wsdot2g9[1]

Project Name

SR XX

MP XX.XX to MP XX.XX

Noise Discipline Report

Month Day, Year

Prepared by:

Preparer

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# Executive Summary

**Should not exceed 2-pages**

## Project Objectives

Brief summary of project, in general and include SR, MP limits, jurisdiction vicinity, and action triggering Type1 study.

## Current Noise Environment

Include brief summary of adjacent land uses and current impacts, if any. Tables ok.

## Noise Impacts of Alternatives

Include brief summary of noise impacts for all alternatives including No-Build. Tables ok

## Abatement (Recommended/Not Recommended)

Brief summary of wall(s) lengths, heights and general alignments *or* why abatement is not recommended.

# Introduction

## Project Description

Typically provided by the project office, but can be summarized to include only relevant design features.

Include vicinity map and maps comparing alternatives (if applicable).

## Type 1 Trigger for Noise Analysis

A traffic noise analysis is required by law[[1]](#footnote-1) for federally funded projects and required by state policy[[2]](#footnote-2) for other funded projects that:

* Involve construction of a new highway,
* Significantly change the horizontal or vertical alignment,
* Increase the number of through traffic lanes on an existing highway, or
* Alter terrain to create new line-of-sight to traffic for noise sensitive receivers.

Description of Type 1 activity on this project

## Noise Relevant Project Information

The following information is needed to understand how the project will affect the noise environment for adjacent land uses.

Include list of items relevant to traffic noise analysis for existing, No-Build, and Build conditions, including:

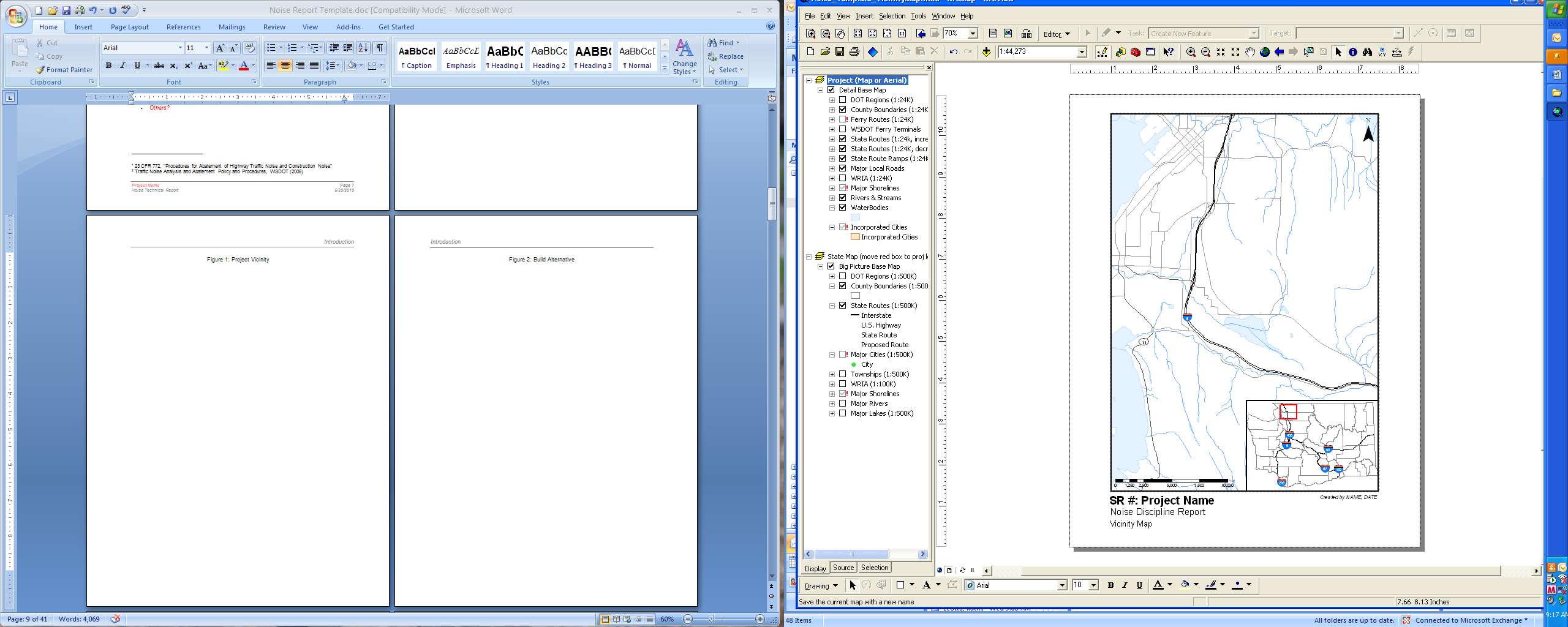
Type of roadway (elevated, depressed, at-grade)

Number of lanes

Changes to existing access

Travel speeds

Exhibit 1: Project Vicinity



Vicinity map shall have the following:

* Scale
* North arrow
* Title that includes SR and Project Name
* Name of map maker and date
* Broader context (county, region, state, etc.)
* Labeled roadways

Exhibit 2: Build Alternative(s)

Build Alternative map needs the following:

* Scale
* North arrow
* Title that includes SR and Project Name
* Name of map maker and date and date
* Labeled roadways
* Comparison to existing

# Characteristics of Sound and Noise

## Definition of Sound

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 is a measure of the physical sound energy in the air. The range of magnitude the ear can hear, from the faintest to the loudest sound, is so large that sound pressure is expressed on a logarithmic scale in units called decibels (dB). Loudness refers to how people subjectively judge a sound and varies between people.

Sound is measured using the logarithmic decibel scale, so doubling the number of noise sources, such as the number of cars on a roadway, increases noise levels by 3 dBA. Therefore, when you combine two noise sources emitting 60 dBA, the combined noise level is 63 dBA, not 120 dBA. The human ear can barely perceive a 3 dBA increase, while a 5 dBA increase is about one and one-half times as loud. A 10 dBA increase appears to be a doubling in noise level to most listeners. A tenfold increase in the number of noise sources will add 10 dBA.

In addition to magnitude, Humans also respond to a sound's frequency or pitch. The human ear is very effective at perceiving frequencies between 1,000 and 5,000 Hz, with less efficiency outside this range. Environmental noise is composed of many frequencies. A-weighting (dBA) of sound levels is applied electronically by a sound level meter and combines the many frequencies into one sound level that simulates how an average person hears sounds of low to moderate magnitude

## Definition of Noise

Noise is unwanted or unpleasant sound. Noise is a subjective term because, as described above, sound levels are perceived differently by different people. Magnitudes of typical noise levels are presented in Exhibit X.

## Traffic Noise Sources

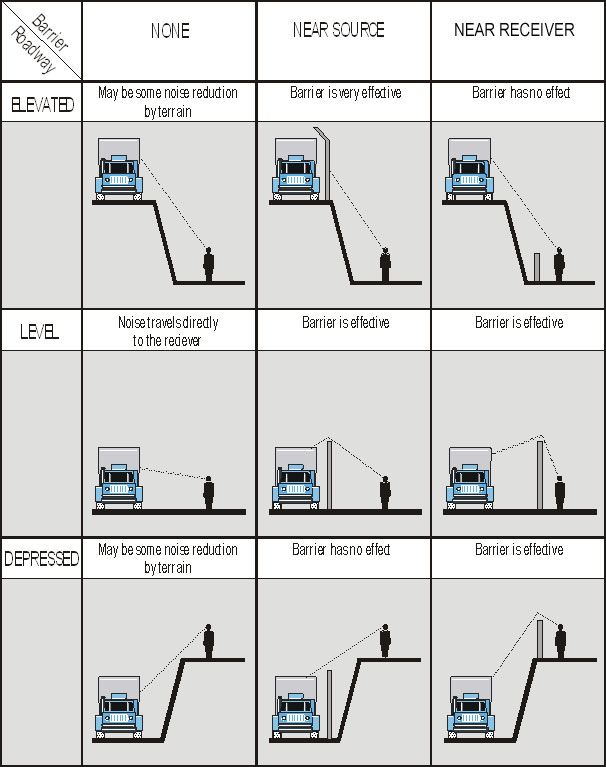
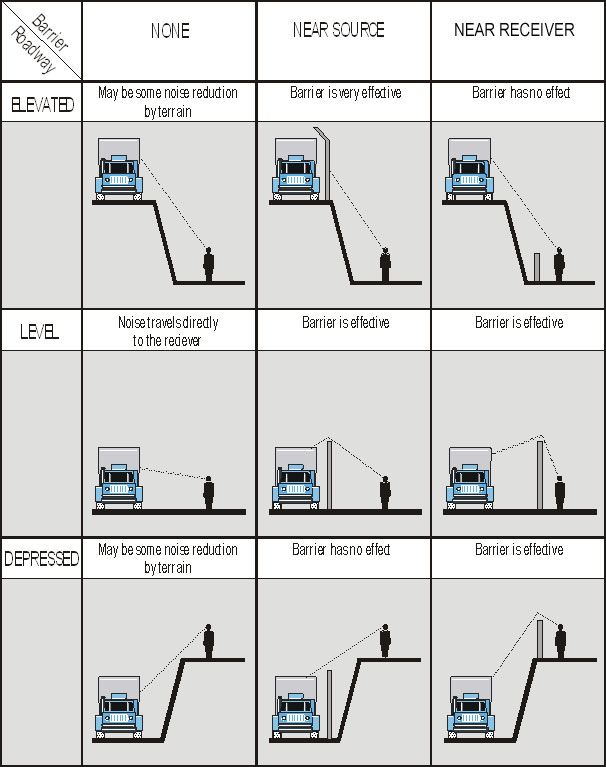
An increase in traffic volumes, vehicle speeds, or the amount of heavy trucks will increase traffic noise levels. Traffic noise is a combination of noises from the engine, exhaust, and tires. Defective mufflers, truck compression braking, steep grades, the terrain and vegetation near the roadway, shielding by barriers and buildings and the distance from the road can also contribute to the traffic noise heard at the roadside.

Exhibit 3: Typical Noise Levels

|  |  |  |  |
| --- | --- | --- | --- |
| Transportation Noise Sources | Noise Level (dBA) | Other Sources | Description |
|  | 130 |  | Painfully loud |
| Jet takeoff (200 feet) | 120 |  |
| Car horn (3 feet) | 110 |  |
|  | 100 | Shout (.5 foot) | Very annoying |
| Heavy truck (50 feet) | 90 | Jack hammer (50 feet) | Hearing loss with prolonged exposure |
| Train on structure (50 feet) | 85 | Backhoe (50 feet) |
| City bus passing (50 feet) | 80 | Bulldozer (50 feet) | Annoying |
|  |  | Vacuum cleaner (3 feet) |
| Train (50 feet) | 75 | Blender (3 feet) |
| City bus at stop (50 feet) | 70 |  |
| Freeway traffic (50 feet) |  | Lawn mower (50 feet) |
| Train in station (50 feet) | 65 | Washing machine (3 feet) | Intrusive |
| Light traffic (50 feet) | 60 | TV (10 feet) |
|  |  | Talking |
| Light traffic (100 feet) | 50 |  | Quiet |
| Source: FTA 1995 |  |  |  |

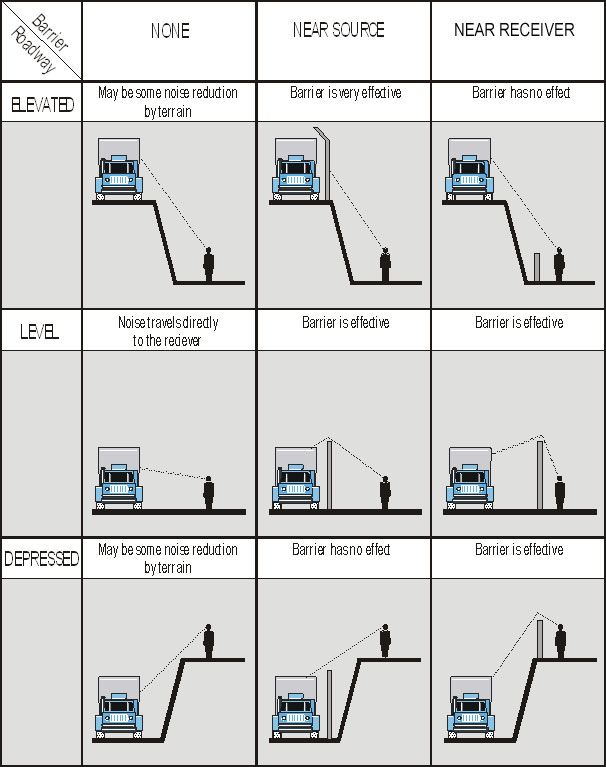
## Sound Propagation

Sound propagation, or how far the sound travels, is affected by the terrain and the elevation of the receiver relative to the noise source. Noise levels can be reduced by breaking the line of sight between the receiver and the noise source.

* Level ground: noise travels in a straight path between the source and receiver. *Level Ground*
* Depressed source/elevated receiver: terrain may act like a partial noise barrier and reduce noise levels if it crests between the source and receiver.

*Depressed source/elevated receiver*

* Elevated source/depressed receiver: the edge of the roadway acts as a partial noise barrier. Even a short barrier, like a concrete safety barrier, can reduce

* Elevated source/depressed receiver*

Line and Point Sources

Noise levels decrease with distance from the noise source. For a line source, like highway, noise levels decrease 3 dBA for every doubling of distance, e.g., from 50’ to 100’, between the source and the receiver over hard ground (concrete, pavement) or 4.5 dBA over soft ground (grass). For point source, like most construction noise, the levels decrease between 6 and 7.5 dBA for every doubling of distance.

## Effects of Noise

The FHWA noise abatement criteria are based on speech interference, which is a well documented impact that is relatively reproducible in human response studies. Environmental noise indirectly affects human welfare by interfering with sleep, thought, and conversation. Prolonged exposure to very high levels of environmental noise can cause hearing loss and the Environmental Protection Agency (EPA) has established a protective level 70 dBA Leq(24)[[3]](#footnote-3) for hearing loss. Noise also can affect some types of wildlife during certain activities.

## Noise Level Descriptors

The equivalent sound level (Leq) is a measure of the average noise level during a specified period of time. A one-hour period, or hourly Leq [Leq(h)], is used to measure highway noise. Leq is a measure of total noise during a time period that places more emphasis on occasional high noise levels that accompany general background noise levels. For example, if you have two different sounds, and one contains twice as much energy, but lasts only half as long as the other, the two would have the same Leq noise levels.

Either the total noise energy or the highest instantaneous noise level can describe short-term noise levels, such as those from a single truck passing by. 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 noise events occur. Lmax is the maximum sound level that occurs during a single event and is related to impacts on speech interference and sleep disruption. Lmin is the minimum sound level during a period of time.

With Ln, “n” is the percent of time that a sound level is exceeded and is used describe the range of sound levels recorded during the measurement period. For example, the L10 level is the noise level that is exceeded 10% of the time. Sound varies in the environment and people will generally find a higher, but constant, sound level more tolerable than a quiet background level interrupted by higher sound level events. For example, steady traffic noise from a highway is normally less bothersome than occasional aircraft flyovers in an otherwise quiet area.

## Noise Regulations and Impact Criteria

Traffic noise impacts occur when predicted Leq(h) noise levels approach or exceed noise abatement criteria (NAC) established by the FHWA, or substantially exceed existing noise levels[[4]](#footnote-4). WSDOT considers a noise impact to occur if predicted Leq(h) noise levels approach within 1 dBA of the noise abatement criteria. The FHWA noise abatement criteria specify exterior Leq(h) noise levels for various land activity categories as described in Table 2. WSDOT also considers an increase of 10 dBA or more to be a substantial increase and constitute a traffic noise impact.

Exhibit 4: FHWA Noise Abatement Criteria by Land Use

|  |  |  |
| --- | --- | --- |
| Activity  Category | Leq(h) at  Evaluation Location  (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) | Residential (single and multi-family units) |
| C | 67 (exterior) | Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools , television studios, trails, and trail crossings |
| D | 52 (interior) | Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios. |
| E | 72 (exterior) | Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F. Includes undeveloped land permitted for these activities. |
| F | - | Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing |
| G | - | Undeveloped lands that are not permitted |

Construction Noise Levels Limits

Traffic noise and construction noise are exempt from the property line noise limits during daytime hours, but noise limits still apply to construction noise at night. Noise levels in Exhibit X apply only to construction noise at residential properties at “night”: between 10 p.m. and 7 a.m. At night, construction noise must meet Washington State Department of Ecology property line regulations[[5]](#footnote-5) that set limits based on the Environmental Designation for Noise Abatement (EDNA) of the land use: residential (Class A), commercial (Class B), and industrial (Class C).

Allowable nighttime (10:00 PM to 7:00 AM) noise levels at Class A receiving properties (residential) are reduced by 10 dBA.

Exhibit 5: Maximum Permissible Environmental Noise Levels

|  |  |  |  |
| --- | --- | --- | --- |
| EDNA of Noise Source | EDNA of Receiving Property (dBA) | | |
| Class A | Class B | Class C |
| Class A | 55 | 57 | 60 |
| Class B | 57 | 60 | 65 |
| Class C | 60 | 65 | 70 |

Short-term exceedance of the sound levels in Exhibit X is allowed. During any one-hour period, the maximum level may be exceeded by:

* 5 dBA for a total of 15 minutes,
* 10 dBA for a total of 5 minutes, or
* 15 dBA for a total of 1.5 minutes[[6]](#footnote-6).

The allowed exceptions are defined by the percentage of time a given level is exceeded. For example, L25 is the noise level exceeded 15 minutes during an hour. Therefore, the permissible L25 would be 5 dBA greater than the values in Exhibit X, provided that the noise level is below the permissible level for the rest of the hour and never exceeds the permissible level by more than 5 dBA.

An hourly Leq of approximately 2 dBA higher than the values in Exhibit X is an equivalent sound level to the permissible levels, including the short term exceedances. An Leq(h) of 59 dBA corresponds approximately to a noise level of 57 dBA for 45 minutes and 62 dBA for 15 minutes, which are the maximum permissible noise levels created by a commercial source (Class B) and received by a residential property (Class A).

# Traffic Noise Analysis Methodology

## Determination of the Traffic Noise Study Area

Study area includes…briefly describe:

1. How the study area was established
2. The boundaries of the study are

Reference appropriate Exhibit where study area is defined.

## Traffic Noise Measurement and Validation

Ambient noise levels were measured to describe the existing noise environment, identify major noise sources in the project area, and validate the noise model. 15-minute Leq measurements were collected at locations representative of all sound level environments within the study area during free-flowing traffic conditions. FHWA allows 15-min Leq measurements to represent the Leq(h). These traffic noise measurements are not a representation of “average” existing noise levels.

To ensure that the noise model used to predict traffic noise impacts accurately reflects the sound levels in the noise study area, a model is constructed using the same traffic volumes, speed, and vehicle types that were present during the sound level measurements. Modeled values must be within ±2.0 dBA of the measured levels for the model to be validated.

FHWA's Traffic Noise Model (TNM) Version 2.5 (FHWA, 2004) was used for validation and to predict future Leq(h) traffic noise levels. TNM calculates precise estimates of noise levels at discrete points. The model estimates the sound levels from a series of straight-line roadway segments. TNM also considers the effects of existing barriers, topography, vegetation, and atmospheric absorption. Noise from sources other than traffic is not included so when non-traffic noise is present, such as aircraft noise, TNM will under predict the actual noise level. To create the model, design files outlining major roadways, topographical features, and sensitive receptors were imported into the TNM model as background features and the corresponding values were entered manually. Aerial photographs and site visits were used to verify site conditions.

Exhibit X describes the validation locations and the comparison of measured to model values. Recorded traffic information during the measurements is including in Appendix A. Exhibit X shows the receiver locations (describe how color/shape/number of symbol distinguishes measured from modeled locations).

Exhibit 6: Noise Model Validation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
| Location | Date | Start  Time | Measured  Leq (dBA) | Modeled  Leq (dBA) | Difference  (dBA) |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Exhibit 7: Traffic Noise Measurement and Modeling Locations

* Study area map needs the following:
* Scale
* North arrow
* Title that includes SR and Project Name
* Name of map maker and date
* Labeled roadways
* Project limits with MPs
* Clearly marked study area limits; both project limits and 500’ boundary
* Aerial photo is strongly preferred

## Traffic Noise Modeling – Predicted Traffic Noise Levels

Additional receivers were added to the model to represent the outdoor use areas for all noise sensitive locations within the study area. The modeled receiver locations are shown in Exhibit 7 as (describe how color/shape/number or symbol distinguishes measured from modeled locations).

Predicted noise levels were based on peak hour traffic volumes to estimate future noise levels (Appendix B) for the current and design, or future, year (*Year)* traffic (Build) with and without the project (No-Build). Include all alternatives here.

## Construction Noise Assessment

Construction noise was qualitatively assessed and compared to Department of Ecology property line regulations and described in Chapter X - XXXX.

More if necessary.

# Traffic Noise Levels

## Description of Study Area

The study area is described in Exhibit X.

Modeled noise sensitive receivers (R*X* – R*XX*) are shown in Exhibit X.

## Operational Traffic Noise

* Existing condition traffic noise impacts - XX
* No-Build condition traffic noise impacts – XX
* Build condition traffic noise impacts – XX

### Existing Noise Levels

Existing traffic noise levels for all modeled receivers are described in Exhibit X. Of the XXtotal receivers, XX receivers currently experience traffic noise levels above the NAC of 66 dBA.

### Design Year Traffic Noise Levels – No-Build

Describe the general effect of not building the project on nearby traffic noise levels. Compare these with existing noise levels.

### Design Year Traffic Noise Levels –Build

Describe how/why the Type 1 activity effects traffic noise levels in general terms. Compare design year build against existing and no-build levels.

Exhibit 8: Modeled Noise Levels

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site and Land  Use Category | NAC  (Leq)  (dBA) | Dwelling  Units | Existing  (Leq)  (dBA) | No-Build  (Leq)  (dBA) | | Build  (Leq)  (dBA) |
| R1 (c) |  |  |  |  | |  |
| R2 |  |  |  |  | |  |
| R3 |  |  |  |  | |  |
| R4 |  |  |  |  | |  |
| R5 |  |  |  |  | |  |
| R6 |  |  |  |  | |  |
| R7 |  |  |  |  | |  |
| R8 |  |  |  |  | |  |
| R9 |  |  |  |  | |  |
| R10 |  |  |  |  | |  |
| *Impacts are noted by bolded values.* | | | | | | |
| *Reasonableness allowance based on $51.61/ft2* | | | | |

# Traffic Noise Abatement

## Traffic Noise Abatement - Background

Briefly state if traffic noise abatement was considered for the project, or why not. Other forms of abatement should be discussed only if they were evaluated and/or recommend for the project.

Example: *Abatement has not been considered for this project because the modeled noise levels are below the FHWA NAC levels and no traffic noise impacts are expected.*

Abatement must be both feasible and reasonable for it to be recommended.

## Feasibility

Feasibility is a combination of acoustic and engineering considerations. All of the following must occur for abatement (e.g., noise barrier) to be considered feasible.

* Abatement must be physically constructible.
* The majority first row impacted receivers must obtain a minimum 5 dBA of noise reduction as a result of abatement (insertion loss), assuring that every reasonable effort will be made to assess outdoor use areas as appropriate.

For this project, a noise barrier (or other abatement) was evaluated at LOCATION(s) to determine whether abatement could sufficiently reduce traffic noise levels. A minimum feasible barrier height of X feet-XX feet tall and X feet long will reduce traffic noise levels by at least 5 dBA at the majority of receiver locations in the noise study area. Additional noise wall dimensions were evaluated as part of the reasonableness determination.

Strongly suggest using a table to show feasibility for each individual barrier evaluated so that work can be easily checked. Feasibility and reasonableness can be combined into one table as in Exhibit 11 below if needed. If, for example, driveways interfere with feasibility this can be addressed qualitatively in the text.

A barrier along the general alignment shown in Exhibit X appears to be constructible. Verification of constructability will be confirmed by the project engineering office during final design.

Exhibit 9: Evaluated Noise Wall Alignment(s)

* Noise wall alignment map needs the following:
* Scale
* North arrow
* Title that includes SR and Project Name
* Name of map maker and date
* Labeled roadways
* Clearly marked study area limits; both project limits and 500’ boundary
* Aerial photo is strongly preferred
* Clearly identified modeled receiver locations that includes labels (e.g., R-1)
* Line showing recommended noise wall location

## Reasonableness

If not reasonable – Example: *Reasonableness was not evaluated for this project because a barrier could not 1) achieve sufficient noise reductions (not feasible), and/or 2) was not constructible for the following reasons…*

Since abatement is feasible, the reasonableness of abatement was evaluated. Noise walls, or other types of abatement, will only be constructed by the department if they have been determined to be reasonable by satisfying three criteria below.

1. Cost Effectiveness  
The cost of noise abatement sufficient to provide at least the minimum feasible noise reductions must be equal to or less than the allowable cost of abatement for each noise wall location analyzed. Based on noise wall costs from 2007-2010, the current average costs for Washington State is $51.61. The cost is applied to the allowed wall surface area (ft2) to generate the allowable cost per qualified resident described in Exhibit X.

Either wall square footage or cost can be used to evaluate cost effectiveness, unless costs for the wall will exceed the cost of a standard design noise wall, then cost must be used to compare the wall cost to the allowable cost. For this project, a standard noise wall design was evaluated and costs are used to describe the cost effectiveness. The allowable cost per receiver, based on Build condition traffic noise levels is described in Exhibit X.

Exhibit 10: Reasonableness Allowances

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| **Column A** | **Column B** | **Column C** | **Column D** |
| Design Year Traffic Sound Decibel Level (dBA) | Noise level increase as a result of the project (dBA)(2) | Allowed Wall Surface Area Per Qualified Residence or Residential Equivalent | Allowed Cost Per Qualified Residence or Residential Equivalent(1) |
| 66 |  | 700 Sq Feet | $36,127 |
| 67 |  | 768 Sq Feet | $39,636 |
| 68 |  | 836 Sq Feet | $43,146 |
| 69 |  | 904 Sq Feet | $46,655 |
| 70 |  | 972 Sq Feet | $50,165 |
| 71 | 10 (substantial, step 1) (3) | 1,040 Sq Feet | $53,674 |
| 72 | 11 (substantial, step 1) | 1,108 Sq Feet | $57,184 |
| 73 | 12 (substantial, step 1) | 1,176 Sq Feet | $60,693 |
| 74 | 13 (substantial, step 1) | 1,244 Sq Feet | $64,203 |
| 75 | 14 (substantial, step 1) | 1,312 Sq Feet | $67,712 |
| 76 | 15 (substantial, step 2)(4) | 1,380 Sq Feet | $71,222 |
| *(1) Current costs based on $51.61 per square foot constructed cost developed in 2011.* | | | |
| *(2) If the noise level increases 10 dBA or more as the result of the project (Column B), follow the allowed wall surface and cost for the level of increase in Column C in lieu of the total design year sound decibel level in Column A. For total highway related sound levels at 76 or more dBA or the project results in an increase of 15 or more decibels, continue increasing the allowance at the rate provided in the table unless circumstances determined on a case-by case basis require an alternative methodology for determining allowance.* | | | |
| *(3) Step 1 is when the noise levels are 10 to 14 dBA over future No Build condition traffic noise as a result of the transportation project.* | | | |
| *(4) Step 2 is when the noise levels are 15 or more dBA over existing traffic noise as a result of the transportation project (or total highway related noise levels are between 76 and 79 decibels). Additional consideration for abatement may be considered under these circumstances.* | | | |

2. Design Goal Achievement  
The minimum feasibility design goal for abatement on all projects is at least 5 dBA of noise reduction for the majority of impacted front row receivers and, for reasonableness, at least 7 dBA of reduction for one receiver. Noise walls cannot be recommended if they do not achieve the design goal. In addition to the design goal requirement, WSDOT makes a reasonable effort to get 10 dBA or greater insertion loss (noise reduction) at the first row of receivers for all projects where abatement is recommended.

Exhibit X describes the allowable cost per receiver and the cost of the minimum barrier size to achieve the design goal. A barrier that gets 10 dBA of reduction for the majority of 1st row receivers was also evaluated.

Additional/Optimized noise walls can also be described. Suggest evaluating two or three different wall heights for feasibility and reasonableness and selecting one to be recommended for construction with justification.

Exhibit 11: Reasonableness Evaluation for Cost

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Site and  Land  Use  Category | Dwelling  Units | Existing  (Leq)  (dBA) | Build  (Leq)  (dBA) | Reasonableness  Allowance | | Minimum Design  Goal Noise Wall | | - 10 dBA  in 1st Row | |
| Per  Modeled  Receiver | Total  Cost | Total  Cost | Insertion  Loss  (dBA) | Total  Cost | Insertion  Loss  (dBA) |
| R1 (c) |  |  |  |  |  |  |  |  |  |
| R2 |  |  |  |  |  |  |
| R3 |  |  |  |  |  |  |
| R4 |  |  |  |  |  |  |
| R5 |  |  |  |  |  |  |
| R6 |  |  |  |  |  |  |
| R7 |  |  |  |  |  |  |
| R8 |  |  |  |  |  |  |
| R9 |  |  |  |  |  |  |
| R10 |  |  |  |  |  |  |
| Cost Effective? | | | | | | Yes |  | Yes |  |
| *Impacts are noted by bolded values.* | | | |  |  |  |  |  |  |
| *Reasonableness allowance based on $51.61/ft2* | | | | |  |  |  |  |  |

### 3. Desire for Abatement from Public within the Noise Study Area

Public involvement must occur when traffic noise abatement is recommended for Type 1 projects; even when public involvement is not required as part of the NEPA or SEPA processes. Public opinion must be considered when making a determination of reasonableness for traffic noise abatement. Noise abatement will not be planned if more than 50% of eligible property owners oppose the proposed noise abatement.

Describe public outreach, how public opinion was solicited, and whether it was determined that abatement was/was not desired.

## Recommendation for Traffic Noise Abatement

Traffic noise abatement is/is not recommend because… If recommended, the final noise wall design, costs and benefits are reiterated.

The recommended noise wall is approximately:

* Height = XX
* Length = XX
* Cost = XX

The planning level noise wall design is shown in Exhibit XX.

# Construction Noise

## Construction Noise Background

Construction creates temporary noise. Construction is usually carried out in reasonably discrete steps, each with its own mix of equipment and noise characteristics. For example, roadway construction involves demolition, construction, and paving.

The most constant noise source at construction sites is usually engine noise. Mobile equipment generally operates intermittently or in cycles of operation, while stationary equipment, such as generators and compressors, generally operates at fairly constant sound levels. Trucks are present during most phases of construction and are not confined to the project site, so noise from trucks may affect more receivers than other construction noise. Other common noise sources include impact equipment, which could be pneumatic, hydraulic, or electric powered.

Noise levels during the construction period depend on the type, amount, and location of construction activities.

* The type of construction methods establishes the maximum noise levels.
* The amount of construction activity establishes how often construction certain noises occur throughout the day.
* The location of construction equipment relative to adjacent properties determines the effect of distance in reducing construction noise levels.

The maximum noise levels of construction equipment will be similar to the maximum construction equipment noise levels presented in Exhibit X and typically range from 69 to 106 dBA at 50 feet. As a point source, construction noise decreases by 6 dBA per doubling of distance from the source moving away from the equipment. The various pieces of equipment are almost never operating simultaneously at full-power and some will be turned off, idling, or operating at less than full power at any time. Therefore, the average Leq noise levels will be less than aggregate of the maximum noise levels in Exhibit X.

## Construction Noise Variance for Night Work

Construction noise is exempt from local property line regulations during daytime hours. If nighttime construction is required for this project, WSDOT will apply for variances or exemptions from local noise ordinances for the night work. Noise variances or exemptions require construction noise abatement measures that vary by jurisdiction. If night work is necessary for this project, noise variances are needed from JURISDICTION NAMES.

## Construction Noise Abatement

Construction noise can be reduced by using enclosures or walls to surround noisy equipment, installing mufflers on engines, substituting quieter equipment or construction methods, minimizing time of operation, and locating equipment farther away from noise sensitive receivers, e.g., homes. To reduce construction noise at nearby receptors, the following abatement measures can be incorporated into construction plans and contractor specifications:

* Limiting construction activities to between 7 a.m. and 10 p.m. would reduce construction noise levels during sensitive nighttime hours
* Using haul vehicles with rubber bed-liners would reduce noise from loading trucks
* Equipping trucks with ambient backup alarms would reduce the noise for equipment backing
* Equipping construction equipment engines with adequate mufflers, intake silencers, and engine enclosures would reduce their noise by 5 to 10 dBA (U.S. EPA, 1971)
* Specifying the quietest equipment available would reduce noise by 5 to 10 dBA
* Turning off construction equipment during prolonged periods of nonuse would eliminate noise from construction equipment during those periods
* Requiring contractors to maintain all equipment and train their equipment operators would reduce noise levels and increase efficiency of operation
* Locating stationary equipment away from receiving properties would decrease noise from that equipment in relation to the increased distance
* Constructing temporary noise barriers or curtains around stationary equipment that must be located close to residences would decrease noise levels at nearby sensitive receptors

X jurisdiction requires the following provisions for night work to occur. The above measure may need amending if non-standard abatement is required by relevant jurisdiction(s).

Exhibit 12: Construction Equipment Noise Ranges



# References

1. U.S. Department of Transportation, Federal Highway Administration directive "Highway Traffic Noise: Analysis and Abatement,” Revised December 2010.
2. U.S. Department of Transportation, Federal Highway Administration “Highway Traffic Noise: Analysis and Abatement Guidance,” Revised December 2010.
3. United States Code of Federal Regulations (CFR) Part 772 (23 CFR Part 772), July 2010
4. U.S. Department of Transportation, Federal Highway Administration, 1996. *Measurement of Highway-Related Noise*. Washington D.C.
5. U.S. Department of Transportation, Federal Highway Administration, 1998. *FHWA Traffic Noise Model User’s Guide*. Washington D.C.
6. U.S. Department of Transportation, Federal Transit Administration, 1995. *Transit Noise and Vibration Impact Assessment*. Washington D.C.
7. U.S. Environmental Protection Agency, 1971. Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances. Washington, D.C.
8. 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.
9. Washington Administrative Code, 1989. Chapter 173-60*. Maximum Environmental Noise Levels*. Olympia, Washington.
10. Washington State Department of Transportation, July 2011. Traffic Noise Policy and Procedures. Olympia, Washington.

# Appendix A - Traffic Noise Analysis and Abatement Process

## When are noise reports and/or recommendations final?

The noise abatement process from the preparation of a noise wall to the final noise wall design (or decision not to build) can be confusing. The following process attempts to provide some clarification to project teams and outlines a recommended “standard” process, but acknowledges that variations to this process are likely because of the differences between projects.

## Environmental Discipline Reports

The noise analyst works with the project team to model project elements affecting noise that include traffic, topography, and the location of noise sensitive receivers. If traffic noise impacts are discovered through modeling, then abatement is evaluated.

Abatement is compared to the feasibility (constructability, effectiveness) and reasonableness (allowable barrier size/cost) for a “standard” project. If abatement is feasible and reasonable, the report recommends the optimal (cost to benefit) noise barrier.

The traffic noise discipline report can be finalized.

## Design Phase

*Design Phase and Public Involvement steps (below) may be incorporated before report is finalized.*

The project office reviews the recommended noise wall height and horizontal alignment to determine if there are any conflicts that were not realized at the time the discipline report was prepared.

If conflicts from utilities, steep slopes, etc. are present, the details and costs of the conflicts are provided to the noise analyst by the project team. The noise analyst will then add any additional (“but for” the noise wall) costs to the reasonableness evaluation. If noise wall costs including accommodation of conflicts are still less than the allowable costs for the noise wall, the barrier height and/or alignment are re-evaluated and a new barrier will be recommended. If barrier costs plus the new costs exceed the allowable costs, the barrier may not be recommended by the ANE Program.

If a noise wall is recommended, ANE Program will review and confirm noise wall dimensions throughout design process.

## Public Involvement

If abatement is recommended in the Traffic Noise Discipline Report, public outreach to determine public desires for abatement must occur. The noise wall discussion may be introduced to the public before the Design Phase, but should happen after the noise wall alignment, height, and length (or other abatement description) is established so that people can understand any effects of the noise wall (or other abatement) on their community.

The final determination whether to construct a noise wall or other abatement that is recommend in the traffic noise analysis, cannot be made until public outreach has occurred.

## Final Steps

Any updates to the Traffic Noise Discipline report to clarify changes that occurred during the Design Phase or from Public Involvement can be made at the project engineering offices discretion. Addendum or supplementary memorandum to clarify changes can also be added to the discipline report or project file.

The noise wall is constructed or a letter from the ANE Program is added to the project file clarifying why a noise wall was not constructed.

# Appendix B – Traffic Data

Exhibit 13: Measured Traffic Volumes during Validation Measurement

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Traffic during Validation (*Date)* | | | |
| Measurement  Location | Modeled  Speed  (mph) | Cars | Medium  Trucks | Heavy  Trucks |
| Address (M1) |  |  |  |  |
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Exhibit 14: Modeled Hourly Traffic Volumes for Existing and future No-Build and No Build Conditions

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Existing Conditions (*Year)* | | | | No Build Design Year Traffic (Year) | | | | Build Design Year Traffic (Year) | | | |
| Modeled  Speed  (mph) | Cars | Medium  Trucks | Heavy  Trucks | Modeled  Speed  (mph) | Cars | Medium  Trucks | Heavy  Trucks | Modeled  Speed  (mph) | Cars | Medium  Trucks | Heavy  Trucks |
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# Appendix C – TNM Barrier Graphics

# Appendix D - TNM Output

## TNM Output

Included in the attached CD-ROM are TNM v2.5 files marked as follows:

* Project Name\_Build
* Project Name\_NoBuild
* Project Name\_Existing
* Project Name\_BarrierX
* Project Name\_BarrierX

1. 23 CFR 772, "Procedures for Abatement of Highway Traffic Noise and Construction Noise" [↑](#footnote-ref-1)
2. 2011 WSDOT Traffic Noise Policy and Procedures, WSDOT [↑](#footnote-ref-2)
3. U.S. EPA, 1974 [↑](#footnote-ref-3)
4. U.S. Department of Transportation, 1982, Noise Abatement Council [↑](#footnote-ref-4)
5. WAC Chapter 173-40 [↑](#footnote-ref-5)
6. WAC 173-60-040 [↑](#footnote-ref-6)