevations for planned improvements were taken from design profiles, and proposed cut and fill limits.

Predicted noise levels were based on PM peak-hour traffic conditions to estimate worst-case noise levels. Existing traffic volumes for year 2006 and expected future traffic volumes for 2034 were modeled. The traffic volumes and vehicle mix for the project were taken from the *SR 502 Corridor Widening Final Transportation Discipline Report* and are documented in Appendix A. In addition to the measured sites (10), 51 other sites were also included in the model runs to provide information in areas not fully described by the measurement sites for a total of 61 modeled sites. The locations of the sites can be found on Exhibit 8 and Exhibit 9. Numbers on the site locations correspond to the site ID in Exhibit 10 and Exhibit 11.

Predicted noise levels will be compared with the FHWA NAC and the numbers of affected sites counted for the Build Alternative. At sites where modeled noise levels approach or exceed the NAC, abatement measures will be evaluated and a determination of reasonableness and feasibility will be made. Feasible refers to whether the abatement measure can provide a substantial (at least seven decibels) reduction in noise and other constructability issues. Reasonable refers to the maximum cost per residence benefiting from the noise abatement (Exhibit 7).

Exhibit 7. Reasonableness Allowances

| Design Year Traffic Sound Decibel Level | Noise Level Increase as a Result of the Project (dBA)[1] | Allowed Wall Surface Area per Qualified Residence or Residential Equivalent | Allowed Cost Per Qualified Residence or Residential Equivalent[2] |
|---|---|---|---|
| 66 | --[1] | 700 Sq. Feet (65.0 Sq. Meters) | $37,380 |
| 67 | --[1] | 768 Sq. Feet (71.3 Sq. Meters) | $41,110 |
| 68 | --[1] | 836 Sq. Feet (77.7 Sq. Meters) | $44,640 |
| 69 | --[1] | 904 Sq. Feet (84.0 Sq. Meters) | $48,270 |
| 70 | --[1] | 972 Sq. Feet (90.3 Sq. Meters) | $51,900 |
| 71 | 10 (substantial, tier 1[3]) | 1,040 Sq. Feet (96.6 Sq. Meters) | $55,530 |
| 72 | 11 (substantial, tier 1) | 1,108 Sq. Feet (102.9 Sq. Meters) | $59,160 |
| 73 | 12 (substantial, tier 1) | 1,176 Sq. Feet (109.3 Sq. Meters) | $62,790 |

*Source: WSDOT, 2006.*

Construction noise consequences were qualitatively assessed using FHWA reference levels. Suggested construction noise abatement measures are provided for inclusion in contractor documents.

[1] If the noise level increase as a result of the project is 10 dBA or more, follow the allowed wall surface and cost for the level of increase in this column in lieu of the total design year sound decibel level in the first column.
[2] Cost Reevaluated as needed. Based on $53.40 per square foot constructed cost.
[3] Tier 1 is when the noise levels are 10 to 14 dBA over existing traffic noise as a result of the transportation project.

Exhibit 8. Locations of Measured and Modeled Receivers West Study Area

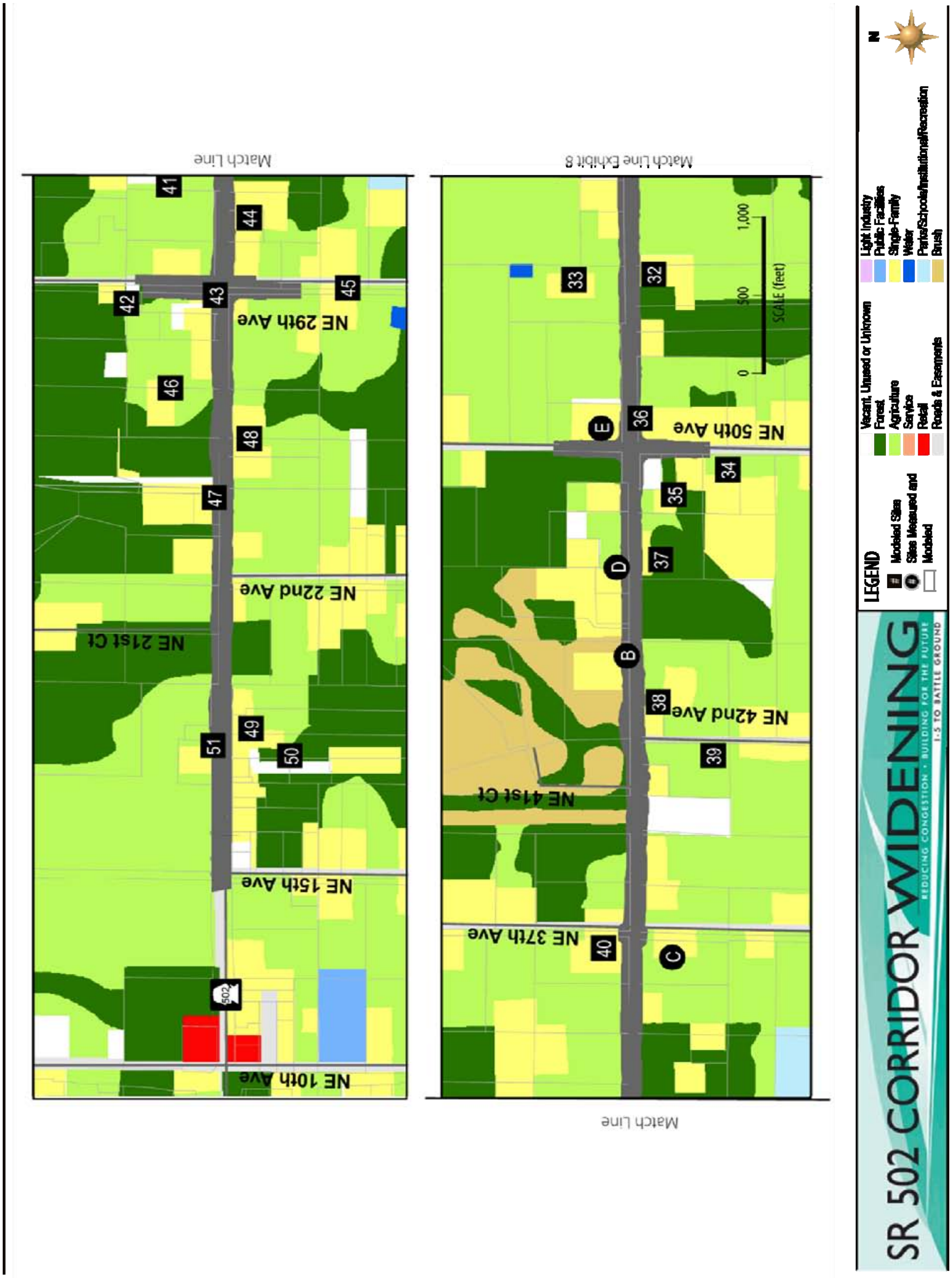
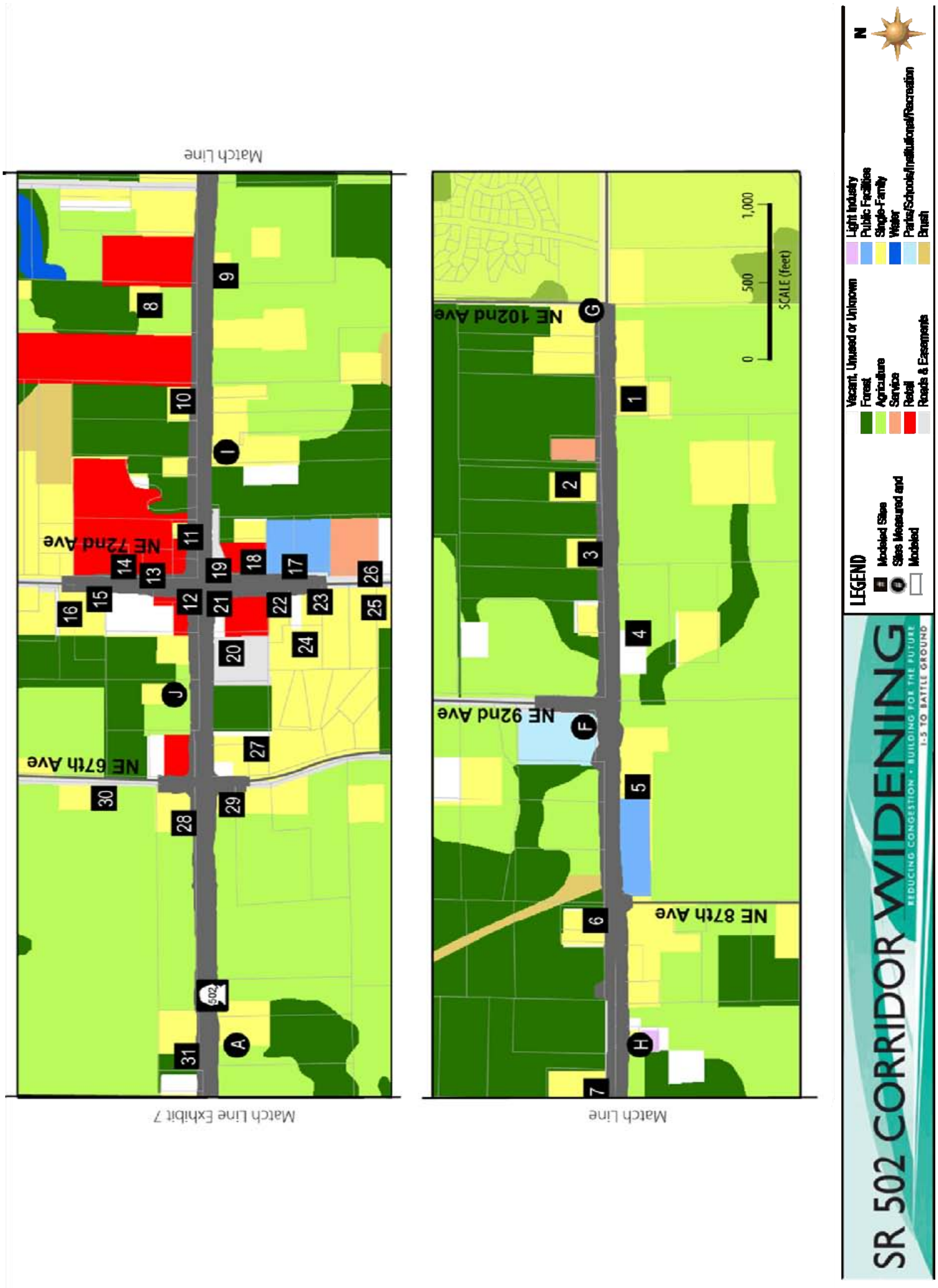


Exhibit 9. Locations of Measured and Modeled Receivers East Study Area



# 3.0 Affected Environment

This section describes the affected environment, or existing conditions, within the study area.

## 3.1 Description of Study Area

The general area is characterized by a relatively low population density with few urban features other than the I-5 interchange area to the west and commercial areas near Dollars Corner, and within the City of Battle Ground. Dollars Corner is centered at the intersection of SR 502 and NE 72nd Avenue, and is within the study area. Rural residential, rural commercial and open spaces are the dominant land uses in the study area vicinity. The Sunset Oaks wetland mitigation site and the Mill Creek North Potential Mitigation Site are also part of the study area. The wetland mitigation site is approximately six miles south of the SR 502 corridor and the Mill Creek North Potential Mitigation Site is 350 feet northwest of the SR 502 and 67th Avenue intersection.

Within the study area, SR 502 passes through a semi-rural area of unincorporated Clark County. Land uses in this area include a variety of low-density residential homes, agricultural uses, churches, and rural commercial properties. In September 2007, the City of Battle Ground's Urban Growth Area (UGA) was expanded, and the area along SR 502 east of NE 92nd Avenue is now designated as part of the City's UGA. Land uses within the UGA are similar to the rest of the study area but because of the new designation, transition to more urban land uses will be encouraged by the County and City.

Approximately 48 commercial businesses are located at the Dollars Corner intersection. There are no concentrated residential areas or developments within the study area.

Residences and business have direct access to SR 502 from their driveways and access at the intersections is controlled by both signs and signals in the corridor.

Population growth and urban land uses are increasing in the study area. Development trends indicate that growth is still occurring in Clark County—although at a slightly slower rate than a few years ago—and affecting land uses in the study area (Clark County Community Development, 2007). Development in the study area is likely to increase, especially as the comprehensive planning designation of Urban Reserve and the Urban Reserve Overlay west of 102nd Avenue was changed to more intensive-use zones in the comprehensive plan update in September 2007. According to county planners, the area in the new UGA is expected to become more urbanized and more commercial uses are likely to be developed in the area southeast of the intersection of 92nd Avenue and SR 502 (Mabrey, 2007).

Recent and current development activity in the study area includes a proposed five-lot subdivision and three short plats according to recent *Clark County Washington Development Projects Weekly Reports* and Clark County GIS data reports (Pearrow, 2007). A Ridgefield Church of Latter-Day Saints (LDS) is currently being constructed at the southwest corner of SR 502 and NE 29th Avenue and a large retail development at the southeast corner of SR 502 and NE 92nd Avenue is expected. According to the Land Use Discipline Report for this project commercial development has been relatively strong in the study area with a new floor covering warehouse, chiropractic office, solid waste facility, auto body shop, rockery and supply business, and auto clinic being developed within the last four years. Exhibit 8 and Exhibit 9 show the existing land uses in the study area excluding Sunset Oaks wetland mitigation site, based on zoning designation. The Sunset Oaks wetland mitigation site is property that is owned by WSDOT, zoned residential but is currently vacant.

## 3.2 Existing Noise Levels

Existing noise levels were measured in the field at 10 locations (Exhibit 10). Fifteen-minute noise measurements were taken during various time periods throughout the day. The measured noise levels and traffic counts taken during the measurements were used to validate the traffic noise model (as described in the Methodology section of this report).

The noise levels at the 10 measured and at 51 additional sites were modeled using TNM with the loudest hour traffic volumes (Exhibit 11). The fifty-one additional sites were added to the TNM model to represent additional noise sensitive sites not represented by the 10 measured sites.

Traffic noise was the dominant noise source in the study area. Noise levels ranged from 46 dBA to 66 dBA in the existing conditions. Noise levels at one of the 61 sites which represents one residential unit was modeled to currently approach or exceed the NAC during the loudest traffic hour.

Exhibit 10. Noise Measurement and Modeled Results

| Measured Site ID and Address | Date | Start Time | Measured Leq (dBA) | Validated Leq (dBA) |
|---|---|---|---|---|
| A - 5909 NE 219TH ST | October 22, 2007 | 1:40 PM | 57 | 58 |
| B* - 4402 NE 219TH ST | October 22, 2007 | 2:15 PM | 63 | 64 |
| C* - 21810 NE 37TH AVE | October 22, 2007 | 2:58 PM | 56 | 56 |
| D - 4608 NE 219TH ST | October 22, 2007 | 4:00 PM | 59 | 59 |
| E - 22001 NE 50TH AV | October 22, 2007 | 4:30 PM | 60 | 58 |
| F* - 9100 NE 219TH ST | October 23, 2007 | 10.05 AM | 57 | 58 |
| G - 10112 NE 219TH ST | October 23, 2007 | 10:40 AM | 62 | 63 |
| H - 8315 NE 219TH ST | October 23, 2007 | 11:10 AM | 55 | 56 |
| I - 7511 NE 219TH ST | October 23, 2007 | 12:24 PM | 61 | 60 |
| J - 6816 NE 219TH ST | October 23, 2007 | 1:06 PM | 57 | 55 |

** Indicates location is a church*

Exhibit 11. Noise Modeling Results at Sites both Measured and Modeled

| Site ID | Land Use Activity Category | Total Residences Represented | Closest Existing Road (feet) | Existing Noise Level (dBA) | NO BUILD ALTERNATIVE (2034) | | BUILD ALTERNATIVE (2034) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Noise Level (dBA) | Change from Existing | Noise Level (dBA) | Change from Existing |
| A | B | 1 | 170 | 59 | 64 | 5 | **69** | **10** |
| B | B | 3 | 70 | 65 | **69** | 4 | **72** | 7 |
| C | B | 4 | 235 | 57 | 61 | 5 | **66** | 9 |
| D | B | 4 | 140 | 60 | 64 | 4 | **69** | **10** |
| E | B | 1 | 80 | 57 | 61 | 4 | 65 | 8 |
| F | B | 2 | 80 | 60 | 64 | 4 | **67** | 7 |
| G | B | 3 | 35 | 63 | **67** | 4 | **69** | 6 |
| H | B | 4 | 70 | 57 | 61 | 4 | **67** | **10** |
| I | B | 5 | 115 | 60 | 64 | 4 | **68** | 8 |
| J | B | 1 | 225 | 56 | 60 | 4 | 63 | 7 |
| 1 | B | 3 | 150 | 62 | **66** | 4 | **69** | 7 |
| 2 | B | 1 | 140 | 55 | 59 | 4 | 63 | 8 |
| 3 | B | 3 | 65 | 62 | **66** | 4 | **69** | 7 |
| 4 | C | 1 | 160 | 61 | 65 | 4 | 69 | 8 |
| 5 | B | 1 | 140 | 63 | **67** | 4 | **69** | 6 |
| 6 | B | 2 | 135 | 63 | **67** | 4 | **69** | 5 |
| 7 | B | 4 | 50 | 63 | **67** | 4 | **68** | 5 |
| 8 | B | 2 | 100 | 53 | 57 | 4 | 61 | 8 |
| 9 | B | 3 | 125 | 63 | **67** | 4 | **71** | 8 |
| 10 | B | 1 | 120 | 63 | **67** | 4 | **70** | 7 |
| 11 | C | 5 | 115 | 60 | 64 | 4 | 67 | 7 |
| 12 | B | 2 | 85 | 60 | 63 | 3 | **67** | 7 |
| 13 | C | 2 | 85 | 58 | 58 | 0 | 64 | 6 |
| 14 | C | 2 | 145 | 53 | 54 | 1 | 59 | 6 |
| 15 | C | 1 | 75 | 58 | 58 | 0 | 61 | 3 |
| 16 | B | 3 | 175 | 50 | 52 | 2 | 55 | 5 |
| 17 | C | 2 | 145 | 55 | 56 | 1 | 59 | 4 |
| 18 | C | 1 | 180 | 56 | 59 | 3 | 62 | 6 |
| 19 | C | 1 | 70 | 64 | 68 | 4 | 69 | 5 |
| 20 | C | 1 | 155 | 57 | 61 | 4 | 64 | 7 |
| 21 | C | 2 | 80 | 63 | 67 | 4 | 68 | 5 |
| 22 | B | 1 | 110 | 57 | 58 | 1 | 61 | 4 |
| 23 | B | 1 | 90 | 58 | 58 | 0 | 61 | 3 |
| 24 | B | 1 | 45 | 48 | 51 | 3 | 54 | 6 |
| 25 | B | 3 | 110 | 57 | 57 | 0 | 58 | 1 |
| 26 | B | 4 | 90 | 58 | 58 | 0 | 60 | 2 |
| 27 | B | 1 | 180 | 52 | 56 | 4 | 58 | 6 |
| 28 | B | 1 | 135 | 61 | **66** | 5 | **70** | 9 |
| 29 | B | 1 | 65 | 59 | 63 | 4 | **66** | 7 |

| Site ID | Land Use Activity Category | Total Residences Represented | Closest Existing Road (feet) | Existing Noise Level (dBA) | No Build Alternative (2034) | | Build Alternative (2034) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Noise Level (dBA) | Change from Existing | Noise Level (dBA) | Change from Existing |
| 30 | B | 1 | 70 | 46 | 50 | 4 | 54 | 8 |
| 31 | B | 5 | 160 | 59 | 63 | 4 | **68** | 9 |
| 32 | B | 3 | 170 | 60 | 64 | 4 | **68** | 8 |
| 33 | B | 1 | 30 | 50 | 54 | 4 | 60 | **10** |
| 34 | B | 1 | 100 | 49 | 52 | 3 | 57 | 8 |
| 35 | B | 3 | 105 | 54 | 58 | 4 | 63 | 9 |
| 36 | B | 2 | 120 | 63 | **67** | 4 | **70** | 7 |
| 37 | B | 2 | 170 | 60 | 64 | 4 | **69** | 9 |
| 38 | B | 2 | 140 | 63 | **67** | 4 | **71** | 8 |
| 39 | B | 2 | 135 | 49 | 54 | 5 | 59 | **10** |
| 40 | B | 3 | 225 | 56 | 60 | 4 | 65 | 9 |
| 41 | B | 5 | 260 | 50 | 54 | 4 | 61 | **11** |
| 42 | B | 3 | 260 | 49 | 54 | 5 | 57 | 8 |
| 43 | B | 3 | 95 | 63 | **68** | 5 | **71** | 8 |
| 44 | B | 5 | 180 | 59 | 63 | 4 | **69** | **10** |
| 45 | B | 5 | 90 | 47 | 51 | 4 | 54 | 7 |
| 46 | B | 3 | 40 | 50 | 55 | 5 | 61 | **11** |
| 47 | B | 2 | 100 | 62 | **66** | 4 | **71** | 9 |
| 48 | B | 6 | 185 | 58 | 63 | 5 | **68** | **10** |
| 49 | B | 9 | 60 | 57 | 62 | 5 | **68** | **11** |
| 50 | B | 1 | 35 | 49 | 54 | 5 | 59 | **10** |
| 51 | B | 1 | 65 | **66** | **70** | 4 | **73** | 7 |

***BOLD** indicates an effect per the NAC.*

## 4.0 Effects and Benefits

This section identifies potential effects and benefits to noise conditions associated with the No Build Alternative and the Build Alternative. Effects and benefits are discussed in terms of temporary effects associated with construction activities, and long-term effects associated with the operation and maintenance of the facility or permanent changes resulting from the project. Indirect and cumulative effects of the project are documented in a separate report, *Indirect Effects and Cumulative Effects Discipline Report.*

### 4.1 Temporary Effects and Benefits

#### 4.1.1 No Build Alternative

The No Build Alternative includes WSDOT's continued routine maintenance, which consists of the short-term minor construction necessary for continued operation of the existing SR 502 corridor.

### 4.1.2 Build Alternative

Construction activities would generate noise during the construction period. Construction usually would be carried out in several reasonably discrete steps, each of which would have its own mix of equipment and, consequently, its own noise characteristics. Roadway construction would involve clearing and cut-and-fill (grading) activities as well as importing fill and paving. The Sunset Oaks wetland mitigation site and the Mill Creek North potential mitigation site may also have temporary effects from construction equipment. Construction activities for this project would begin in 2012 and last for about two years.

The most prevalent noise source at construction sites would be the internal combustion engine. Engine-powered equipment includes earth-moving equipment, material-handling equipment, and stationary equipment. Mobile equipment operates in an episodic fashion with periods of high and low noise, while stationary equipment, such as generators and compressors, operates at sound levels fairly constant over time. Because trucks would be present during most phases and would not be confined to the project site, noise from trucks could affect more area residents. Other construction noise sources would include impact-equipment and tools such as pile drivers. Impact-tools could be pneumatically powered, hydraulic, or electric.

Construction noise levels would depend on the type, amount, and location of construction activities. The type of construction methods would establish the maximum noise levels of construction equipment used. The amount of construction activity would quantify how often construction noise would occur throughout the day. The location of construction equipment relative to adjacent properties would determine any effects of distance in reducing construction noise levels. Estimates of maximum noise levels at a distance of 50 feet for various pieces of construction equipment are provided in Exhibit 12.

Exhibit 12. Construction Equipment Noise Levels

| Equipment Description | Does Device Result in Effect? | Acoustical Use Factor (%) | Spec 721.560 Lmax @ 50 feet (dBA, Slow) | Actual Measured Lmax @ 50 feet (dBA, Slow) |
|---|---|---|---|---|
| All Other Equipment > 5 HP | No | 50 | 85 | N/A |
| Auger Drill Rig | No | 20 | 85 | 84 |
| Backhoe | No | 40 | 80 | 78 |
| Bar Bender | No | 20 | 80 | N/A |
| Blasting | Yes | N/A | 94 | N/A |
| Boring Jack Power Unit | No | 50 | 80 | 83 |
| Chain Saw | No | 50 | 85 | 84 |
| Clam Shovel (dropping) | Yes | 20 | 93 | 87 |
| Compactor (ground) | No | 20 | 80 | 83 |
| Compressor (air) | No | 40 | 80 | 78 |
| Concrete Batch Plant | No | 15 | 83 | N/A |
| Concrete Mixer Truck | No | 40 | 85 | 79 |
| Concrete Pump Truck | No | 20 | 82 | 81 |
| Concrete Saw | No | 20 | 90 | 90 |
| Crane | No | 16 | 85 | 81 |
| Dozer | No | 40 | 85 | 82 |
| Drill Rig Truck | No | 20 | 84 | 79 |
| Drum Mixer | No | 50 | 80 | 80 |
| Dump Truck | No | 40 | 84 | 76 |
| Excavator | No | 40 | 85 | 81 |
| Flat Bed Truck | No | 40 | 84 | 74 |
| Front End Loader | No | 40 | 80 | 79 |
| Generator | No | 50 | 82 | 81 |
| Generator (<25 KVA, VMS signs) | No | 50 | 70 | 73 |
| Gradall | No | 40 | 85 | 83 |
| Grader | No | 40 | 85 | 83 |
| Grapple (on backhoe) | No | 40 | 85 | 87 |
| Horizontal Boring Hydr. Jack | No | 25 | 80 | 82 |
| Hydra Break Ram | Yes | 10 | 90 | N/A |
| Impact Pile Driver | Yes | 20 | 95 | 101 |
| Jackhammer | Yes | 20 | 85 | 89 |
| Man Lift | No | 20 | 85 | 75 |
| Mounted Impact Hammer (hoe | Yes | 20 | 90 | 90 |
| Pavement Scarafier | No | 20 | 85 | 90 |
| Paver | No | 50 | 85 | 77 |
| Pickup Truck | No | 40 | 55 | 75 |
| Pneumatic Tools | No | 50 | 85 | 85 |
| Pumps | No | 50 | 77 | 81 |
| Refrigerator Unit | No | 100 | 82 | 73 |
| Rivit Buster/Chipping Gun | Yes | 20 | 85 | 79 |
| Rock Drill | No | 20 | 85 | 81 |
| Roller | No | 20 | 85 | 80 |

| Equipment Description | Does Device Result in Effect? | Acoustical Use Factor (%) | Spec 721.560 Lmax @ 50 feet (dBA, Slow) | Actual Measured Lmax @ 50 feet (dBA, Slow) |
|---|---|---|---|---|
| Sand Blasting (Single Nozzle) | No | 20 | 85 | 96 |
| Scraper | No | 40 | 85 | 84 |
| Shears (on Backhoe) | No | 40 | 85 | 96 |
| Slurry Plant | No | 100 | 78 | 78 |
| Soil Mix Drill Rig | No | 50 | 80 | N/A |
| Tractor | No | 40 | 84 | N/A |
| Vacuum Excavator (Vac-truck) | No | 40 | 85 | 85 |
| Vacuum Street Sweeper | No | 10 | 80 | 82 |
| Ventilation Fan | No | 100 | 85 | 79 |
| Vibrating Hopper | No | 50 | 85 | 79 |
| Vibratory Concrete Mixer | No | 20 | 80 | 80 |
| Vibratory Pile Driver | No | 20 | 95 | 101 |
| Warning Horn | No | 5 | 85 | 83 |
| Welder/Torch | No | 40 | 73 | 74 |

*Source: FHWA 2006*

## 4.2 Long Term Effects and Benefits

The future noise levels were modeled using projected peak-hour volumes at posted speed limits (Appendix A) for the No Build Alternative and the Build Alternative which includes the proposed roadway improvements. The main source of noise is from vehicular traffic.

### 4.2.1 No Build Alternative

Noise levels for the No Build Alternative are predicted to increase by 0 to 5 dBA due to increases in traffic volumes (Appendix A). Noise levels would approach or exceed the Noise Abatement Criteria (NAC) at 15 out of 61 sites, representing 34 residential units and one church. See Exhibit 13 for the location of these affected sites.

### 4.2.2 Build Alternative

Noise levels for the Build Alternative are predicted to increase by 1 to 11 dBA relative to existing modeled noise levels (Exhibit 11) due to increases in the proximity to the widened roadway and the increases in vehicular traffic in the build year (2034). Noise levels would approach or exceed the NAC at 34 out of 61 sites, representing 96 residences and 3 churches. Twenty to thirty of the affected residences would be displaced under the Build Alternative. While increases in roadway noise occur at commercial sites in the study area none of these increases exceed the NAC under the Build Alternative. See Exhibit 13 and Exhibit 14 for the location of these affected sites. The Sunset Oaks wetland mitigation site and the Mill Creek North potential mitigation site would not have any long term noise effects under the Build Alternative.

Exhibit 13. Sites Affected by Roadway Noise West Study Area

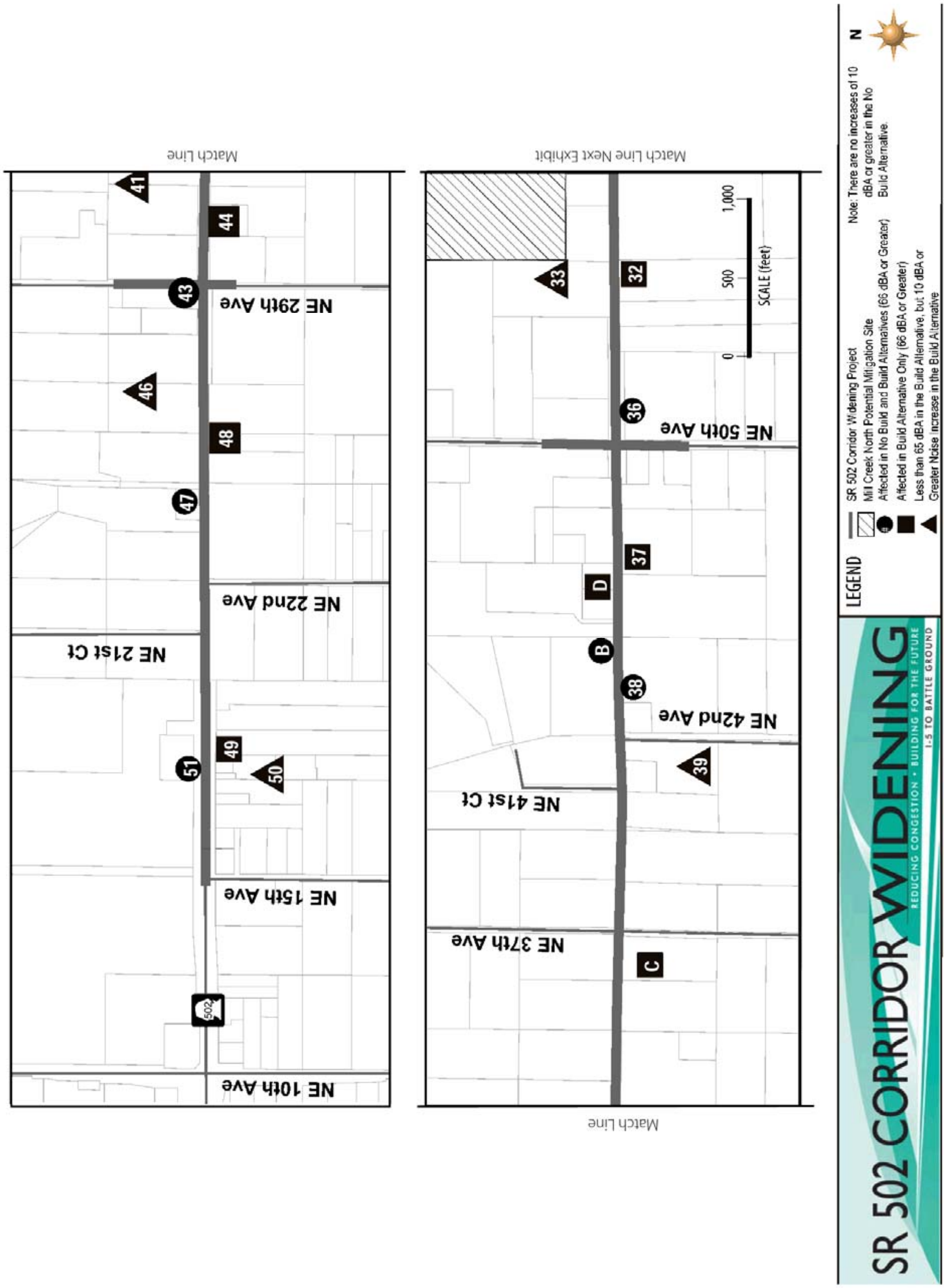
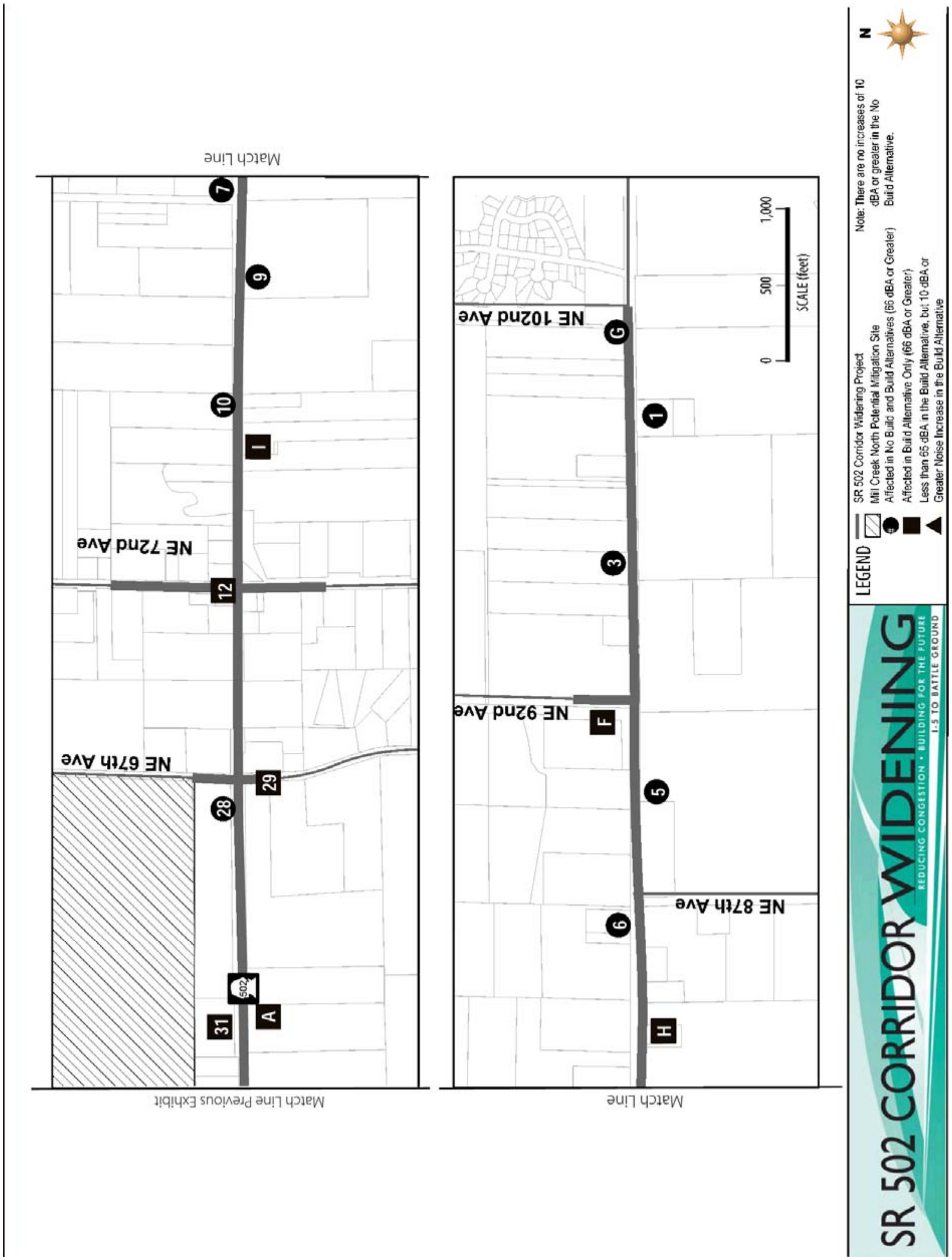


Exhibit 14. Sites Affected by Roadway Noise East Study Area



# 5.0 Abatement

This section discusses potential abatement measures that could be used to avoid or minimize noise effects. Potential abatement measures are discussed for the temporary effects and the long-term effects of the Build Alternative only.

Noise can be controlled at three locations: 1) at the source, such as with mufflers and quieter engines; 2) along the noise path, with barriers; and 3) at the receptor, with insulation. Noise abatement is necessary only where frequent human use occurs and where a lower noise level would provide benefits (U.S. DOT, 1982).

## 5.1 Abatement for Temporary Effects

Several construction noise abatement methods can be implemented to limit the effect on the noise environment. The following list of standard noise control specifications could be incorporated into construction contracts for the abatement of construction noise:

- Limiting noisier construction activities, such as pile-driving and jack-hammering, to between 7 a.m. and 10 p.m. to reduce construction noise levels during sensitive nighttime hours;
- Equipping and maintaining construction equipment engines with adequate mufflers to reduce their noise by 5 to 10 dBA (U.S. EPA, 1971);
- Turning off construction equipment during prolonged periods of nonuse to eliminate noise;
- Locating stationary equipment such as compressors or generators away from noise-sensitive receptors to decrease noise.

## 5.2 Abatement for Long-Term Effects

A variety of abatement methods can effectively reduce traffic noise levels. For example, noise generated from long-term operation of the project could be reduced by implementing traffic management measures, acquiring land as buffer zones or for constructing noise barriers or berms, realigning the roadway, noise insulating public use or nonprofit institutional structures, and constructing noise barriers or berms. Each of these measures was evaluated for its potential to reduce noise impacts from the project. The results of this evaluation are summarized in this section. Final determination of the size and placement of noise barriers or berms, and implementation of other abatement methods would take place during detailed project design, after an opportunity for public involvement and after approval at the local, state, and federal levels.

### 5.2.1 Traffic Management Measures

Traffic management measures include time restrictions or traffic control devices and signing to prohibit certain vehicle types (i.e., motorcycles and heavy trucks), modify speed limits, and implement exclusive lane designations.

Restricting vehicle types and lowering speed limits on SR 502 could worsen congestion and is contrary to the purpose of the facility. Land use controls could help reduce noise impacts throughout the study area. A transportation system management plan combined with increased transit facilities to encourage the use of car pools and public transit, could reduce vehicle trips and subsequently traffic noise. However, a 3-dBA decrease in traffic noise would require an approximately 50-percent reduction in traffic. Additionally SR 502 is a National Highway System route for which traffic management measures are not used. Traffic management as a abatement measures is not reasonable.

### 5.2.2 Land Acquisitions for Noise Buffers or Barriers

Ninety-six residences and three churches are affected by increased roadway noise either as an increase of at least 10 dBA or an increase that exceeds the NAC. It is unreasonably expensive to relocate this quantity of structures for the purpose of noise abatement and could also have increased environmental impacts.

### 5.2.3 Realigning the Roadway

The project's horizontal alignment is defined by available right of way and the need for the facility to connect the City of Battle Ground with areas to the west including I-5. Lowering the vertical profile of the facility to provide for abatement of noise would remove access to homes along the corridor; therefore, this is not feasible. Lowering the vertical profile of the roadway would also be difficult due to the surrounding water table. Acquiring land to realign the roadway would be too costly to be considered reasonable for noise abatement.

### 5.2.4 Noise Insulation of Buildings

Insulation of buildings could be feasible, but this remedy only applies to structures with public or non-profit uses (23 CFR 772 and 67 FR 13731, March 26, 2002). This option also would not reduce exterior noise effects.

Three churches would be affected by an increase in roadway noise under the Build Alternative. The appropriate criterion at these sites is 52 dBA (NAC Category E) inside the building with the windows closed. The FHWA indicates that lower noise levels occur inside structures than outside. Exhibit 15 shows typical noise reduction factors inside of structures. Each of the building types at the three churches are light frame. The churches also have storm windows. Exhibit 15 indicates the predicted noise levels inside each of the churches under several conditions. To predict these noise levels receptors were placed at the façade of each church and modeled. With the windows closed noise levels inside the churches is below 52 dBA (NAC Category E) therefore abatement is not warranted.

Additionally the churches in the SR 502 study area residential equivalencies can be found in Exhibit 16. None of the churches have a residential equivalency of one. In other words none of the churches can be considered for abatement because in order to be considered they would need to have a residential equivalency of at least one residence per the WSDOT Noise Analysis and Abatement Policy and Procedures (WSDOT, 2006).

Exhibit 15. WSDOT Building Noise Reduction Factors

| Location | Building Type | Window Condition | Noise Reduction (dBA) | Site B Noise Levels (dBA) | Site C Noise Levels (dBA) | Site F Noise Levels (dBA) |
|---|---|---|---|---|---|---|
| Façade | All | All | 0 | 71 | 66 | 68 |
| Interior | Light Frame | Ordinary Sash (closed) | 20 | 51 | 46 | 48 |
| Interior | Light Frame | Storm Windows | 25 | 46 | 41 | 43 |
| Interior | Masonry | Single Glazed | 25 | 46 | 41 | 38 |
| Interior | Masonry | Double Glazed | 35 | 36 | 31 | 28 |

*Source: Table 7 FHWA Highway Traffic Noise Analysis and Abatement Policy and Guidance, June 1995.*

Exhibit 16. Residential Equivalency for Churches

| Location | Hours/Day | Days/Week | Months/Year | Total Hours Use | Maximum Possible Hours | Usage Factor |
|---|---|---|---|---|---|---|
| Site B | 1 | 1 | 12 | 12 | 2016 | 0.01 |
| Site C | 0 | 0 | 0 | 0 | 2016 | 0.00 |
| Site F | 1 | 2 | 12 | 24 | 2016 | 0.01 |

*Source: PB April 2008.*

### 5.2.5 Noise Barriers

WSDOT evaluates many factors to determine whether barriers will be feasible and reasonable. To be feasible, a barrier must be constructible in a location that achieves a noise reduction of at least 7 dBA at one or more sites and a reduction of at least 5 dBA at most of the first row sites. In order for the barrier to be feasible, it must break the line of sight to SR 502.

There are 96 residences and 3 churches affected by an increase in roadway noise under the Build Alternative. Each of these sites requires access to SR 502. A continuous wall would need to be constructed along SR 502 to break the line of sight. Such a barrier would cut off access to SR 502 from the sites. To accommodate the noise barrier a frontage road would need to be constructed which would require additional right of way. The costs associated with acquiring land for additional right of way for a frontage road is not reasonable for this project. Additionally, a frontage road would likely displace many homes or businesses. Therefore construction of a barrier is not reasonable for noise abatement.

### 5.2.6 Summary of Feasible and Reasonable Abatement

Exhibit 17 summarizes the feasible and reasonable determination for each of the abatement categories listed above.

Exhibit 17. Summary of Abatement Methods

| Abatement Method | Determination |
|---|---|
| Traffic Management Measures | Not reasonable (counter to the purpose of the SR 502 facility) |
| Land acquisition for noise buffers and barriers | Not reasonable (too costly) |
| Realigning the Roadway | Not reasonable (too costly) |
| Noise Insulation of Buildings | Not reasonable because interior noise levels are below 52 dBA (NAC Category E) |
| Noise Barriers | Not reasonable (too costly) |

## 6.0 References

U.S. Department of Transportation, Federal Highway Administration, 1973. *Fundamentals and Abatement of Highway Traffic Noise*. Washington D.C.

U.S. Department of Transportation, Federal Highway Administration, 1982. *"Procedures for Abatement of Highway Traffic Noise and Construction Noise."* Federal-Aid Highway Program Manual. Volume 7, Chapter 7, Section 3. Washington, D.C.

U.S. Department of Transportation, Federal Highway Administration, 1996. *Measurement of Highway-Related Noise*. Washington D.C.

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

U.S. Department of Transportation, Federal Highway Administration, 1998, 2004. *FHWA Traffic Noise Model User's Guide*. Washington D.C.

U.S. Department of Transportation, Federal Highway Administration, 2006. *FHWA Highway Construction Noise Handbook and Roadway Construction Noise Model (RCNM, ver 1.0)*. Washington D.C.

U.S. Environmental Protection Agency, 1974. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*. Report Number 550/9-74-004.

Washington Administrative Code, 1989. Chapter 173-60. *Maximum Environmental Noise Levels*. Olympia, Washington.

Washington State Department of Transportation, 2006. *Traffic Noise Analysis and Abatement Policy and Procedures*. Olympia, Washington.

Washington State Department of Transportation, March 1987. Directive D22-22, *Noise Evaluation Procedures for Existing Highways*. Olympia, Washington

Washington State Department of Transportation, April 2008. SR 502 Corridor Widening Transportation Discipline Report. Olympia, Washington

Mabrey, Michael. 2007. Planner III, Clark County Community Planning. In-person communication. 7 November 2007.

Clark County Noise, 2005. *Clark County Code, Chapter 9.14.01*0, Clark County, Washington.

City of Battle Ground, 1998. *Municipal Code, Chapter 9.42.010*. City of Battle Ground, Washington.

Clark County Community Development, 2007. *Clark County Development Projects Weekly Report*. http://www.clark.wa.gov/commdev/documents/devservices/agendas/report-10-17-07.pdf. 7 October 2007.

Pearrow, Ken. GIS Coordinator, Clark County Department of Assessment and GIS. Email communication. 21 November 2007

# 7.0 Glossary

| | |
|---|---|
| **Abatement** | A reduction in degree or intensity. |
| **Affected Property Owners (Residences, Receivers and Receptors)** | Within 500 feet of pavement edge line (commonly known as fog line, ref. o), all property owners who are found to benefit from a 3dBA or greater noise reduction as a result of the proposed abatement; or, receivers directly behind the barrier who will have visual blockage as a result of proposed abatement but who may not benefit from abatement. |
| **Ambient sound** | Noise levels of the surrounding area. |
| **Approach** | This term has been defined as 1 dBA below the set FHWA Noise Abatement Criteria (NAC). |
| **A-Weighted Sound Level (dBA)** | The sound pressure levels in decibels measured with a frequency weighting network corresponding to the A-scale on a standard sound level meter as specified by ANSI S1.4-1971. The A-scale tends to suppress lower frequencies, (e.g., below 1,000 Hz) and best approximates the sound as heard by the normal human ear. |
| **Background Sound** | The total of all sound in a system or situation, independent of highway traffic noise under study. |
| **Barrier** | A solid wall or earth berm located between the roadway and receiver location that provides noise reduction. |
| **Benefited** | Property owners (receivers) within 500 feet of the highway edge line (fog line) found to receive a 3 dBA or greater traffic sound level reduction as a result of the proposed abatement. |
| **CFR** | The Code of Federal Regulations. |
| **Date of Public Knowledge** | The original date of approval of the initial National Environmental Policy Act (NEPA) Record of Decision (ROD), Finding of No Significant Impact (FONSI), or State Environmental Policy Act (SEPA) document. If there are two conflicting dates for state and federal environmental documents, the NEPA document date shall take precedence. |
| **dBA** | (see Decibel) |
| **Decibel** | Decibel is a unit for relative sound intensity. For highway traffic noise, an adjustment, or weighting, of the high and low-pitched sounds is made to approximate the way that an average person hears sounds. The adjusted sounds are called "A-weighted levels" (dBA) |

**Department** — Washington State Department of Transportation, also known as WSDOT.

**Design Year** — The future year used to estimate the probable traffic volume for which a highway is designed. A time, usually 20 years from the year construction is scheduled to begin, is generally used.

**Existing Sound Level** — The current sound level, made up of all natural and human-made sounds, considered to be usually present within a particular area's acoustic environment.

**Feasible (noise)** — Feasible refers to whether the barrier can provide a substantial (at least seven decibels) reduction in noise and other constructability issues.

**Heavy Truck** — Any vehicle having three or more axles and designed for the transportation of cargo. Generally, the gross weight is greater than 26,000 pounds (12,000 kilograms).

**Highway** — The entire width between the right of way boundary lines of every publicly maintained travel way when any part thereof is open to the public use for purposes of motorized vehicular travel (reference k). May also be referred to as a street or road.

**Impacted Community** — A grouping of acoustically sensitive receptor sites that reflect the group of citizens exposed to traffic sound levels at least approaching the noise abatement criteria or increasing to substantially exceed existing sound levels due to a project.

**Insertion Loss** — The actual acoustical benefit derived from a sound barrier.

**Leq** — The equivalent steady-state sound level that, in a stated period of time, contains the same acoustic energy as the time-varying sound level during the same period.

**Majority** — Defined as 60% of the first row residents or residential equivalents and 55% of all other residents or residential equivalents behind the proposed barrier where property lines are within 500 feet of the pavement edge line (fog line).

**Medium Trucks** — All vehicles having two axles and six wheels designed for the transportation of cargo. Generally, the gross vehicle weight is greater than 10,000 pounds (4,500 kilograms) but less than 26,000 pounds (12,000 kilograms).

| | |
|---|---|
| **Noise abatement criteria** | If future noise levels with a project are predicted to approach or exceed the FHWA noise criteria at a sensitive receptor, abatement is evaluated at the receptor. For residences, the criterion is 67 dBA. WSDOT considers a noise impact to occur if the noise level is within 1 dBA of the 67 dBA criterion. |
| **Noise Abatement Criteria** | Sound levels for various activities or land uses that represent traffic sound levels that identify highway traffic noise impacts. One way traffic noise impacts are identified are when traffic noise levels in the design year of a project approach or exceed the NAC for residences or residential equivalents within 500 feet of the pavement edge line (fog line). See NAC table above in Section 2. |
| **Planned, Designed, and Programmed (or Date of Development)** | A new development is so designated when a definite commitment and local approval has been made to develop the property in question, and there is also official local knowledge and approvals that such development has been "planned, designed, and programmed." A definite commitment means that a developer has shown a definite interest to develop the land within a reasonable amount of time and has reached a point where he/she can no longer practically change his/her plans. For noise analysis purposes under this policy, the commitment is identified as the date of issuance of the building permit. |
| **Reasonable (noise)** | Reasonable refers to the maximum cost per residence benefiting from the noise abatement. |
| **Sensitive receptors** | Sensitive receptors represent all land use activity categories where FHWA noise abatement criteria specify exterior and interior noise levels. Land use activity categories include residences, recreation areas, hotels, schools, churches, libraries, and hospitals. |
| **Severe impact (noise)** | Severe noise impacts occur when traffic noise levels reach 75 dBA and higher for outdoor activity areas or when predicted noise levels exceed existing levels by 15 dBA over existing noise levels. |
| **Severe Traffic Sound Level Impacts** | Traffic sound levels of 80 dBA Leq and higher for outdoor activity areas. Measurements must be in accordance with reference c. |
| **Severely Exceed** | A 30-dBA increase over existing sound levels. |
| **Shielding Objects** | Natural or artificial barriers (blockage) (e.g., natural topography, house rows, vegetation) that intervene between a noise source and receiver. |

| | |
|---|---|
| **Significant Change in Horizontal or Vertical Alignment** | A relocation of the highway that would result in an increase in the noise environment for affected residences (receivers) or residential equivalent locations by three or more decibels. |
| **Sound Level Measurements** | Measurements taken by the acoustics analyst or qualified staff person to calibrate and validate the traffic noise model for the existing year and design year. |
| **Sound Level Meter Calibration** | A step to assure accuracy of a sound level measurement instrument (meter). Occurs in two circumstances: |
| **Substantially Exceed, Tier 1** | A 10-dBA increase over existing sound levels. |
| **Substantially Exceed, Tier 2** | A 15-dBA increase over existing sound levels. |
| **Traffic Noise Impacts** | Impacts which occur when the predicted traffic sound levels approach or exceed the Noise Abatement Criteria or when the predicted traffic sound levels substantially exceed the existing sound levels. |
| **Traffic Through Lanes** | A portion of the paved roadway surface (highway) on which motor vehicles are allowed to travel and extends between two access points (public intersections and interchanges). Access points do not include driveways. Interchange ramp lanes are considered as traffic through lanes except when expanded to add vehicle storage. |
| **Validation** | Comparison of measured traffic sound levels with current modeled traffic sound levels in the same location to ensure the traffic noise model is developed and constructed properly. The difference between measured and modeled sound levels must be within 2 decibels (dBA). |
| **Worst Case Noise Hour** | A period of (60) minutes throughout a (24) hour day in the existing year and future design year that reflects the peak traffic noise hour, usually associated with the peak traffic hour but not in every instance (e.g., where high traffic volumes cause vehicle speeds to drop far below the posted speed). Identification of this hour is not applicable for field sound level measurements used to calibrate and validate the model. |
| **WSDOT** | Washington State Department of Transportation. Also know as the department. |
| **Abatement** | A reduction in degree or intensity. |

*Source: WSDOT, March 2006 and PB, February 2008*

# Appendix A

# Traffic Data

(From the SR 502 Corridor Widening Transportation Discipline Report, 2008)

| Location | Peak Hour Traffic Volumes | | | Truck Percentages | | | Speed (mph) |
|---|---|---|---|---|---|---|---|
| | 2006 Existing | 2034 No Build | 2034 Build | Small (Single Unit) | Medium (Double Unit) | Large (Triple Unit) | |
| **Eastbound on SR 502** | | | | | | | |
| NE 15th Ave to NE 22nd Ave | 751 | 1954 | 2084 | 4% | 1% | 0% | 50 |
| NE 22nd Ave to NE 29th Ave | 767 | 1982 | 2125 | 4% | 1% | 0% | 50 |
| NE 29th Ave to NE 37th Ave | 748 | 2023 | 2204 | 4% | 1% | 0% | 50 |
| NE 37th Ave to NE 42nd Ave | 752 | 2063 | 2248 | 4% | 1% | 0% | 50 |
| NE 42nd Ave to NE 50th Ave | | 2056 | 2248 | 4% | 1% | 0% | 50 |
| NE 50th Ave to NE 67th Ave | 762 | 2019 | 2184 | 4% | 1% | 0% | 50 |
| NE 67th Ave to NE 72nd Ave | 787 | 2007 | 2198 | 4% | 1% | 0% | 35 |
| NE 72nd Ave to NE 82nd Ave | 796 | 1959 | 2155 | 4% | 1% | 0% | 35 |
| NE 82nd Ave to NE 87th Ave | | 1969 | 2153 | 4% | 1% | 0% | 50 |
| NE 87th Ave to NE 92nd Ave | | 2013 | 2146 | 4% | 1% | 0% | 50 |
| East of NE 92nd Ave | 808 | 1986 | 2086 | 4% | 1% | 0% | 50 |
| **Westbound on SR 502** | | | | | | | |
| East of NE 92nd Ave | 577 | 1375 | 1400 | 4% | 1% | 0% | 50 |
| NE 92nd Ave to NE 87th Ave | 566 | 1449 | 1503 | 4% | 1% | 0% | 50 |
| NE 87th Ave to NE 82nd Ave | | 1439 | 1508 | 4% | 1% | 0% | 50 |
| NE 82nd Ave to NE 72nd Ave | | 1493 | 1528 | 4% | 1% | 0% | 35 |
| NE 72nd Ave to NE 67th Ave | 518 | 1405 | 1495 | 4% | 1% | 0% | 35 |
| NE 67th Ave to NE 50th Ave | 529 | 1439 | 1496 | 4% | 1% | 0% | 50 |
| NE 50th Ave to NE 42nd Ave | 518 | 1432 | 1535 | 4% | 1% | 0% | 50 |
| NE 42nd Ave to NE 37th Ave | | 1435 | 1547 | 4% | 1% | 0% | 50 |
| NE 37th Ave to NE 29th Ave | 520 | 1455 | 1568 | 4% | 1% | 0% | 50 |
| NE 29th Ave to NE 22nd Ave | 435 | 1325 | 1411 | 4% | 1% | 0% | 50 |
| NE 22nd Ave to NE 15th Ave | 446 | 1330 | 1411 | 4% | 1% | 0% | 50 |
| **Northbound** | | | | | | | |
| NE 15th Ave south of SR 502 | 9 | 14 | 14 | 2.5% | 0% | 0% | 30 |
| NE 22nd Ave south of SR 502 | 37 | 60 | 60 | 2.5% | 0% | 0% | 30 |
| NE 29th Ave south of SR 502 | 86 | 314 | 298 | 8% | 0% | 0% | 30 |
| NE 29th Ave north of SR 502 | 105 | 376 | 372 | 8% | 0% | 0% | 30 |
| NE 37th Ave south of SR 502 | 54 | 90 | 92 | 2.5% | 0% | 0% | 30 |
| NE 37th Ave north of SR 502 | 36 | 57 | 47 | 2.5% | 0% | 0% | 30 |
| NE 42nd Ave south of SR 502 | | 28 | 28 | 2.5% | 0% | 0% | 30 |
| NE 50th Ave south of SR 502 | 85 | 312 | 311 | 2.5% | 0% | 0% | 30 |
| NE 50th Ave north of SR 502 | 80 | 343 | 339 | 2.5% | 0% | 0% | 30 |
| NE 67th Ave south of SR 502 | 39 | 48 | 68 | 2.5% | 0% | 0% | 30 |
| NE 67th Ave north of SR 502 | 50 | 57 | 48 | 2.5% | 0% | 0% | 30 |
| NE 72nd Ave south of SR 502 | 608 | 978 | 978 | 5% | 0% | 0% | 30 |
| NE 72nd Ave north of SR 502 | 565 | 909 | 898 | 5% | 0% | 0% | 30 |

| Location | Peak Hour Traffic Volumes | | | Truck Percentages | | | Speed (mph) |
|---|---|---|---|---|---|---|---|
| | 2006 Existing | 2034 No Build | 2034 Build | Small (Single Unit) | Medium (Double Unit) | Large (Triple Unit) | |
| NE 82nd Ave north of SR 502 | | 30 | 30 | 2.5% | 0% | 0% | 30 |
| NE 87th Ave south of SR 502 | | 13 | 13 | 2.5% | 0% | 0% | 30 |
| NE 92nd Ave south of SR 502 | | 178 | 178 | 2.5% | 0% | 0% | 30 |
| NE 92nd Ave north of SR 502 | 72 | 94 | 93 | 2.5% | 0% | 0% | 30 |
| **Southbound** | | | | | | | |
| NE 15th Ave south of SR 502 | 9 | 14 | 15 | 2.5% | 0% | 0% | 30 |
| NE 22nd Ave south of SR 502 | 10 | 16 | 19 | 2.5% | 0% | 0% | 30 |
| NE 29th Ave south of SR 502 | 61 | 211 | 204 | 8% | 0% | 0% | 30 |
| NE 29th Ave north of SR 502 | 54 | 203 | 203 | 8% | 0% | 0% | 30 |
| NE 37th Ave south of SR 502 | 40 | 57 | 48 | 2.5% | 0% | 0% | 30 |
| NE 37th Ave north of SR 502 | 40 | 78 | 68 | 2.5% | 0% | 0% | 30 |
| NE 42nd Ave south of SR 502 | | 32 | 25 | 2.5% | 0% | 0% | 30 |
| NE 50th Ave south of SR 502 | 54 | 280 | 273 | 2.5% | 0% | 0% | 30 |
| NE 50th Ave north of SR 502 | 47 | 274 | 268 | 2.5% | 0% | 0% | 30 |
| NE 67th Ave south of SR 502 | 12 | 59 | 54 | 2.5% | 0% | 0% | 30 |
| NE 67th Ave north of SR 502 | 19 | 41 | 49 | 2.5% | 0% | 0% | 30 |
| NE 72nd Ave south of SR 502 | 311 | 780 | 739 | 5% | 0% | 0% | 30 |
| NE 72nd Ave north of SR 502 | 253 | 527 | 527 | 5% | 0% | 0% | 30 |
| NE 82nd Ave north of SR 502 | | 30 | 30 | 2.5% | 0% | 0% | 30 |
| NE 87th Ave south of SR 502 | | 25 | 20 | 2.5% | 0% | 0% | 30 |
| NE 92nd Ave south of SR 502 | | 147 | 145 | 2.5% | 0% | 0% | 30 |
| NE 92nd Ave north of SR 502 | 43 | 110 | 110 | 2.5% | 0% | 0% | 30 |

*Notes: mph = miles per hour*

# Appendix B

# Noise Field Data

**Parsons Brinckerhoff Quade & Douglas Inc.**

**Noise Measurement Data Sheet**

| Project SR 502 | Date 1-22-07 | Sheet No. 1 |
|---|---|---|
| Road SR 502 | | By: SN |

## Equipment Check

| | | | | |
|---|---|---|---|---|
| ☒ A-Weight | ☒ Fast Response | ☐ Slow Response | ☐ Battery Check | ☐ Range |
| ☒ Wind Screen | ☒ Other Setting | Calibrator | Model 1503 | Serial No. 2399 |

## Meteorology

| | | |
|---|---|---|
| Temperature 70° °F | Humidity 50 in mg | Cloud cover ∅ % |
| Wind Speed ∅ mph | Wind Direction N__ S__ E__ W__ | Notes — |

## Noise Measurement

| Site No. A | Meter Model 820 Serial No. 1313 | Calib. Before 114 After 113.8 |
|---|---|---|
| Begin Time: 1:40 | L (1) 64.4 | Noise Sources |
| End Time: 1:55 | L (5) 61.7 | |
| $L_{EQ}$ 56.8 | L (10) ~~53.5~~ 60.0 | |
| $L_{MAX}$ 72.5 | L (20) ~~51.9~~ 58.7 | |
| $L_{MIN}$ 37.8 | L (50) 54.9 | |
| Peak 104.8 | L (90) 45.3 | |

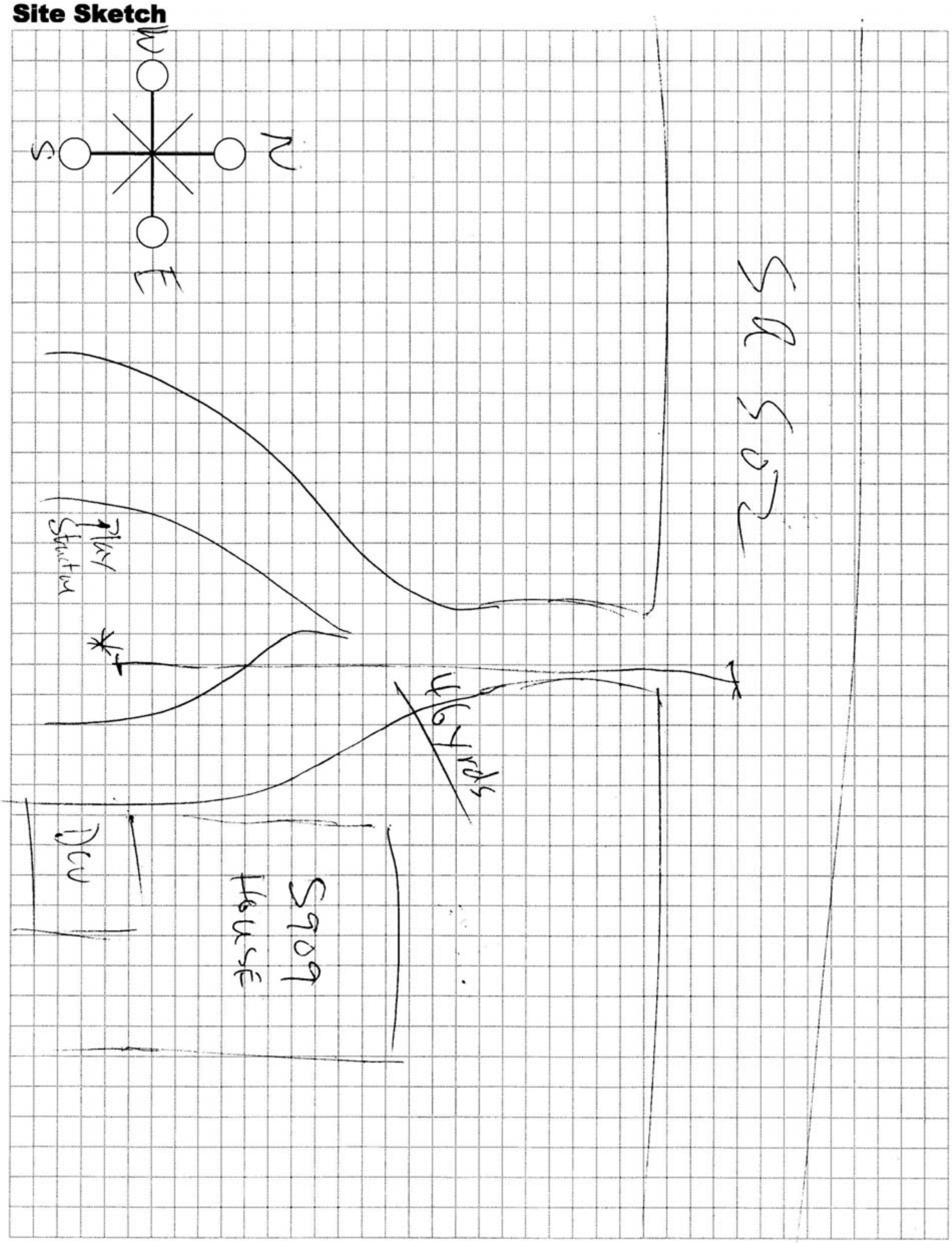
## Traffic Data

| Roadway Description | 502 WB | | 502 EB | | | |
|---|---|---|---|---|---|---|
| Count Duration 10 min. | Count | VPH | Count | VPH | Count | VPH |
| Autos | 44 | 264 | 44 | 264 | | |
| Med. Trucks (6 tires, 2 axles) | 5 | 30 | 3 | 18 | | |
| Heavy Trucks (more than 2 axels) | 1 | 6 | 2 | 12 | | |
| Speed (mph) | 50 | | 50 | | | |

## Photographs

| Number | Notes |
|---|---|
| 14, 15, 16 | 5909 SR 502 |

**Site Sketch**



**Parsons Brinckerhoff Quade & Douglas Inc.**

# Noise Measurement Data Sheet

| Project SR 502 | Date 10-22-07 | Sheet No. 1 |
|---|---|---|
| Road SR 502 | | By: SN |

## Equipment Check

| | | | | |
|---|---|---|---|---|
| ☑ A-Weight | ☐ Fast Response | ☑ Slow Response | ☑ Battery Check | ☑ Range |
| ☑ Wind Screen | ☑ Other Setting | Calibrator 1501? Model | Serial No. 2399 | |

## Meteorology

| | | |
|---|---|---|
| Temperature 72 °F | Humidity 50 in mg | Cloud cover 0 % |
| Wind Speed — mph | Wind Direction N__ S__ E__ W__ | Notes — |

## Noise Measurement

| Site No. 13 | Meter Model 820 Serial No. 1313 | Calib. Before 114 After 114 |
|---|---|---|
| Begin Time: 2115 | L (1) 71.6 | Noise Sources |
| End Time: 2130 | L (5) 67.6 | |
| $L_{EQ}$ 62.9 | L (10) 65.9 | |
| $L_{MAX}$ 81.2 | L (20) 64.0 | |
| $L_{MIN}$ 46.6 | L (50) 60.4 | |
| Peak 93.7 | L (90) 53.5 | |

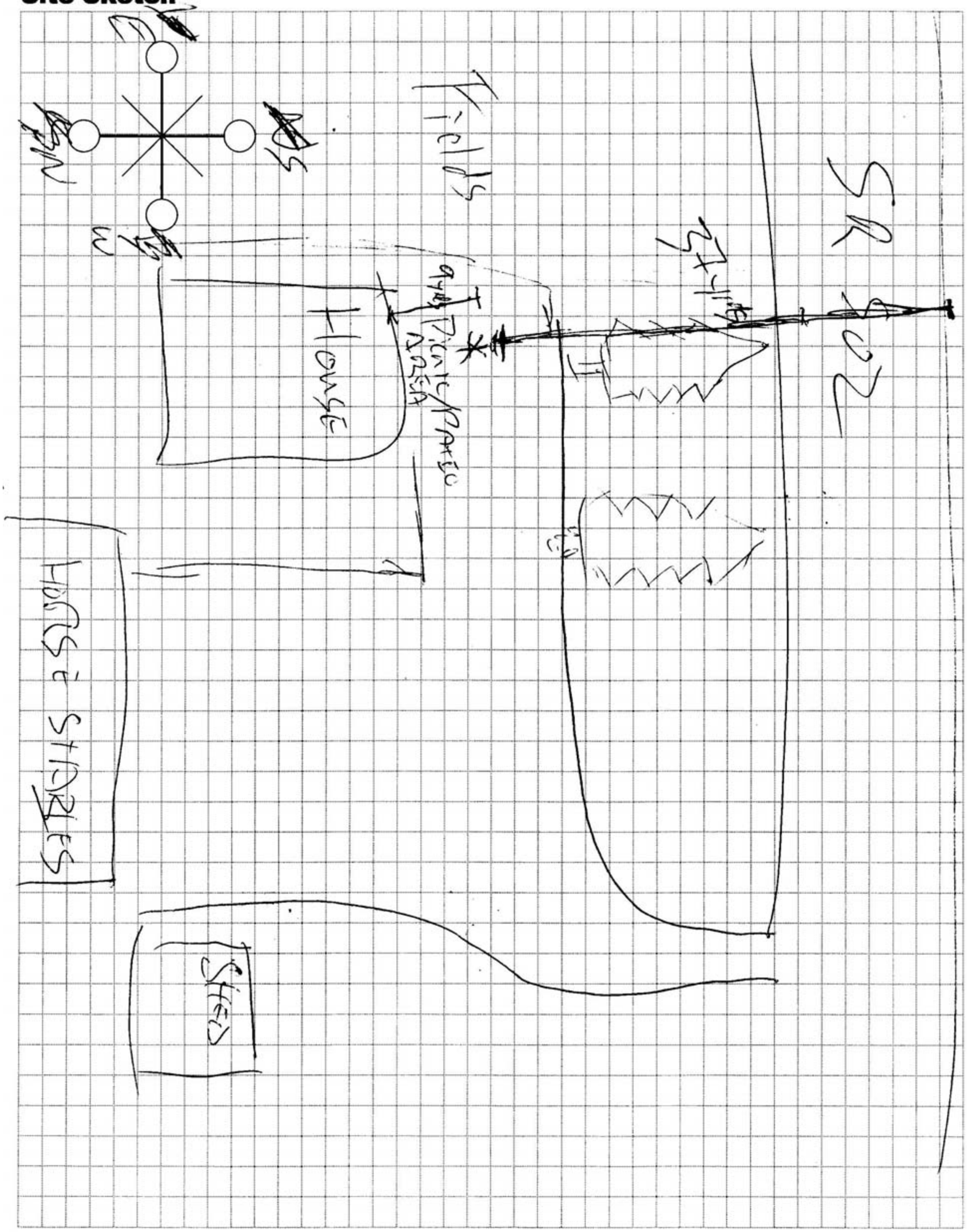
## Traffic Data

| Roadway Description | 502 WB | | 502 EB | | | |
|---|---|---|---|---|---|---|
| Count Duration 10 min. | Count | VPH | Count | VPH | Count | VPH |
| Autos | 48 | 288 | 63 | 378 | | |
| Med. Trucks (6 tires, 2 axles) | 2 | 12 | 0 | 0 | | |
| Heavy Trucks (more than 2 axels) | 1 | 6 | 6 | 36 | | |
| Speed (mph) | 50 | | 50 | | | |

## Photographs

| Number | Notes |
|---|---|
| | COWBOY CHURCH |

**Site Sketch**



**Parsons Brinckerhoff Quade & Douglas Inc.**

# Noise Measurement Data Sheet

| | | |
|---|---|---|
| Project SR 502 | Date 10-22-07 | Sheet No. 1 |
| Road SR 502 | | By: SN |

## Equipment Check

| | | | | |
|---|---|---|---|---|
| ☒ A-Weight | ☒ Fast Response | ☒ Slow Response | ☒ Battery Check | ☒ Range |
| ☒ Wind Screen | ☒ Other Setting | Calibrator | Model 1503 | Serial No. 2399 |

## Meteorology

| | | |
|---|---|---|
| Temperature 75 °F | Humidity 30 in mg | Cloud cover Ø % |
| Wind Speed Ø mph | Wind Direction N__ S__ E__ W__ | Notes |

## Noise Measurement

| | | | |
|---|---|---|---|
| Site No. C | Meter Model 820 Serial No. 1313 | Calib. Before 114.0 After 114.1 | |
| Begin Time: 2:58 | L (1) 64.6 | Noise Sources | |
| End Time: 3:13 | L (5) 61.1 | SR 502 | |
| $L_{EQ}$ 55.9 | L (10) 59.1 | Wood chipper @ 100 yards | |
| $L_{MAX}$ 70.0 | L (20) 56.9 | 1 Airplane | |
| $L_{MIN}$ 42.3 | L (50) 53.6 | | |
| Peak 82.3 | L (90) 47.0 | | |

## Traffic Data

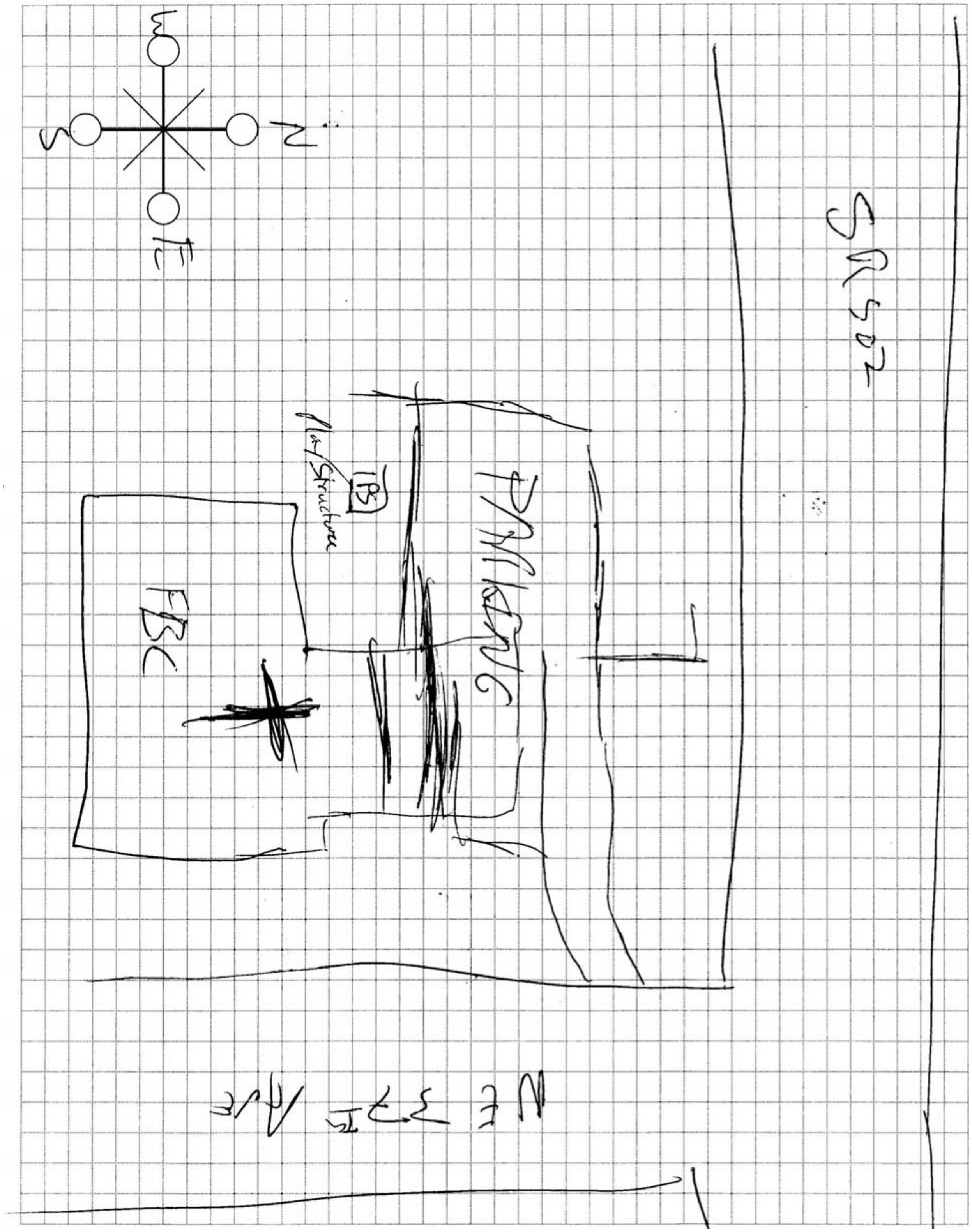
| Roadway Description | 502 WB | | 502 EB | | | |
|---|---|---|---|---|---|---|
| Count Duration 10 min. | Count | VPH | Count | VPH | Count | VPH |
| Autos | 58 | 348 | 54 | 324 | | |
| Med. Trucks (6 tires, 2 axles) | 1 | 6 | 1 | 6 | | |
| Heavy Trucks (more than 2 axels) | 3 | 18 | 2 | 12 | | |
| Speed (mph) | 50 | | 50 | | | |

## Photographs

| Number | Notes |
|---|---|
| | Fellowship Bible Church |

21810 NE 37th Ave

**Site Sketch**



**Parsons Brinckerhoff Quade & Douglas Inc.**

# Noise Measurement Data Sheet

| Project SR 502 | Date 10-22-07 | Sheet No. 1 |
|---|---|---|
| Road SR 502 | | By: SN |

## Equipment Check

| | | | | |
|---|---|---|---|---|
| [X] A-Weight | [x] Fast Response | [x] Slow Response | [x] Battery Check | [x] Range |
| [x] Wind Screen | [x] Other Setting | Calibrator | Model 1503 | Serial No. 2399 |

## Meteorology

| | | |
|---|---|---|
| Temperature 75 °F | Humidity 20 in mg | Cloud cover 0 % |
| Wind Speed 0 mph | Wind Direction N__ S__ E__ W__ | Notes |

## Noise Measurement

| Site No. D | Meter | Model 820 | Serial No. 1313 | Calib. | Before 114.0 | After 114.0 |
|---|---|---|---|---|---|---|
| Begin Time: 4:00 | L (1) | 66.4 | Noise Sources | | | |
| End Time: 4:15 | L (5) | 63.4 | SR 502 | | | |
| $L_{EQ}$ 58.9 | L (10) | 62.1 | | | | |
| $L_{MAX}$ 72.0 | L (20) | 60.4 | | | | |
| $L_{MIN}$ 40.5 | L (50) | 57.2 | | | | |
| Peak 84.3 | L (90) | 49.2 | | | | |

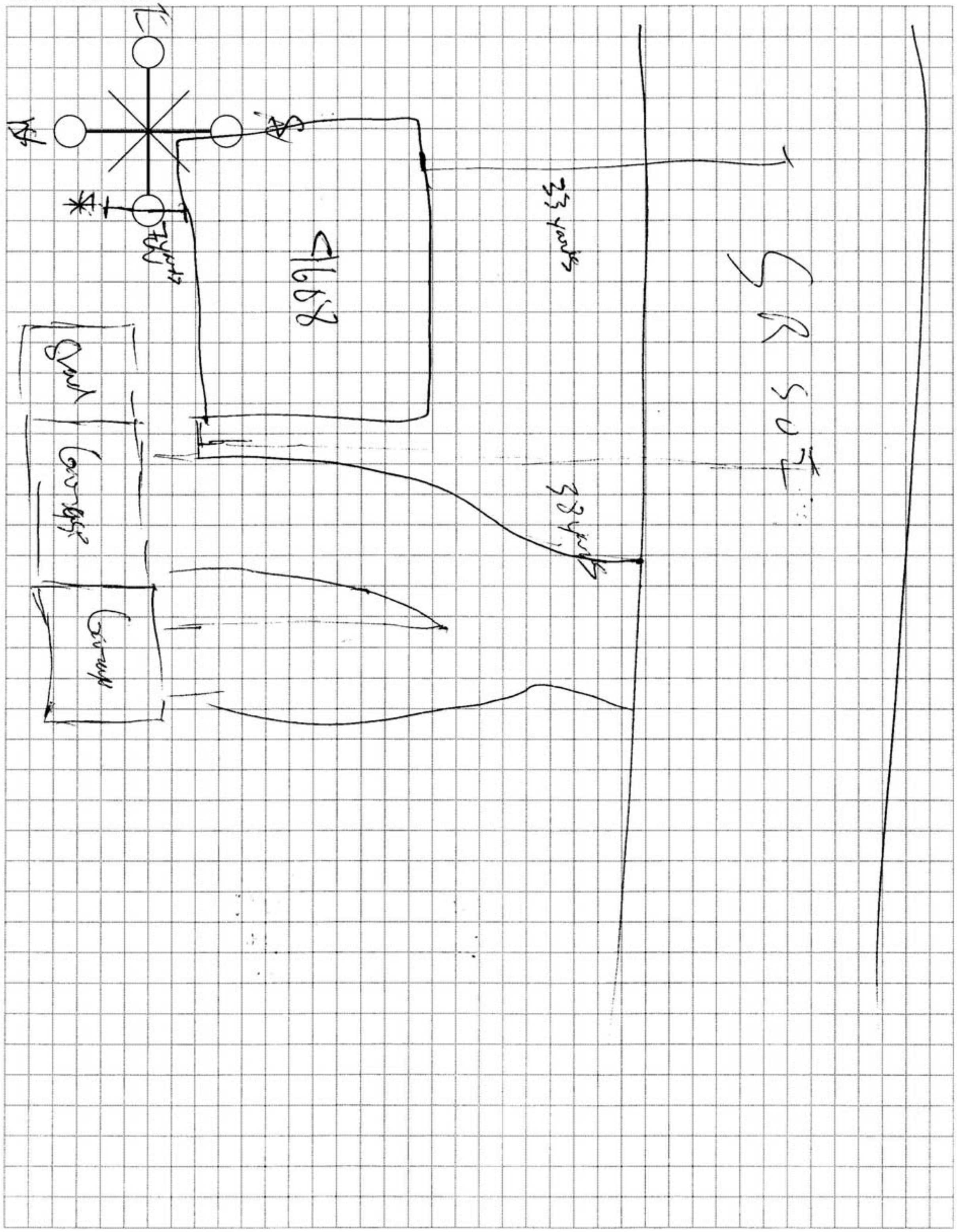
## Traffic Data

| Roadway Description | 502 WB | | 502 EB | | | |
|---|---|---|---|---|---|---|
| Count Duration 10 min. | Count | VPH | Count | VPH | Count | VPH |
| Autos | 50 | 300 | 67 | 402 | | |
| Med. Trucks (6 tires, 2 axles) | 5 | 60 | 4 | 24 | | |
| Heavy Trucks (more than 2 axels) | 1 | 6 | 2 | 12 | | |
| Speed (mph) | 50 | | 50 | | | |

## Photographs

| Number | Notes |
|---|---|
| | 4608 SR 502 |

**Site Sketch**



**Parsons Brinckerhoff Quade & Douglas Inc.**

# Noise Measurement Data Sheet

| Project SR 502 | Date 10-22-07 | Sheet No. 1 |
|---|---|---|
| Road SR 502 | | By: SN |

## Equipment Check

| | | | | |
|---|---|---|---|---|
| ☒ A-Weight | ☒ Fast Response | ☒ Slow Response | ☒ Battery Check | ☒ Range |
| ☒ Wind Screen | ☒ Other Setting | Calibrator | Model 1503 | Serial No. 2399 |

## Meteorology

| | | |
|---|---|---|
| Temperature 75 °F | Humidity 22 in mg | Cloud cover ø % |
| Wind Speed ø mph | Wind Direction N__ S__ E__ W__ | Notes |

## Noise Measurement

| Site No. E | Meter Model 820 | Serial No. 1313 | Calib. Before 114.0 | After 113.8 |
|---|---|---|---|---|
| Begin Time: 4:30 | L (1) 67.7 | Noise Sources | | |
| End Time: 4:45 | L (5) 64.2 | SR 502 | | |
| $L_{EQ}$ 59.6 | L (10) 62.3 | NE 50th | | |
| $L_{MAX}$ 74.9 | L (20) 60.8 | | | |
| $L_{MIN}$ 48.3 | L (50) 58.1 | | | |
| Peak 85.0 | L (90) 53.1 | | | |

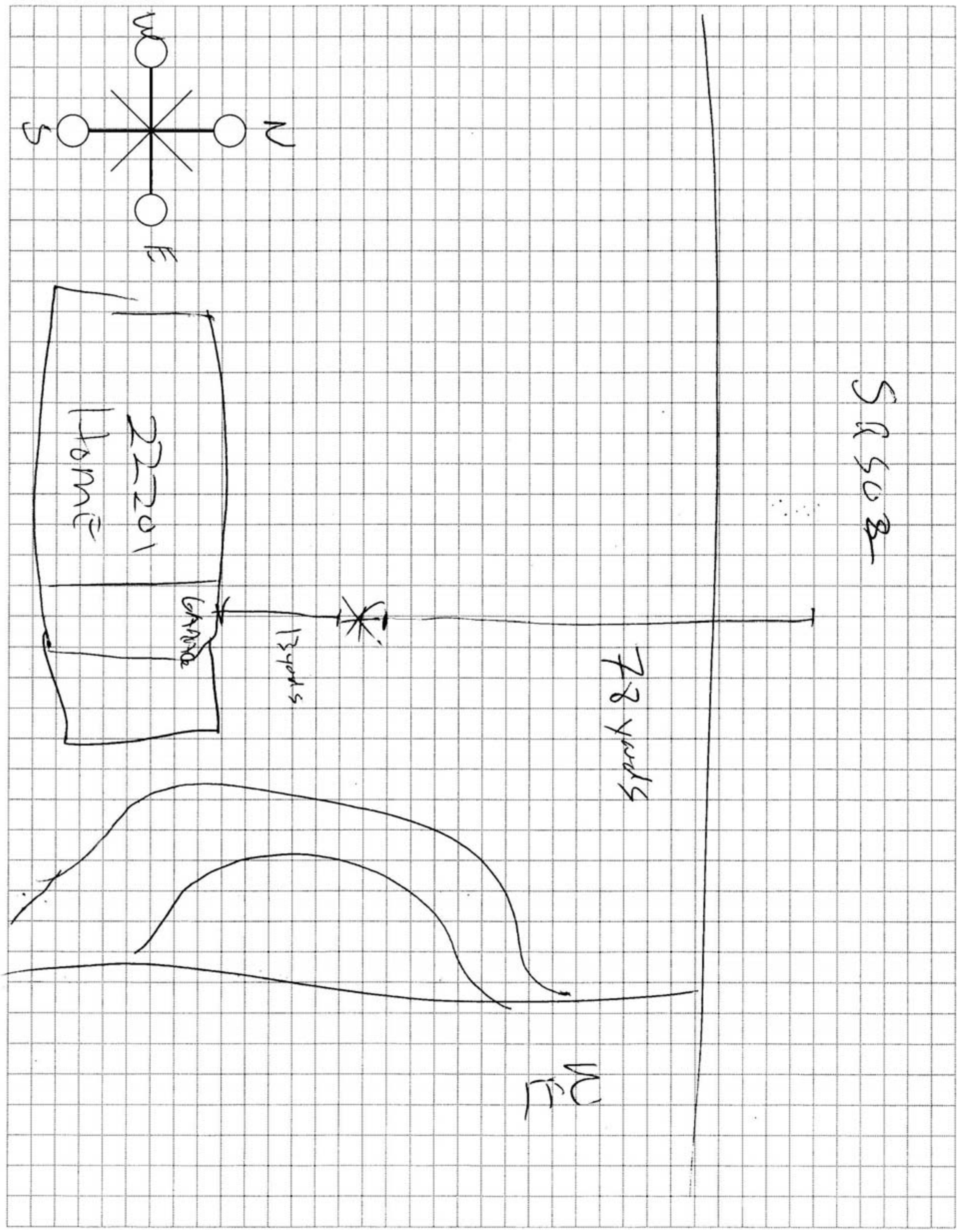
## Traffic Data

| Roadway Description | SR 502 WB | | SR 502 EB | | NE 50th | |
|---|---|---|---|---|---|---|
| Count Duration 10 min. | Count | VPH | Count | VPH | NB/SB Count | VPH |
| Autos | 56 | 336 | 80 | 480 | 12/9 | 72/54 |
| Med. Trucks (6 tires, 2 axles) | 1 | 6 | 1 | 1 | 2/0 | 6/0 |
| Heavy Trucks (more than 2 axels) | ø | ø | ø | ø | 0/0 | 0/0 |
| Speed (mph) | 50 | | 50 | | 35 | |

## Photographs

| Number | Notes |
|---|---|
| | 22001 NE 50th |

**Site Sketch**



**Parsons Brinckerhoff Quade & Douglas Inc.**

# Noise Measurement Data Sheet

| | | |
|---|---|---|
| Project SR 502 | Date 10-23-07 | Sheet No. 1 |
| Road SR 502 + NE 92nd Ave | | By: SN |

## Equipment Check

| | | | | |
|---|---|---|---|---|
| ☒ A-Weight | ☒ Fast Response | ☒ Slow Response | ☒ Battery Check | ☒ Range |
| ☒ Wind Screen | ☐ Other Setting | Calibrator | Model 1503 | Serial No. 2399 |

## Meteorology

| | | |
|---|---|---|
| Temperature 63 °F | Humidity 77 in mg | Cloud cover Ø % |
| Wind Speed Ø mph | Wind Direction N x S__ E x W__ | Notes |

## Noise Measurement

113.9

| Site No. F | Meter | Model 820 | Serial No. 1713 | Calib. | Before 114.0 | After ~~[illegible]~~ |
|---|---|---|---|---|---|---|
| Begin Time: 10:05 | L (1) | 66.0 | Noise Sources | | | |
| End Time: 10:20 | L (5) | 61.9 | 502 + NE 92nd | | | |
| $L_{EQ}$ 56.7 | L (10) | 60.0 | | | | |
| $L_{MAX}$ 73.4 | L (20) | 57.4 | | | | |
| $L_{MIN}$ 44.2 | L (50) | 53.8 | | | | |
| Peak 82.8 | L (90) | 48.9 | | | | |

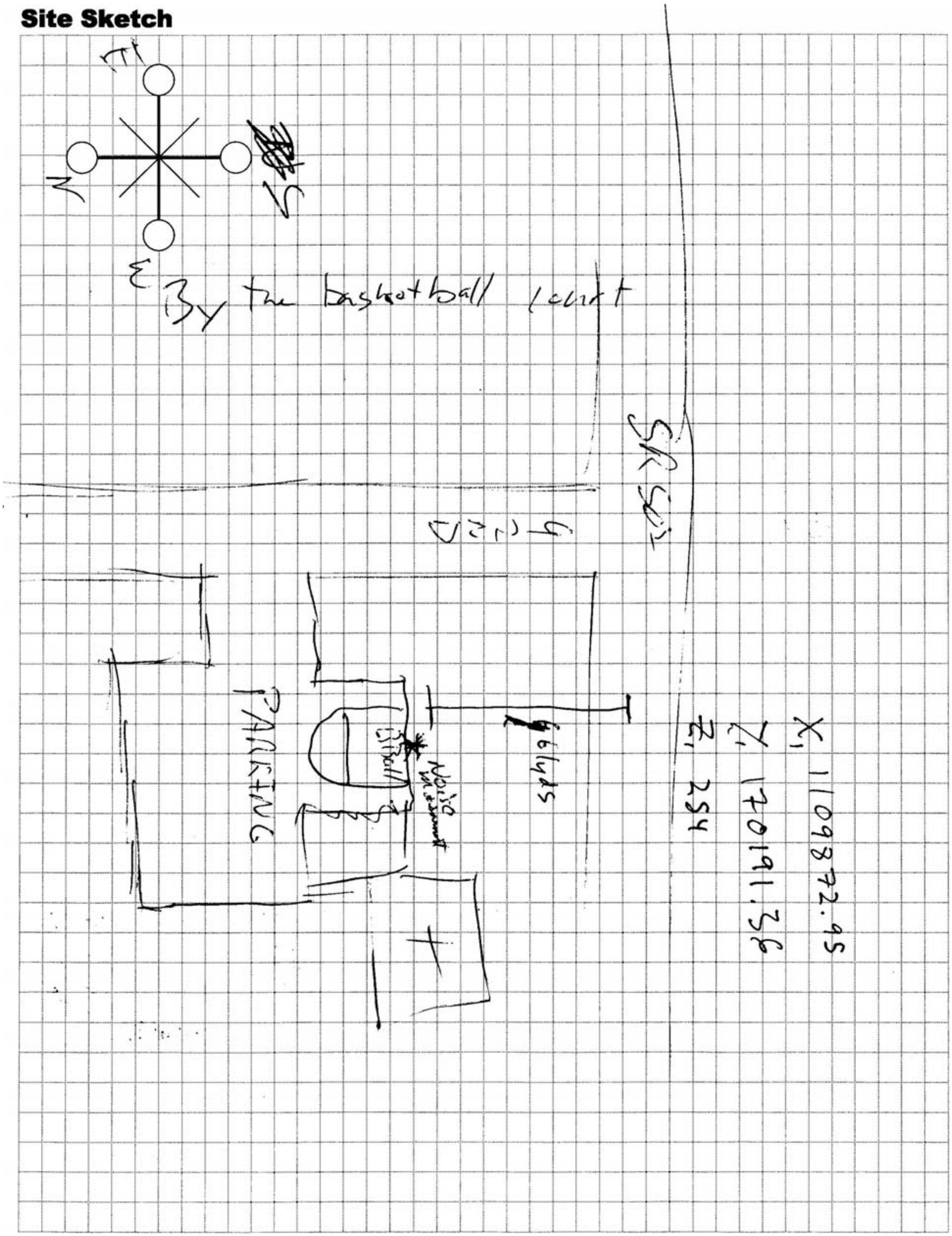
## Traffic Data

| Roadway Description | 502 WB | | 502 EB | | 92nd | |
|---|---|---|---|---|---|---|
| Count Duration 10 min. | Count | VPH | Count | VPH | ~~Count~~ N/S/SB | VPH |
| Autos | 70 | 420 | 49 | 294 | 5/10 | 30/60 |
| Med. Trucks (6 tires, 2 axles) | 1 | 6 | 3 | 18 | Ø/Ø | Ø/Ø |
| Heavy Trucks (more than 2 axels) | 2 | 12 | 1 | 6 | 3/Ø | 18/Ø |
| Speed (mph) | 50 | | 50 | | Posted 35 | |

## Photographs

| Number | Notes |
|---|---|
| | |

## Site Sketch


By the basketball court
SR 502
PARKING
Noise
6 blyds
X, 1109872.95
Y, 170191.36
Z, 254

**Parsons Brinckerhoff Quade & Douglas Inc.**

# Noise Measurement Data Sheet

| Project SR502 | Date 12-23-07 | Sheet No. 1 |
|---|---|---|
| Road SR 502 | | By: SN |

## Equipment Check

| ☒ A-Weight | ☒ Fast Response | ☒ Slow Response | ☒ Battery Check | ☒ Range |
|---|---|---|---|---|
| ☒ Wind Screen | ☒ Other Setting | Calibrator Model 1202 Serial No. 2399 | | |

## Meteorology

| Temperature 65 °F | Humidity 53 in mg | Cloud cover 0 % |
|---|---|---|
| Wind Speed 0 mph | Wind Direction N__ S__ E__ W__ | Notes |

## Noise Measurement

| Site No. 6 | Meter Model 820 Serial No. 1313 | | Calib. Before 114.0 After 114.0 |
|---|---|---|---|
| Begin Time: 10:40 | L (1) | 70.1 | Noise Sources: 502 |
| End Time: 10:55 | L (5) | 66.9 | |
| $L_{EQ}$ 61.8 | L (10) | 65.4 | |
| $L_{MAX}$ 75.2 | L (20) | 63.8 | |
| $L_{MIN}$ 38.8 | L (50) | 59.3 | |
| Peak 89.7 | L (90) | 47.5 | |

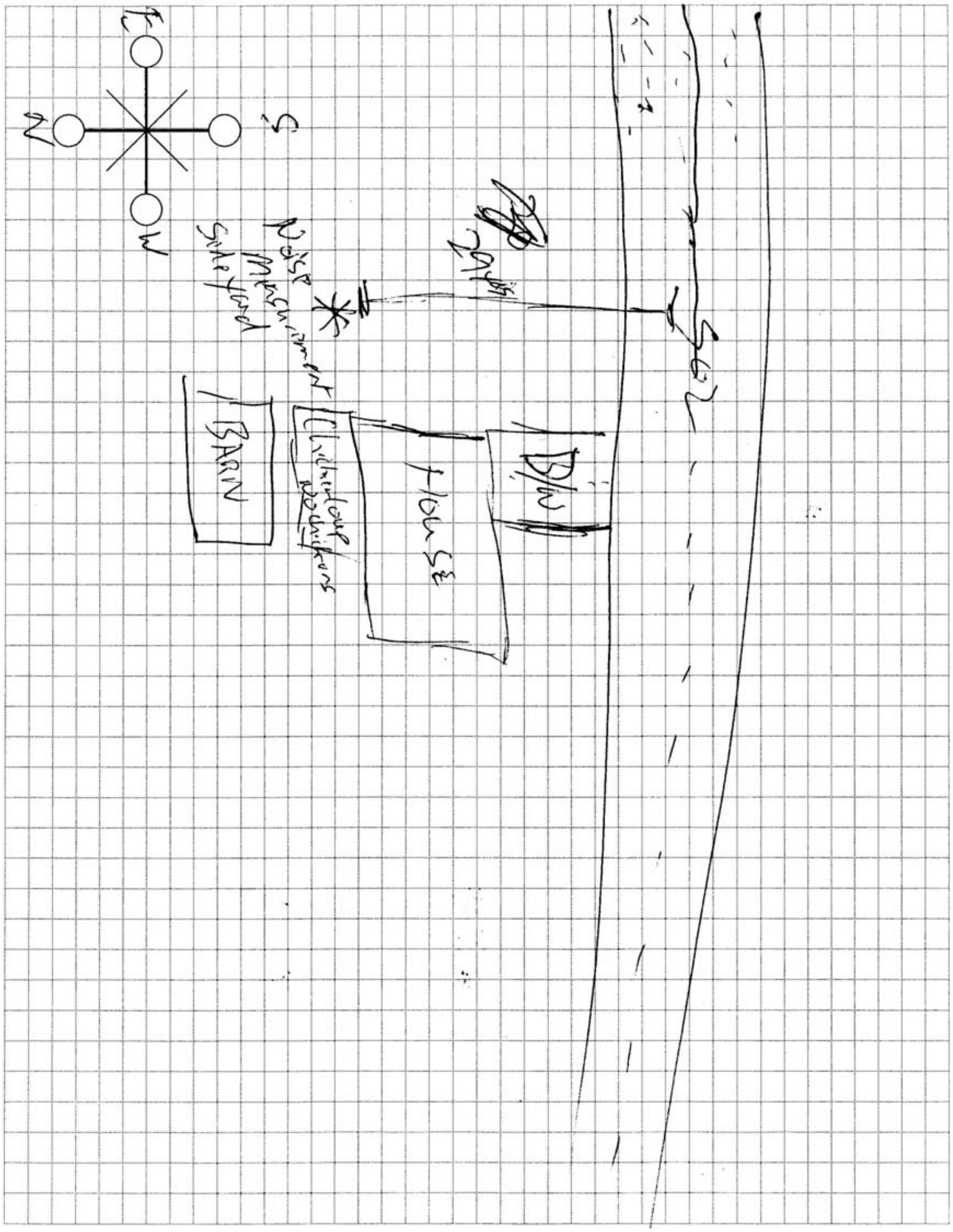
## Traffic Data

| Roadway Description | 502 WB | | 502 EB | | | |
|---|---|---|---|---|---|---|
| Count Duration 10 min. | Count | VPH | Count | VPH | Count | VPH |
| Autos | 69 | 414 | 62 | 372 | | |
| Med. Trucks (6 tires, 2 axles) | 4 | 24 | 3 | 18 | | |
| Heavy Trucks (more than 2 axels) | 3 | 18 | 6 | 36 | | |
| Speed (mph) | 50 | | 50 | | | |

## Photographs

| Number | Notes |
|---|---|
| | |

**Site Sketch**



**Parsons Brinckerhoff Quade & Douglas Inc.**

# Noise Measurement Data Sheet

| | | |
|---|---|---|
| Project SR 502 | Date 10-23-07 | Sheet No. 1 |
| Road SR 502 | | By: SN |

## Equipment Check

| | | | | |
|---|---|---|---|---|
| [x] A-Weight | [x] Fast Response | [x] Slow Response | [x] Battery Check | [x] Range |
| [x] Wind Screen | [x] Other Setting | Calibrator | Model 1503 | Serial No. 2399 |

## Meteorology

| | | |
|---|---|---|
| Temperature 65 °F | Humidity 55 in mg | Cloud cover 0 % |
| Wind Speed 0 mph | Wind Direction N__ S__ E__ W__ | Notes |

## Noise Measurement

| | | | |
|---|---|---|---|
| Site No. H | Meter Model 820 Serial No. .317 | | Calib. Before 114 After |
| Begin Time: 11:10 | L (1) 64.1 | Noise Sources | Two trucks pulled into the Electrical shop in back |
| End Time: 11:25 | L (5) 60.1 | | |
| $L_{EQ}$ 55.3 | L (10) 58.4 | | |
| $L_{MAX}$ 69.2 | L (20) 56.8 | | |
| $L_{MIN}$ 39.1 | L (50) 53.0 | | |
| Peak 87.9 | L (90) 45.7 | | |

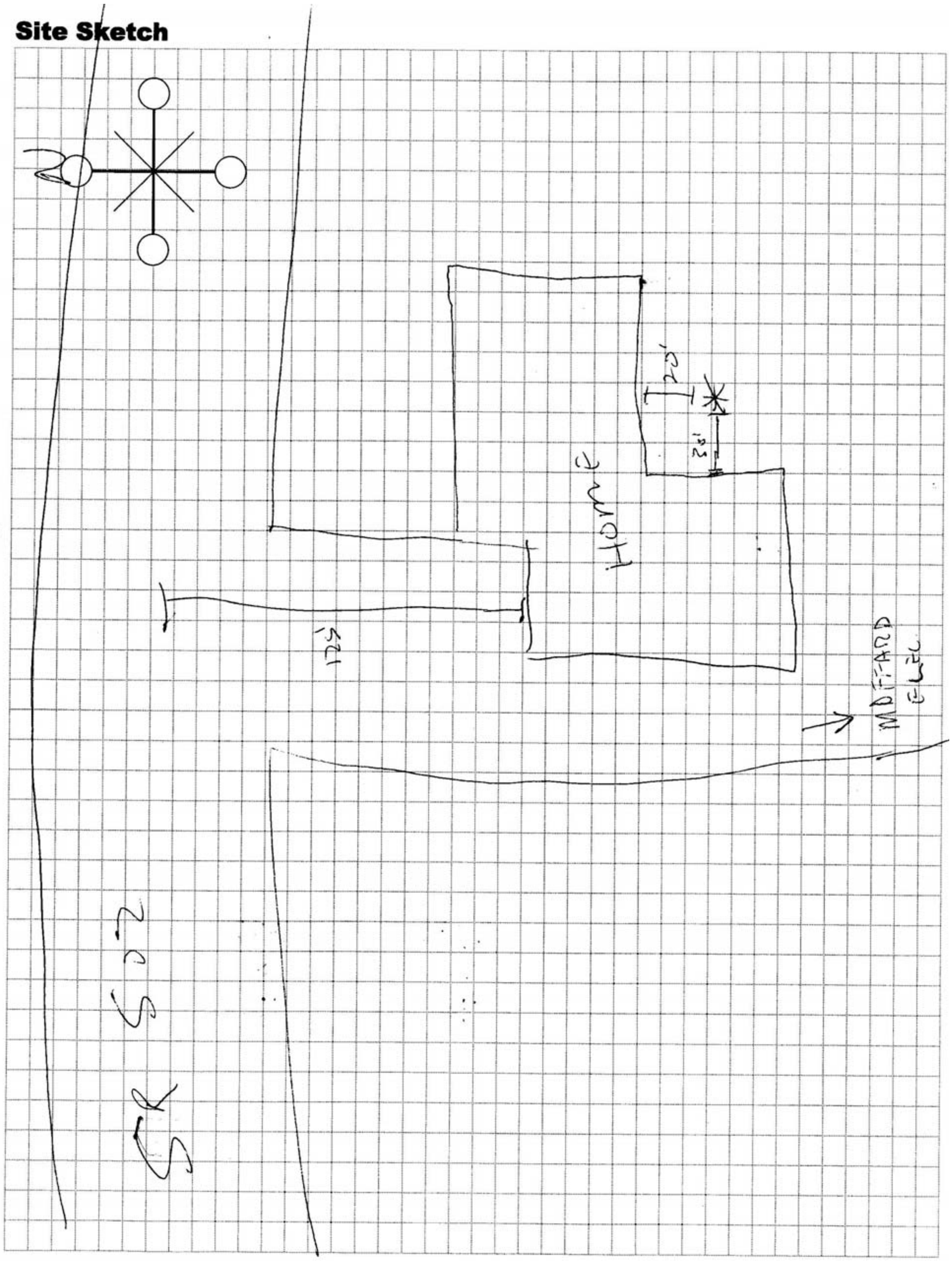
## Traffic Data

| Roadway Description | 502 WB | | 502 EB | | | |
|---|---|---|---|---|---|---|
| Count Duration 10 min. | Count | VPH | Count | VPH | Count | VPH |
| Autos | 63 | 378 | 47 | 282 | | |
| Med. Trucks (6 tires, 2 axles) | 4 | 24 | 3 | 18 | | |
| Heavy Trucks (more than 2 axels) | 5 | 30 | 2 | 12 | | |
| Speed (mph) | 45 | | 47 | | | |

## Photographs

| Number | Notes |
|---|---|
| | Moffard Electric / Home |

**Site Sketch**



**Parsons Brinckerhoff Quade & Douglas Inc.**

# Noise Measurement Data Sheet

| | | |
|---|---|---|
| Project SR 502 | Date 10-22-07 | Sheet No. 1 |
| Road SR 502 | | By: SN |

## Equipment Check

| | | | | |
|---|---|---|---|---|
| ☒ A-Weight | ☒ Fast Response | ☒ Slow Response | ☒ Battery Check | ☒ Range |
| ☒ Wind Screen | ☒ Other Setting | Calibrator | Model 1503 | Serial No. 2399 |

## Meteorology

| | | |
|---|---|---|
| Temperature 65 °F | Humidity 55 in mg | Cloud cover Ø % |
| Wind Speed Ø mph | Wind Direction N__ S__ E__ W__ | Notes |

## Noise Measurement

| | | |
|---|---|---|
| Site No. I | Meter Model 820 Serial No. 1313 | Calib. Before 114.0 After 114.0 |
| Begin Time: 12:24 | L (1) 70.7 | Noise Sources |
| End Time: 12:39 | L (5) 66.4 | |
| $L_{EQ}$ 61.2 | L (10) 64.5 | |
| $L_{MAX}$ 77.6 | L (20) 62.6 | |
| $L_{MIN}$ 39.8 | L (50) 58.0 | |
| Peak 90.3 | L (90) 45.1 | |

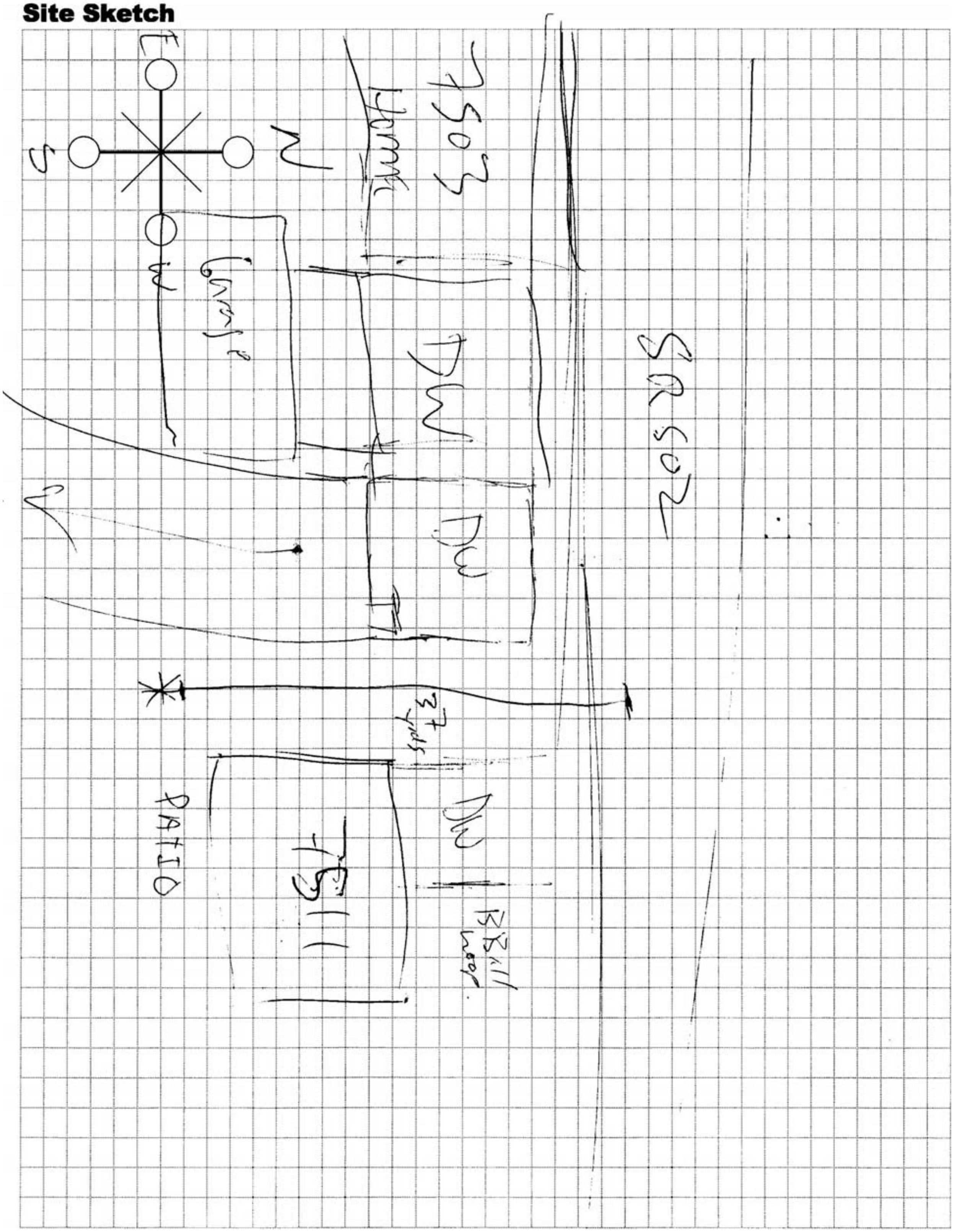
## Traffic Data

| Roadway Description | 502 WB | | 502 EB | | | |
|---|---|---|---|---|---|---|
| Count Duration 10 min. | Count | VPH | Count | VPH | Count | VPH |
| Autos | 71 | 426 | 61 | 366 | | |
| Med. Trucks (6 tires, 2 axles) | 3 | 18 | 2 | 12 | | |
| Heavy Trucks (more than 2 axels) | 2 | 12 | 3 | 18 | | |
| Speed (mph) | 42 | | 40 | | | |

## Photographs

| Number | Notes |
|---|---|
| | 7511 SR 502 |

## Site Sketch



**Parsons Brinckerhoff Quade & Douglas Inc.**

# Noise Measurement Data Sheet

| Project SR 502 | Date 10-23-07 | Sheet No. 1 |
|---|---|---|
| Road SR 502 | | By: SN |

## Equipment Check

| | | | | |
|---|---|---|---|---|
| ☒ A-Weight | ☒ Fast Response | ☐ Slow Response | ☒ Battery Check | ☒ Range |
| ☒ Wind Screen | ☐ Other Setting | Calibrator | Model 1503 | Serial No. 2379 |

## Meteorology

| | | |
|---|---|---|
| Temperature 70 °F | Humidity 47 in mg | Cloud cover Ø % |
| Wind Speed Ø mph | Wind Direction N__ S__ E__ W__ | Notes |

## Noise Measurement

| Site No. J | Meter | Model 820 | Serial No. 1313 | Calib. Before 114.0 After 115.9 |
|---|---|---|---|---|
| Begin Time: 1:06 | L (1) | 64.9 | Noise Sources | |
| End Time: 1:21 | L (5) | 62.0 | | |
| $L_{EQ}$ 56.9 | L (10) | 60.4 | | |
| $L_{MAX}$ 70.1 | L (20) | 58.6 | | |
| $L_{MIN}$ 44.9 | L (50) | 54.6 | | |
| Peak 93.0 | L (90) | 48.4 | | |

## Traffic Data

| Roadway Description | 502 WB | | 502 EB | | | |
|---|---|---|---|---|---|---|
| Count Duration 10 min. | Count | VPH | Count | VPH | Count | VPH |
| Autos | 47 | 282 | 60 | 240 | | |
| Med. Trucks (6 tires, 2 axles) | 4 | 24 | 2 | 12 | | |
| Heavy Trucks (more than 2 axels) | 4 | 24 | Ø | Ø | | |
| Speed (mph) | 45 | | 45 | | | |

## Photographs

| Number | Notes |
|---|---|
| | 6816 SR 502 |

**Site Sketch**