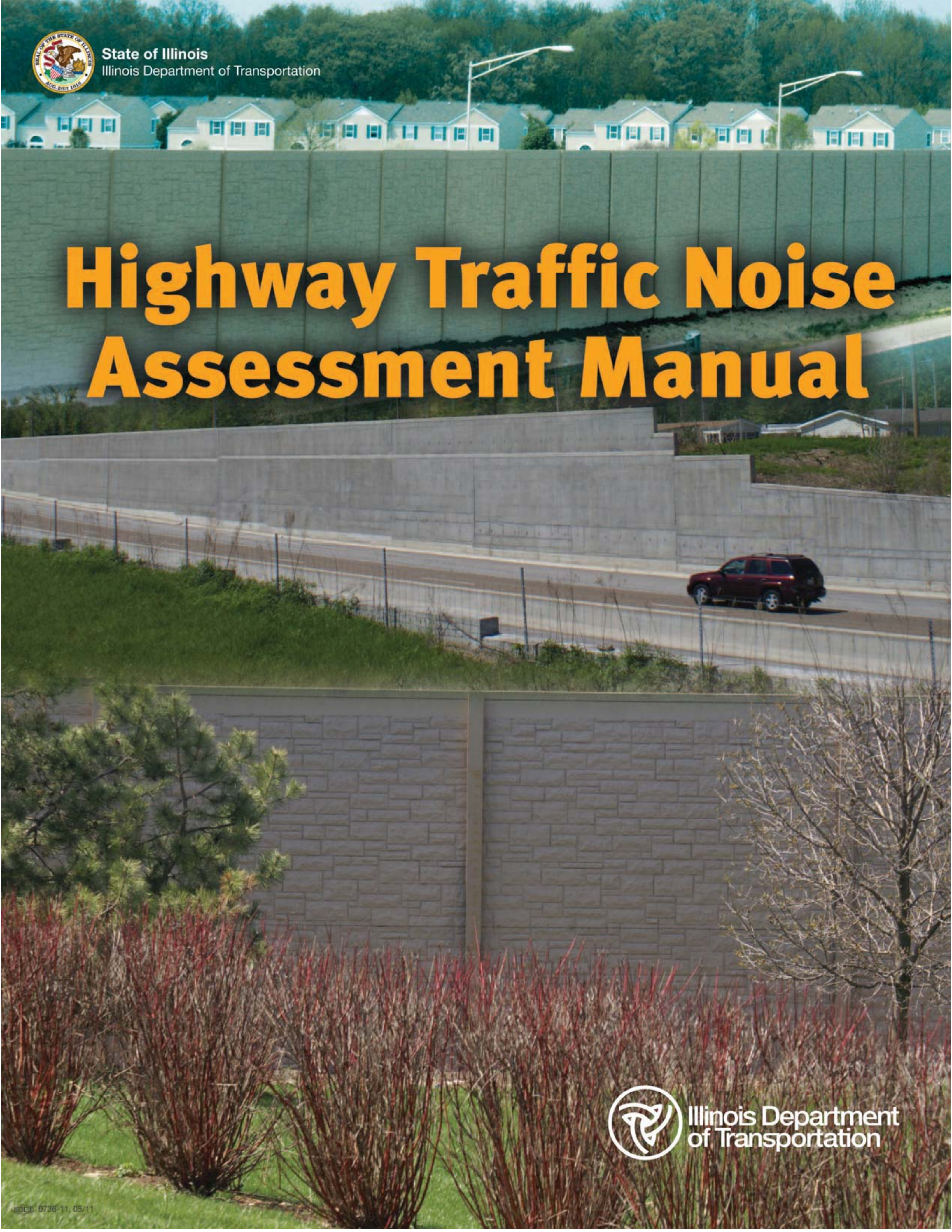
State of Illinois
Illinois Department of Transportation

Highway Traffic Noise Assessment Manual



Illinois Department of Transportation

IOCI 0736-11, 05/11

HIGHWAY TRAFFIC NOISE

ASSESSMENT MANUAL

Illinois Department of Transportation
Division of Highways
Bureau of Design and Environment

Springfield, Illinois

JUNE 2011

IDOT Mission

We provide safe, cost-effective transportation for Illinois in ways that enhance quality of life, promote economic prosperity, and demonstrate respect for our environment.

FORWARD

This guidance has been developed by the Illinois Department of Transportation (IDOT) as a companion document to the noise policy presented in Chapter 26 of the IDOT Bureau of Design and Environment (BDE) Manual. It provides technical information and procedures that should be used when performing highway traffic noise analyses in the State of Illinois. This manual also includes a glossary of terms. An example traffic noise memorandum/report outline has been included in Appendix A. Frequently asked questions and responses have been included in Appendix B. Additionally, Appendix C contains two example noise abatement evaluations.

The procedures presented herein are based on the Federal Highway Administration's (FHWA), Title 23 of the Code of Federal Regulations, Part 772 and the "Highway Traffic Noise: Analysis and Abatement Guidance" dated June 2010, January 2011, as revised. This document replaces the 2007 IDOT Highway Traffic Noise Assessment Manual.

Illinois Department of Transportation
Departmental Policies

D&E-6
Effective Date: June 29, 2011
Scheduled Review Date: June 29, 2016

HIGHWAY TRAFFIC NOISE ASSESSMENT MANUAL

1. POLICY

The Bureau of Design and Environment shall publish and maintain a *Highway Traffic Noise Assessment Manual* that shall be used as a basis for preparing noise analyses required for Environmental Impact Statements and other environmental documents and studies for projects on the State Highway System.

2. PURPOSE

This policy is issued in order to ensure that studies and reports on traffic noise prepared by or for the department are consistent with existing laws and regulations and are technically accurate and sufficient.

The manual:

a. Describes techniques and procedures for analyzing and reporting potential traffic noise impacts.

b. Describes noise barriers and other abatement measures that can be evaluated for project designs to potentially mitigate traffic noise impacts.

c. Describes obtaining the viewpoints of benefited receptors for noise barriers that are feasible and reasonable.

d. Notes references and examples to aid in the study of traffic noise and includes guidelines for the presentation of study results in environmental documents.

3. GUIDELINES FOR IMPLEMENTATION

The procedures contained in the *Highway Traffic Noise Assessment Manual* are effective June 29, 2011. The procedures and information contained in the manual are intended to apply to all Environmental Impact Statements and other environmental documents regarding traffic noise prepared by or for the department.

4. RESPONSIBILITIES

The Bureau of Design and Environment is responsible for preparing and maintaining this policy memorandum and the associated manual. Studies regarding traffic noise prepared by or for the department shall conform to this policy memorandum and the contents of the *Highway Traffic Noise Assessment Manual.*

5. ACCESSIBILITY

Electronic versions of the policy and its accompanying manual are located at the Policy and Research Center site on InsideIDOT, the department's internal website (all previous versions are obsolete). Electronic versions of the manual can also be found at: http://www.dot.il.gov/environment/HTNAManual.pdf.

Questions regarding the manual may be directed to the Bureau of Design and Environment, Room 330, 2300 S. Dirksen Parkway, Springfield, Illinois 62764.

CLOSING NOTICE

Supersedes: Departmental Policy D&E-6, Highway Traffic Noise Assessment Manual, dated October 1, 2007.

Approved: Christine M Reed

Director of Highways
Chief Engineer

6/16/11

Date

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1. NOISE FUNDAMENTALS

This section presents an overview of basic sound concepts and how they relate to highway traffic noise. This includes general discussions on the definition of noise, how noise is measured, how noise is perceived, how noise changes with distance, and how mobile sources affect noise.

1.1 Noise Metrics

It is important to first differentiate between sound and noise. Sound is vibratory disturbance capable of being detected by the ear while noise is considered unwanted sound that may interfere with normal activities. Sound is produced by the vibration of sound pressure waves in the air and is measured on a logarithmic scale using units of decibels (dB). The decibel expresses the ratio of the sound pressure level being measured to a standard reference level. Sound is composed of a wide range of frequencies; however, the human ear is not uniformly sensitive. The average human with normal hearing can only hear sounds with frequencies ranging from 20 to 20,000 Hertz. Therefore, the "A-weighted" decibel scale was devised to correspond with the ear's sensitivity. The resulting unit of measurement is the dB(A).

The intensity of noise fluctuates with time and therefore the equivalent sound level is used. This is defined as the steady-state, A-weighted sound level, which contains the same amount of acoustic energy as the actual time-varying, A-weighted sound level over a specified period of time. If the time period is one hour, the descriptor is the hourly equivalent sound level or L_{eq}(h), which is widely used by State highway agencies as a descriptor of traffic noise.

1.2 Noise Perceptions

Noise is measured using decibels (dB) that are established on a logarithmic scale because the human ear reacts to logarithmic changes in noise levels. A change of 3 dB(A) is a barely perceivable change in noise, while an increase of 10 dB(A) is perceived as being twice as loud. Table 1-1 shows the perceived changes in noise levels relative to the decibel scale.[1]

TABLE 1-1
PERCEPTION OF CHANGES IN NOISE

Change in Noise Level	Perception of Change
+/- 3 dB(A)	Barely Perceivable Change
+/- 5 dB(A)	Readily Perceivable Change
+/- 10 dB(A)	Doubling/Halving Noise

1.3 Decibel Addition

Because noise is measured on a logarithmic scale, sound levels cannot be added or subtracted by ordinary arithmetic methods. For example, exposure to two 60 dB(A) noise sources does not correspond to a 120 dB(A) noise level. Rather, due to the logarithmic scale, two sources of equal noise added together result in an increase of 3 dB(A). That is, 60 dB(A) plus 60 dB(A) yields a total noise level of 63 dB(A). Applying this to traffic noise, doubling traffic volumes will increase the noise level by 3 dB(A).

Table 1-2 provides general rules of thumb for adding two noise sources together. When two or more sound levels differ by 10 or more decibels, the higher level dominates with no contribution from the lesser level(s).

TABLE 1-2
RULES FOR DECIBEL ADDITION

Difference between sound levels, dB	Amount to add to higher value, dB
0 to 1	3
2 to 3	2
4 to 9	1
10 or more	0

1.4 Common Sound Levels

Table 1-3 on the following page shows representative sound pressure levels (decibels) for a variety of common indoor and outdoor activities. To put common sound levels into perspective, normal speech at a distance of 3 feet is approximately 65 dB(A).

1.5 Highway Noise Generation/Sources

Highway noise generation is dependent on three main factors: traffic volume, traffic speed, and the number of trucks within the traffic. Each of these varies at any given moment. The dominant noise sources vary by speed and by vehicle type (*i.e.,* car vs. heavy truck). Table 1-4 summarizes the dominant noise sources for low and high speeds.

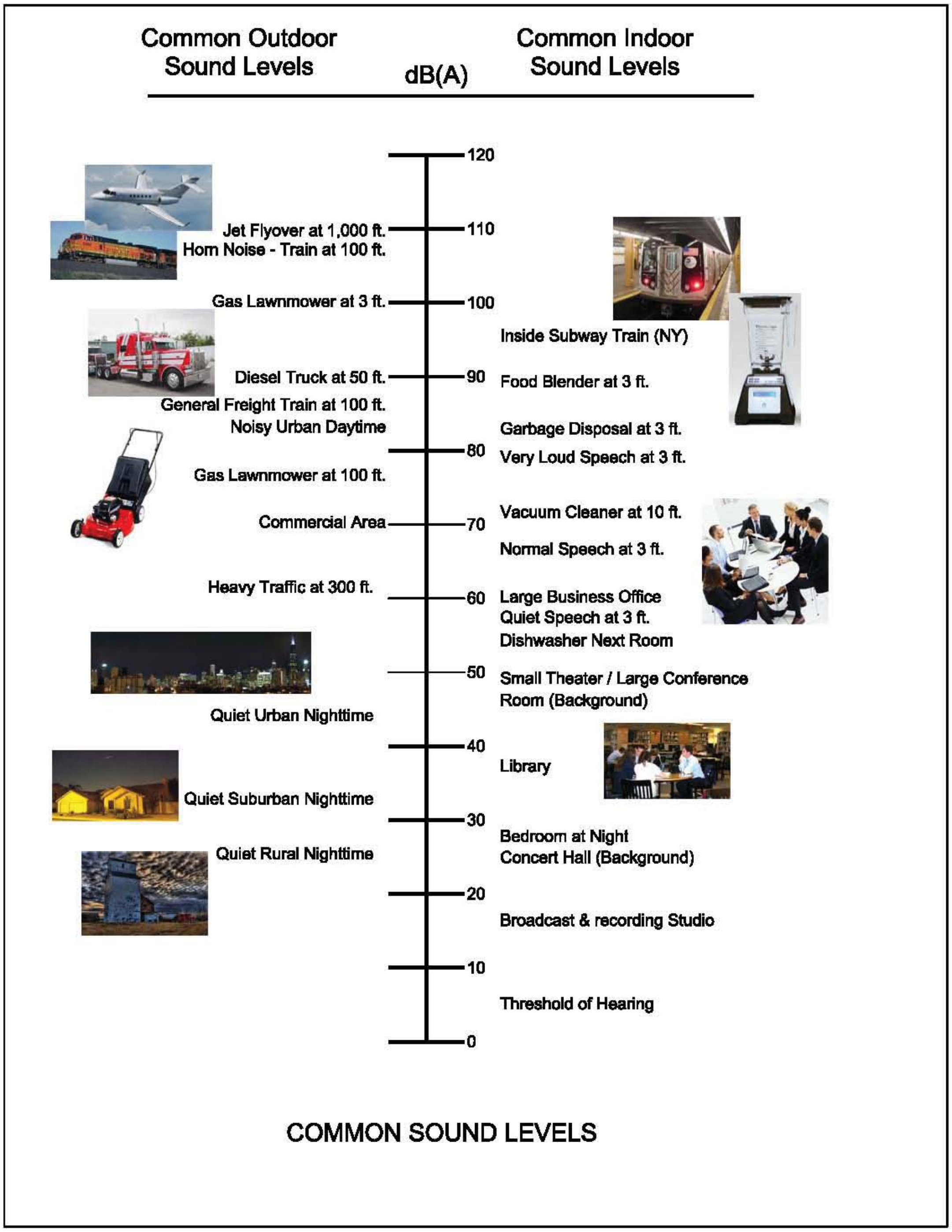
TABLE 1-4
PRIMARY MOBILE NOISE SOURCES

Low Speeds	➢ Engine ➢ Gear Box and Transmission ➢ Exhaust
High Speeds	➢ Tire/Road Noise ➢ Aerodynamics of Vehicle

Noise from vehicles occurs from tire interaction with the pavement and is characterized as the “whine” of traffic noise. While automobile noise is reasonably concentrated at one location on the vehicle, heavy truck noise is made up of three major sources: engine noise, exhaust noise, and tire noise. Figure 1-1 shows an example of how these three noise sources combine to produce a typical truck noise level of 82 dB(A) at an arbitrary distance from the truck.

The height of the noise source also contributes to the noise level. For example, the average truck height is approximately 10 feet and the exhaust outlet height (stack height) can range from 8 to 12 feet high. Figure 1-2 shows a typical stack height for a

TABLE 1-3
COMMON SOUND LEVELS



truck. The relative height of the truck noise source requires higher noise barriers for effective abatement, especially when trucks are a large percentage of the traffic volumes.[1]

1.6 Noise Attenuation

Highway noise is generated by a line of vehicles closely spaced. This gives a listener the perception of a linear noise source rather than a single, identifiable point of noise. As distance increases from the highway, noise is reduced or attenuated. Generally, every time the distance doubles, the noise level will decline approximately 3 dB(A) when the sound travels over hard surfaces. Over soft surfaces, the noise level will decline approximately 4.5 dB(A) for every doubling of distance.

For example, if grass is the predominant ground cover (soft site), with a traffic noise level of 75 dB(A) at 50 feet from the roadway, the noise level at 100 feet would be 4.5 dB(A) lower, or 70.5 dB(A), and at 200 feet the noise level would be 9 dB(A) lower, or 66 dB(A). If asphalt, brick, or concrete is the predominant ground cover (hard site), the resulting noise level, at 200 feet, will be 6 dB(A) lower, or 69 dB(A).

FIGURE 1-1 Typical Truck Noise

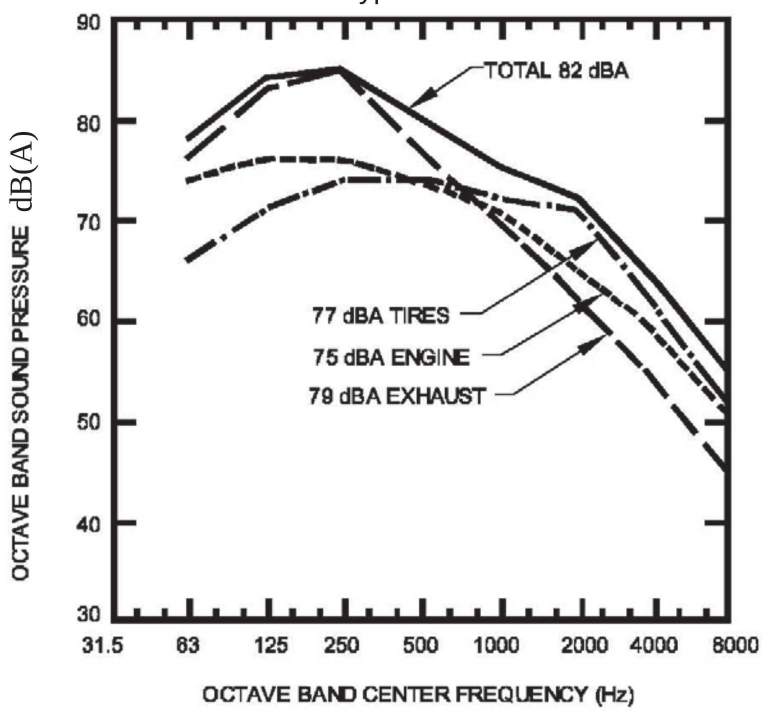
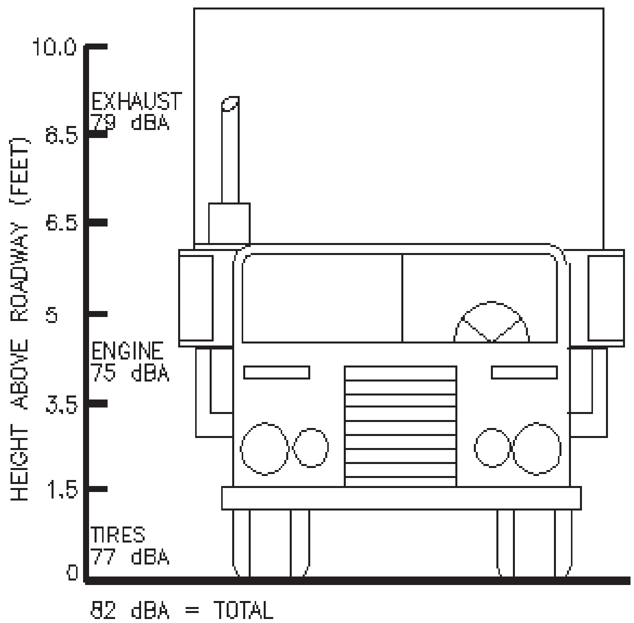


FIGURE 1-2 Average Truck Height



Source: Highway Traffic Noise Sources
U.S. Dept. of Transportation

2. NOISE REGULATIONS

2.1 Federal Regulations

The following regulations and guidelines provide the legal authority and guidance for the noise analysis procedures presented in this Manual:

- National Environmental Policy Act of 1969
- Federal-aid Highway Act of 1970
- Noise Control Act of 1972
- FHWA Noise Standards - 23 CFR Part 772 “Procedures for Abatement of Highway Traffic Noise and Construction Noise”
- FHWA Policy and Guidance - “Highway Traffic Noise: Analysis and Abatement Guidance”, June 2010, January 2011, as revised.

The 1969 National Environmental Policy Act (NEPA) established the decision-making framework for federal actions. The evaluation and mitigation of potential adverse environmental effects, including traffic noise, are to be considered during the decision-making process. However, NEPA does not establish the criteria for the evaluation of impacts. The FHWA has the responsibility to protect the public health and welfare during the planning and design of a highway project. The Federal-aid Highway Act of 1970 required FHWA to develop noise standards and abatement requirements for highway traffic noise. These standards are contained in Part 772 of Title 23 of the Code of Federal Regulations (23 CFR 772).

The federal regulations (23 CFR 772) were developed to prescribe the methods that must be followed for the evaluation of highway traffic noise in Federal-aid highway projects. FHWA will not approve a project unless a project has been satisfactorily evaluated for potential traffic noise impacts and has addressed feasible and reasonable noise abatement measures. The federal regulations were specifically written to allow flexibility in the development of State policies appropriate for the resources and other influences specific to the State. The FHWA Guidance Manual, *Highway Traffic Noise: Analysis and Abatement Guidance* gives State transportation agencies guidance to develop their own State policies.

The Noise Control Act of 1972 establishes the authority for federal agencies to regulate noise emissions from specific sources, such as commercial products, aircraft, railroads and motor vehicles. Noise emission standards are regulated by the U.S. Environmental Protection Agency (USEPA), not by FHWA or IDOT.

2.2 State Policy

The FHWA regulations purposely give flexibility to each individual State’s Department of Transportation (DOT) for determining and evaluating noise impacts. In Illinois, Chapter 26-6 of IDOT’s Bureau of Design and Environment (BDE) Manual outlines the IDOT *Noise Analyses* policy. The policy states that:

> “Special efforts shall be made in the development of a project to comply with Federal and State requirements for noise control; to consult with appropriate officials to obtain the views of the affected community regarding local noise

requirements, noise impacts, and abatement measures; and to mitigate highway-related noise impacts, where feasible and reasonable. The reasonableness evaluation for noise abatement will include the solicitation of viewpoints from benefited receptors."

This policy statement sets forth the intent of the traffic noise analyses, the identification of traffic noise impacts, and the need to offer abatement where feasible and reasonable criteria have been met.

2.3 Traffic Noise Impacts and Applicability

2.3.1 FHWA Regulations

Based on land use, seven separate activity categories are used by FHWA to assess potential noise impacts as defined by 23 CFR 772. Five of the seven activity categories have Noise Abatement Criteria (NAC) that establish noise levels where noise abatement needs to be evaluated. The FHWA considered several approaches to define impact levels, but generally based the criteria on noise levels associated with the interference of speech communication. The NAC are therefore a balance of what is desirable and what is generally achievable.[2]

A traffic noise impact occurs on a project when predicted build noise levels approach, meet or exceed the NAC criteria listed in the following table or when the predicted noise levels are substantially higher than the existing noise level.

TABLE 2-1
FHWA NOISE ABATEMENT CRITERIA - HOURLY WEIGHTED SOUND LEVEL

Activity Category	$L_{eq}(h)$	Evaluation Location	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[1]	67	Exterior	Residential.
C[1]	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[1]	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	---	---	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	---	---	Undeveloped lands that are not permitted.

[1] Includes undeveloped lands permitted for this activity category.

FHWA has deferred to the State agencies to define the noise level that "approaches" the NAC and to define a substantial increase in traffic noise levels. It should be noted that the NAC are not used as goals for noise attenuation design criteria or design targets. Instead, the NAC are noise impact thresholds for considering abatement when they are approached, met, or exceeded. Noise abatement measures are required to be considered as part of the project if impacts are identified.

Examples of Activity Category A may include a monastery or an outdoor prayer area. Areas to be evaluated as Activity Category A shall be reviewed by FHWA on a case-by-case basis for approval by submitting a justification for the use of this designation. Activity Categories F and G do not have NAC established; however, the prediction of traffic noise levels may be required for reporting purposes as presented in Section 6. The technical noise memorandum or report should designate and analyze all land uses within the project corridor, including Activity Category F.

The NAC and noise procedure regulations apply to Type I and Type II (retrofit) projects only; however, the implementation of a Type II program is optional. IDOT does not maintain a Type II program.

Type I projects are defined as follows:

- The construction of a highway on new location; or,
- The physical alteration of an existing highway where there is either:
  + *Substantial Horizontal Alteration*. A project that halves the distance between the traffic noise source and the closest receptor between the existing condition to the future build condition; or,
  + *Substantial Vertical Alteration*. A project that removes shielding therefore, exposing the line-of-sight between the receptor and the traffic noise source. This is done by either altering the vertical alignment of the highway or by altering the topography between the highway traffic noise source and the receptor; or,
- The addition of a through-traffic lane(s). This includes the addition of a through-traffic lane that functions as a HOV lane, High-Occupancy Toll (HOT) lane, bus lane, or truck climbing lane; or,
- The addition of an auxiliary lane, except for when the auxiliary lane is a turn lane; or,
- The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange; or,
- Restriping existing pavement for the purpose of adding a through-traffic lane or an auxiliary lane; or,
- The addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot or toll plaza.

If a project is determined to be a Type I project under this definition, then the entire project area as defined in the NEPA environmental document is a Type I project. In addition, a Type III project is defined as a Federal or Federal-aid highway project that does not meet the classifications of a Type I or Type II project. Type III projects do not require a noise analysis.

2.3.2 IDOT Noise Policy

The IDOT Noise Policy establishes the traffic noise analysis requirements for all Type I projects whether they are federally funded or state-only funded, which includes cost-sharing projects with local funds. The traffic noise impact determination is based on the FHWA NAC as set forth in IDOT's policy found in Chapter 26-6.05(c) (Traffic Noise Analysis) of the BDE Manual. IDOT has established the following criteria to define the occurrence of a traffic noise impact.

- Design year (typically 20 years into the future) traffic noise levels are predicted to approach, meet, or exceed the NAC, with approach defined as 1 dB(A) less than NAC; or

- Design year (typically 20 years into the future) traffic noise levels are predicted to substantially increase (greater than 14 dB(A)) over existing noise levels.

Based on the approach definition determined by IDOT, Table 2-2 provides the noise levels at which a traffic noise impact would occur and would require consideration of traffic noise abatement for the design year.

TABLE 2-2
IDOT TRAFFIC NOISE LEVELS WARRANTING ABATEMENT EVALUATION

Activity Category	L_{eq}(h), dB(A)	Evaluation Location
A	56	Exterior
B	66	Exterior
C	66	Exterior
D	51	Interior
E	71	Exterior
F	---	---
G	---	---

3. TRAFFIC NOISE ANALYSIS

3.1 Section Overview

This section describes the appropriate traffic noise analysis approach and the procedures for conducting a traffic noise analysis. The following topics are presented:

3.2 Analysis Applicability
3.3 Objectives of the Traffic Noise Analysis Process
3.4 Receptor Selection
3.5 Noise Monitoring
3.6 Traffic Noise Model (TNM)
3.7 Traffic Noise Level Predictions

3.2 Analysis Applicability

The noise analysis and abatement procedures shall apply to all Type I projects, whether federally funded or state-only funded, which includes state and local-funded projects. Type I projects are defined in 23 CFR 772 and include the following discussed herein:

Construction of a Highway on New Location

Identification of the construction of a highway on new location is generally self-explanatory. In most cases, there is no roadway in the existing condition and the proposed project is construction of a new roadway. This also includes the evaluation of new interchanges and ramps on existing highways.

Physical Alteration of an Existing Highway

Identification of the physical alteration of an existing highway which substantially alters either the horizontal or vertical alignment requires evaluation on a case-by-case basis. FHWA defines a substantial alteration as follows:

> *Substantial Horizontal Alteration*. A project that halves the distance between the traffic noise source and the closest receptor between the existing condition to the future build condition; or,
>
> *Substantial Vertical Alteration*. A project that removes shielding, therefore, exposing the line-of-sight between the receptor and the traffic noise source. This is done by either altering the vertical alignment of the highway or by altering the topography between the highway traffic noise source and the receptor.

Addition of Through-traffic Lanes

Based on FHWA guidance, identification of the physical alteration of an existing highway which increases the number of through traffic lanes requires consideration of the through traveled way, which is the portion of the highway constructed for the movement of vehicles, not including shoulders and auxiliary lanes. Identification of the physical alteration of an existing highway which increases the number of through traffic lanes requires considering the through traveled way, that portion of the highway constructed for the movement of vehicles, exclusive of the shoulders and turn lanes. The addition of a full lane to the mainline of a highway is a Type I project.

The addition of high-occupancy vehicle (HOV) lanes, high-occupancy toll (HOT) lanes, bus lanes and truck climbing lanes are considered Type I projects. These additions are Type I projects regardless of length.

Addition of an Auxiliary Lane

The addition of an auxiliary lane is also a Type I project, unless the auxiliary lane is a turn lane.

Addition or Relocation of Interchange Lanes or Ramps to Complete a Partial Interchange

The addition or relocation of interchange lanes or ramps to complete an existing partial interchange is considered a Type I project, as the proposed project has the potential to increase the interchange capacity. The relocation of interchange lanes or ramps at an existing full interchange would need to be evaluated to determine if the shift in alignment would be considered a substantial shift in alignment.

Restriping Existing Pavement to Add a Through-traffic Lane or Auxiliary Lane

Restriping existing pavement to add an additional travel lane to add capacity would be considered a Type I project. The auxiliary lane added by restriping would also be considered a Type I project.

Addition of a New or Substantial Alteration of a Weigh Station, Rest Stop, Ride-share Lot, or Toll Plaza

Construction of a new weigh station, rest stop, ride-share lot or toll plaza would be considered a Type I project due to the addition of a new noise source. Substantial alterations to existing facilities would need to be considered using the same substantial alteration guidance provided for ”Physical Alteration of an Existing Highway”.

If any part of a project meets the definition of a Type I project, then the entire project area as defined in the NEPA environmental document needs to be evaluated for traffic noise. For example, if an arterial road is being improved by the addition of a new interstate interchange, traffic noise would need to be evaluated for the entire project area, including proposed improvements to all local roads within the project limits.

If the project is not a Type I project (does not meet the requirements for a traffic noise analysis), the following Type III documentation should be used in the environmental document or engineering document:

> “The referenced project meets the criteria for a Type III project established in 23 CFR Part 772. Therefore, the proposed project requires no traffic noise analysis or abatement evaluation. Type III projects do not involve added

> capacity, construction of new through lanes, changes in the horizontal or vertical alignment of the roadway, or exposure of noise sensitive land uses to a new or existing highway noise source. A noise analysis would be required if changes to the proposed project results in reclassification to a Type I project."

3.3 Objectives of the Traffic Noise Analysis Process

The major objectives of a traffic noise analysis are to:

- Identify areas for each reasonable alternative carried forward in the "Alternatives Section" of the NEPA Document where possible traffic noise impacts may occur
- Determine existing traffic noise levels
- Predict future traffic noise levels (No-Action and Build)
- Identify the possible traffic noise impacts
- Consider and evaluate abatement measures to mitigate highway traffic noise impacts
- Evaluate potential construction traffic noise impacts, if necessary
- Propose implementation of feasible and reasonable abatement measures
- Document the traffic noise evaluation process
- Communicate the results to the public and local officials

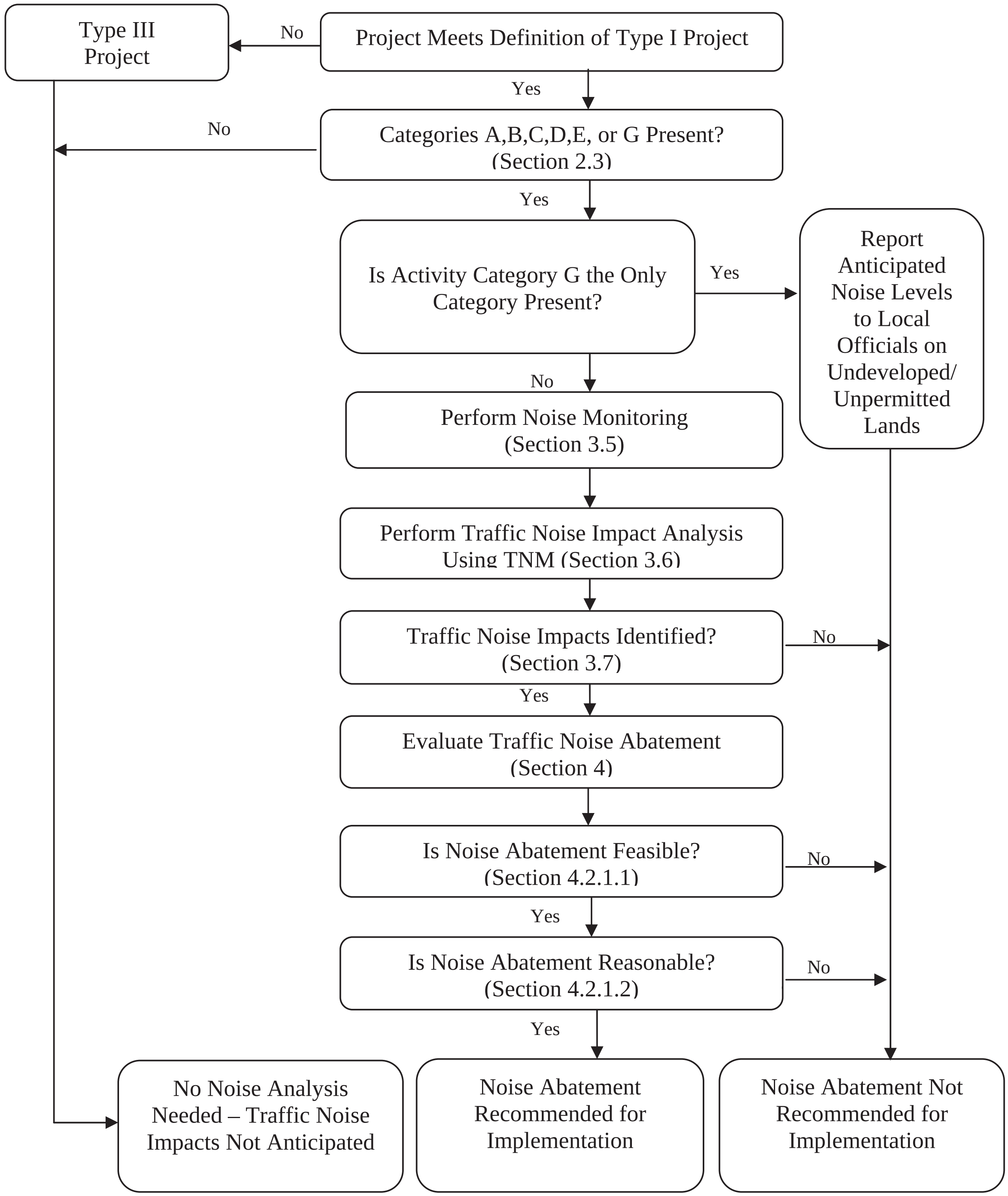
The noise evaluation process is detailed in Figure 3-1.

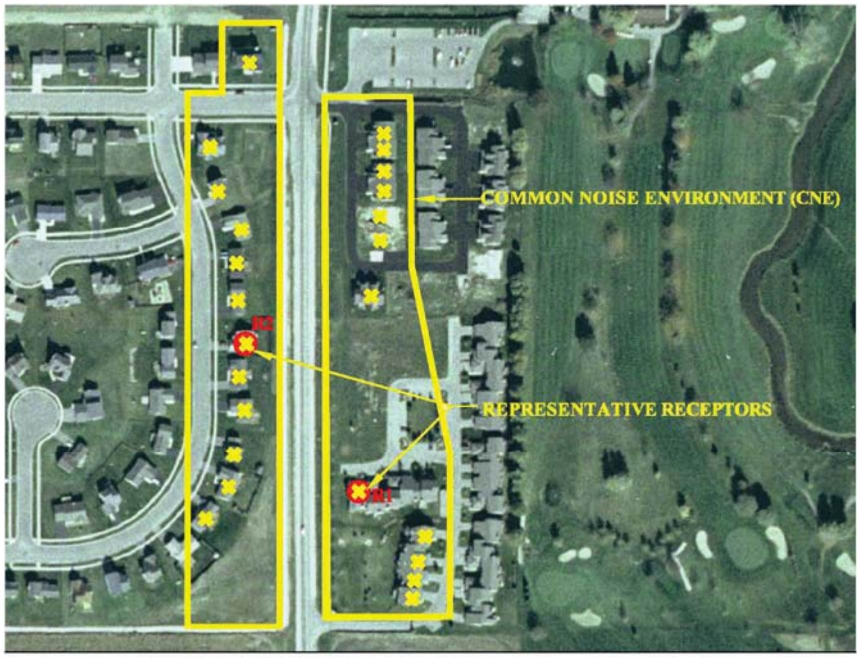
3.4 Receptor Selection

IDOT defines a receptor as a discrete or representative location of a common noise environment for any of the activity categories listed in Table 2-1. Primary consideration should be given to exterior areas where frequent human use occurs for Activity Categories A, B, C, and E. Consideration should be given to Activity Category D land uses only if no exterior use areas are identified.

Land use along a proposed project corridor should be reviewed and identified using the FHWA Activity Categories as shown in Table 2-1. For the initial screening of receptors, land use within 500 feet of the roadway shall be reviewed. Highway traffic noise is not usually a serious problem at distances greater than 500 feet from heavily traveled freeways or more than 100 to 200 feet from lightly traveled roads. If there are sensitive receptors further than 500 feet from the roadway, these should also be considered and could be included on a case-by-case basis in the traffic noise analysis, dependent upon the sensitivity of the receptor (*i.e.,* nursing home).

FIGURE 3-1: IDOT'S NOISE EVALUATION PROCESS





RECEPTOR SELECTION

Once the sensitive land uses have been identified, they may be grouped into common noise environment(s) (CNEs). These areas consist of receptors with the following characteristics:

- Same Activity Category in Table 2-1 (*i.e.,* all single family residential, *etc.*)
- Same exposure to noise sources and levels
- Same basic topography
- Similar traffic characteristics (speed, volume, truck composition)

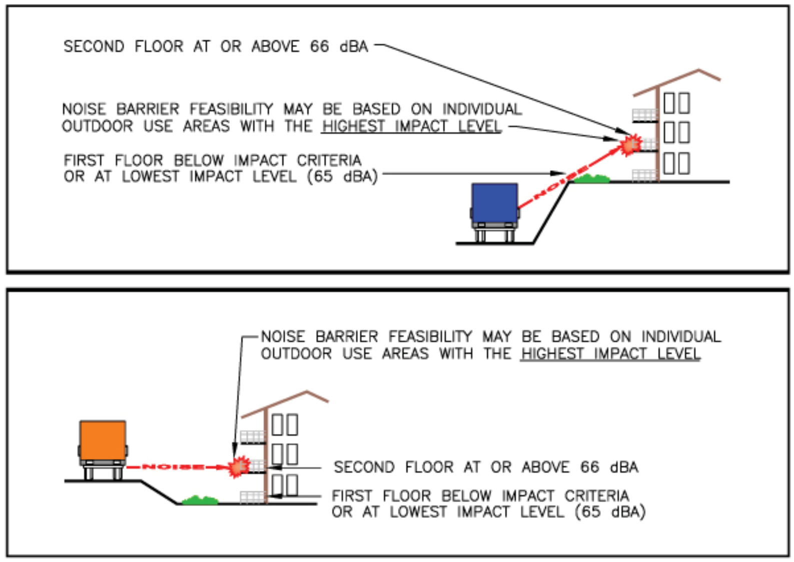
One receptor may be used to represent the equivalent or worst case for several receptors in the same CNE. For example, the representative receptors shown in the figure above are the closest receptors to the roadway, thereby having the probability of the highest noise levels within the CNE. This is termed a "representative receptor". If there is no impact at this receptor, it is unlikely that there will be an impact at any of the remaining receptors. However, if there is an impact at the representative receptor, it may be necessary to model additional receptors in the CNE to determine the impact extent and the number of receptors that may benefit from an abatement measure.

Once the representative receptor has been selected for each CNE, the point for the traffic noise evaluation at the receptor shall be selected. The receptor location should be placed in an area where frequent outdoor human activity occurs. Examples include but are not limited to the following:

- Residences – back yards, front yards, decks, and/or patios
- Schools – playgrounds
- Nursing Homes – decks and/or patios
- Parks – pavilion areas, picnic tables
- Cemeteries – points of anticipated gathering (*i.e.,* bench, pavilion or shelter)

- Trails and Trail Heads - points of anticipated gathering (*i.e.,* bench, information boards)

There are times when traffic noise from elevated roadways may be louder on second or third floors that are within the direct line of sight of the roadway. For these situations, the receptors within the direct line of sight of the roadway, *i.e.,* second floor apartment units, shall be evaluated under the feasibility criteria. This approach shall be used for multi-family residences when ground level exterior areas do not exist, but shall not be used to address second floors of single-family residences. When identifying impacts, impacted receptors may include both ground level and higher levels within a multi-family dwelling.



The evaluation of traffic noise impacts should primarily focus on outdoor activity areas affected by traffic noise levels. Activity Category B land uses should always be evaluated for exterior areas. Activity Category D includes certain land use facilities that may have interior uses. Activity Category D is appropriate for use as a basis for determining traffic noise impacts for these uses where there are no exterior activities affected by traffic noise, or where the exterior activities are far from or physically shielded from the roadway in a manner that prevents an impact on exterior activities. (See Section 3.7.1 for interior noise level predictions). The interior analysis should only be conducted for those activities identified within Activity Category D. It should be noted that Activity Category D does not apply to residential land uses and therefore an interior noise impact analysis would not be conducted for residences.

Receptors shall also include presently undeveloped lands for which development is permitted. Development will be deemed to be permitted if a noise sensitive land use, such as a residence, school, or church, *etc.,* has received a building permit from the local agency with jurisdiction prior to the date of public knowledge. The noise analysis for the permitted development shall be for the permitted activity description. The date of public knowledge shall be the date of environmental approval of the Categorical Exclusion (CE), the Finding of No Significant Impact (for Environmental Assessment-type projects) or Record of Decision (for Environmental Impact Statement-type projects) as defined in 23 CFR Part 771.

Receptor locations for the noise analysis can be approximated by reviewing by using available plat maps or development plans that may define individual lots or building locations. If plat maps and/or subdivision plans are not available, the location of adjacent receptors relative to the roadway may be considered as "typical" when deciding placement of receptor locations. **Noise abatement shall be evaluated for traffic noise impacts identified on undeveloped permitted lands.**

Undeveloped lands for which no permit has been obtained shall be evaluated for traffic noise for the build design year. The purpose of the evaluation is to determine the traffic noise levels if the land were to be developed. The noise levels shall be determined based on both the 66 dBA and 71 dBA noise levels (Table 2-2) to identify the location where traffic noise levels approach the NAC for Activity Categories B, C, and E. Noise abatement does not need to be evaluated if traffic noise levels approach the NAC within the undeveloped and unpermitted land property boundaries. The predicted noise information will be shared with the local officials as presented in Section 6.4.

Agricultural land is identified as one of the descriptors under Activity Category F. Consequently, agricultural lands generally do not require a traffic noise impact analysis as there is no NAC applicable to any land use in this category. However, agricultural land is the most likely land use type that could be developed in the future. For purposes of sharing information with local officials (Section 6.4), lands that are currently or have been historically farmed should be reviewed to determine the current zoning if they are within a planning district or municipal boundary. If the current zoning or the local comprehensive land use plans indicate a plan to eventually develop the agricultural land, the land is recommended to be evaluated as Activity Category G (undeveloped land). The predicted noise information will be shared with the local officials as presented in Section 6.4.

3.5 Noise Monitoring

Noise monitoring is physically measuring noise levels at a particular site. The following sections briefly describe noise monitoring procedures; however, when conducting noise monitoring for a highway project, the following document should be referenced for comprehensive guidance:

> "Measurement of Highway Related Noise," by the U.S. Department of Transportation, Federal Highway Administration, Office of Environment and Planning, Washington, D.C., May 1996. [FHWA-PD-96-046, DOT-VNTSC-FHWA-96-5.]

3.5.1 Applicability

Noise monitoring is generally required for every proposed Type I highway project. Appropriate use of noise monitoring may include the following:

- **Projects that include construction of a new roadway** - When there is no roadway in the existing condition and there is no dominant traffic noise source, a computer model cannot be used for the existing condition and existing noise levels must be determined by noise monitoring.

- **Projects with high public interest** - Conducting noise monitoring when there is a high degree of public interest can help generate greater public involvement and confidence.

- **Other major background noise is present -** Computer noise modeling is only applicable to noise originating from the roadway traffic and should not be used if there is background noise that may be impacting the traffic noise levels; however, if the roadway traffic is the dominant source, then the existing traffic noise levels may be calculated using the traffic noise model.

- **Model Validation** - Federal regulations require validation of the traffic noise model to verify the accuracy of the model runs used to predict the existing noise levels for the project.

3.5.2 Methodology

Noise monitoring is conducted at selected locations to measure existing noise levels. There are two types of sound level meters: Type 1 and 2 as determined by the American National Standards Institute (ANSI S1.4-1983). Use a noise meter with sufficient accuracy to yield valid data for the particular project (ANSI S1.4-1983, Type II or better). The monitoring procedures used should allow for consistent and supportable measurements.

The sound level meter is placed on a tripod approximately five (5) feet high. The noise meter shall be placed a sufficient distance from reflective surfaces to avoid capturing reflected sound. Generally, the microphone should be at least 10 feet from reflecting surfaces.

The duration of the monitoring period is based on the characteristics of the noise source. FHWA generally suggests sampling periods that range from eight (8) minutes to fifteen (15) minutes, depending on the range of noise levels anticipated and the temporal nature of the noise sources. Measurements along low-volume highways may require longer measurements of 30 to 60 minutes. The objective of establishing a sampling period is to obtain a steady-state equivalent noise level. The need for repetitive measurements shall be considered on a case-by-case basis using professional judgment.

Actual noise level measurements characterize existing noise conditions only at the time of measurement. Traffic volumes and other conditions present during the noise measurements should also be considered when evaluating field measurements as typical for the area. The following methodology is therefore offered for collecting and using noise level measurements.

Receptor Locations

Measurements should be taken at locations representative of the types of receptors located within the project area, such as residences, schools, churches, libraries, etc: however, not all receptors chosen for computer modeling need to be monitored. Measurements are normally taken at exterior areas of frequent human use such as a patio or the yard of a home. Generally, if noise monitoring is to be conducted, between 25 percent and 50 percent of the receptor locations selected for noise modeling purposes should be evaluated by noise monitoring. Additional monitoring locations may be required for new highway projects where the noise monitoring will be used to establish the existing noise level data.

Traffic Volumes and Speed

Traffic volumes should be documented during field monitoring by manually counting traffic on adjacent streets. The counts will include the number of automobiles, medium trucks, and heavy trucks. Average traffic speed should be measured using either a Doppler radar gun or stopwatch measurements.

Time and Day for Measurements

Measurements should generally be conducted during the worst traffic-noise conditions. The time of day this occurs depends on the roadway being evaluated, but is typically represented by peak traffic conditions traveling at or near posted speed limits. Recommended noise monitoring periods are Tuesday through Thursday, 8:00 a.m. to 12:00 p.m. and 1:00 to 6:00 p.m.; however, site-specific conditions may warrant monitoring at a time outside these ranges, such as at night. Noise monitoring is not recommended for Mondays, Fridays, weekends or holidays unless the objective of the noise monitoring is to evaluate these time periods.

Weather Conditions

Since weather conditions will affect noise measurement readings, a wind screen should be used at all times. If the wind speed exceeds 12 m.p.h., noise measurements should not be taken. Temperature and humidity limitations are established by the sound level meter manufacturer, but are typically limited to temperature ranging between 14 degrees F to 122 degrees F and humidity ranging from 5% to 90% relative humidity. Other site conditions necessary during the monitoring include dry pavement and no snow cover. The weather condition information shall be documented with the sound data.

3.5.3 Results

Noise monitoring is a tool that only provides information for existing conditions. Computer noise modeling using the latest FHWA-approved Traffic Noise Model (TNM) is used to predict traffic noise levels for both existing and future conditions (see Section 3.6.). Noise monitoring results need to be compared to the computer-predicted existing traffic noise levels to validate the accuracy of the noise model run(s) used to predict existing noise levels for the project.

In general, noise monitoring results should be within +/-3 dB(A) of the TNM generated results for the model to be considered validated. If results are outside of this range, the traffic volumes, composition and speed input into TNM should be compared to the traffic volumes, composition, and speed measured during the monitoring events to evaluate potential discrepancies between the monitoring results and TNM results. Traffic data (volumes, composition and speed) collected during the noise monitoring may need to be input into the existing model and run to make the comparison. In addition, the noise monitoring data should be reviewed for potential non-traffic noise sources that may have affected the measured noise levels.

If the monitored results are still not within 3 dB(A) of the computer-generated results, the noise model input should be reviewed and revised as necessary, the noise monitoring should be redone, or both. If after this approach, the model is still not validated, the analyst shall document the reason for the discrepancy in the traffic noise report. For example, there may be a discrepancy if the noise monitoring data included other noise sources in the area that influenced the readings and could not be accounted for in TNM.

The noise monitoring results should not be used to generate adjustment factors or receiver adjustments to be used in TNM to account for the discrepancy. Other factors to consider include ground cover, building rows, ground zones, or terrain lines. All these have the potential to affect noise that may need to be accounted for in TNM.

3.5.4 Calibration of Monitoring Equipment

Monitoring equipment calibration generally is conducted at two levels: laboratory calibration and field calibration. As per the *Measurement of Highway Related Noise (FHWA-PD-96-046),* all acoustical instrumentation should be calibrated annually by the manufacturer or other certified laboratory to verify accuracy. An acoustical calibrator is typically a handheld instrument that is used to calibrate the meter in the field. Calibration using the acoustical calibrator should be conducted at the beginning and end of each measurement session and before and after any changes made to the meter settings or components.

3.6 Traffic Noise Model (TNM)

Predict the traffic noise levels for each reasonable alternative carried forward under detailed study (including the "no-action" alternative) using the most current version of the FHWA-approved Traffic Noise Model (TNM) which is described in "FHWA Traffic Noise Model" Report No. FHWA-PD-96-010, or any other model determined by the FHWA to be consistent with the methodology of the FHWA TNM.

The eleven main TNM inputs to estimate traffic noise include:

- Traffic Volumes
- Traffic Speed
- Traffic Composition
- Receptor Location and Elevation
- Roadway Alignment (Horizontal and Vertical)
- Terrain Lines
- Ground Zones (*i.e.,* Detention Ponds, High Grass Areas)
- Building Rows
- Tree Zones
- Traffic Control Devices (*i.e.,* Stop Signs, Traffic Signals)
- Pavement Type

Information sources for traffic volumes, traffic speed, traffic composition, and pavement type are briefly described in the following subsections.

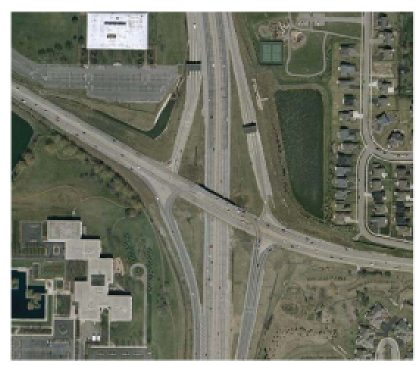
3.6.1 Traffic Volumes

The objective of the traffic noise analysis is to predict the worst hour traffic noise conditions. The traffic data that should be used are the highest volumes of traffic that can travel at the highest possible speed for the particular roadway, which is generally approximated by Level of Service (LOS) "C" conditions. This is typically represented by the design hourly volume (DHV). The traffic volumes can be obtained from traffic counts or intersection design sheets. If traffic volumes have not been manually conducted for the project, general traffic counts are available on the IDOT website (www.dot.il.gov). Design hourly traffic volumes can be estimated as approximately 6 to 10 percent of the Average Daily Traffic (ADT), with 6 percent being typical in rural areas and 10 percent typical in the more urban areas including the six county Chicago metropolitan area. In all cases, the best available traffic data shall be utilized for the TNM noise level predictions.

3.6.2 Traffic Speed

The operating speed during free flow conditions for the individual roadways should be used for the noise analysis. If there is no data available regarding the operating speed, the posted speed can be used. Interchange ramp speeds will be determined on a case-by-case basis. Typically, 35 mph is used for cloverleaf interchange ramps and 45 mph is used for diamond interchange ramps. The operating speed shall be used if it is determined to be consistently higher than the posted speed limit.

CLOVERLEAF INTERCHANGE RAMP



DIAMOND INTERCHANGE RAMP

3.6.3 Traffic Composition

Three types of vehicles (cars, medium trucks, and heavy trucks) are input into TNM. TNM also accounts for buses and motorcycles; however, traffic data are usually not specific enough to include these vehicle types. Unless the traffic characteristics support the use of these inputs, such as a bus route, buses are typically counted in the medium truck category.

Traffic composition should be obtained from traffic counts. If the composition is not available, typically the total truck percentage would be approximately 10 percent of the ADT.

3.6.4 Pavement Type

Four specific pavement types are provided in TNM, including:

- Dense-graded asphaltic concrete (DGAC),
- Portland cement concrete (PCC),
- Open-graded asphalt concrete (OGAC), and
- Average pavement (DGAC and PCC)

The average pavement should be used for all modeling scenarios, include the existing, no-action and build scenarios.

3.7 Traffic Noise Level Predictions

3.7.1 Prediction of Interior Noise Levels

Primary consideration shall be given to exterior areas where frequent human use occurs. In those situations where there are no exterior activities to be affected by the traffic noise, or where the exterior activities are far from or physically shielded from the roadway in a manner that prevents an impact on exterior activities, the interior criterion is appropriate for use as the basis for determining noise impacts for land uses in Activity Category D (See Table 2-1).

Interior noise levels shall be used for the evaluation of potential traffic noise impacts only if no exterior use areas are identified for those land uses within Activity Category D. Interior noise levels (with an NAC of 52 dB(A)) may also be evaluated for land uses in Activity Category D when it has been determined that exterior noise abatement measures are not feasible and reasonable. The interior noise level information may be useful when discussing traffic noise impacts for which no feasible or reasonable abatement measure is available.

Interior noise level predictions may be computed by subtracting the building noise reduction factors (See Table 3-1) from the exterior noise levels. Alternatively, if actual measurements of building noise reduction factors are obtained (available) for each building involved or if the building noise reduction factors are calculated from detailed acoustical (sound) analysis for each building involved, the measurements or calculated noise reduction factors should be used. If the measurements or calculations for the involved buildings are not available then the noise reduction factors provided in Table 3-1 may be used. Generally, the windows shall be considered open unless there is firm knowledge that the windows are in fact kept closed almost every day of the year.

TABLE 3-1
BUILDING NOISE REDUCTION FACTORS

Building Type Structures	Window Condition	Noise Reduction due to Composition of Exterior of the Structures (or 'Structure Type')
All	Open	10 dB
Light Frame	Ordinary Sash (closed)	20 dB
Light Frame	Storm Windows	25 dB
Masonry	Single Glazed	25 dB
Masonry	Double Glazed	35 dB

Source: FHWA Highway Traffic Noise Analysis and Abatement Policy and Guidance, Revised January 2011.

3.7.2 Scenarios Evaluated

Scenarios evaluated for the traffic noise assessment include:

- *Existing Condition* – Existing traffic volumes, existing roadway geometry. In cases where there is no existing roadway, noise monitoring shall be used to determine existing noise levels.
- *Proposed No-Action Condition* – Projected traffic volumes (*i.e.,* typically the design year), existing roadway geometry.
- *Proposed Build Condition* – Projected traffic volumes (*i.e.,* typically the design year), proposed roadway geometry.

3.7.3 Comparison to Criteria/Impact Determination

The noise levels predicted by the model should be rounded to the nearest whole number and compared to the NAC to assess impacts. Whole numbers are to be used for reporting purposes as the NAC is presented as whole numbers. Additionally, there is no perceivable change in noise levels of tenths of a decibel. Reporting decibel levels to the tenth also implies a false sense of accuracy and precision.

3.7.4 Documentation

Traffic noise levels should be documented in a *Noise Analysis Technical Memorandum* or *Report.* A sample outline of a Noise Analysis Report is included in Appendix A.

3.7.5 Noise Contours

Traffic noise impacts are determined using specific identified locations of exterior human use activity, such as a patio or park bench. Impacts for developed or permitted areas shall not be reported using contours or the contour function within TNM. Simple estimated traffic noise contours can be useful as a preliminary or screening tool to establish areas and locations for the specific noise sensitive receptor locations. Contouring can be developed using either the TNM noise contour function or by modeling discrete points and interpolating between the defined points.

Noise contours can also be used to depict traffic noise information for undeveloped areas for which no permit has been obtained for development. The traffic noise information for undeveloped areas is to be provided to local officials (*e.g.* county or municipal officials) within whose jurisdiction the highway project is located. The design year build noise levels should be predicted for the undeveloped lands and the distance from the edge of the nearest travel lane of the highway improvement shall be provided where the noise level approaches the exterior noise abatement criteria in Table 2-1. Contours can be used to depict these distances.

3.7.6 Weigh Stations, Rest Stops, Ride-Share Lots, or Toll Plazas

Improvements to weigh stations, rest stops, ride-share lots or toll plazas need to be evaluated for traffic noise when the proposed improvement includes construction of a new facility or a substantial change to an existing facility is proposed. These facilities include both mobile and stationary noise sources (*i.e.* idling trucks, building facility noise sources). Although the FHWA TNM can be used to evaluate mobile noise sources; it is also necessary to determine the contribution of stationary noise sources in the overall noise environment. If they are found to be a contributing factor, a methodology should be developed in coordination with IDOT to determine the existing and future stationary noise levels at these locations.

4. TRAFFIC NOISE ABATEMENT EVALUATION

The traffic noise analysis is used to predict the location of traffic noise impacts. The traffic noise abatement evaluation is used to identify potential noise abatement measures for the areas identified to be impacted. In addition to the direct benefits of noise abatement, the social, economic and environmental effects must also be considered. Primary consideration is given to exterior locations of residential areas where frequent human activity occurs and reduced traffic noise levels would be beneficial.

Any noise abatement measure must be determined both feasible and reasonable to be considered for implementation. Every effort should be made to achieve the noise reduction design goal (defined in Section 4.2.1.2 as at least 8 dB(A) for at least one benefited receptor). The noise abatement measure must also be considered a prudent expenditure of public funds to be considered reasonable (See Section 4.2.1.2). The following section outlines noise abatement measures when traffic noise impacts have been determined.

4.1 Noise Abatement Measures

Whenever practicable, alignment shifts should be considered to reduce future traffic noise levels. If an alignment shift is not practicable, then noise abatement measures shall be considered for each project where the traffic noise analysis has identified traffic noise impacts. The cost of these measures can be included as part of a Type I Federal-aid participating project. The Federal share and type of funding for noise abatement would be the same as that for the overall project.

At a minimum, noise abatement in the form of noise barriers shall be considered. The remaining noise abatement measures can be considered as alternative abatement measures for IDOT, but are not required to be evaluated. Abatement measures that can be considered include the following:

- *Construction of noise barriers* (Section 4.1.1)
- *Traffic management measures* (Section 4.1.2)
- *Alteration of horizontal and vertical alignments* (Section 4.1.3)
- *Acquisition of property rights for construction of noise barriers* (Section 4.1.4)
- *Acquisition of undeveloped land for buffer zones* (Section 4.1.5)
- *Noise insulation (only for Activity Category D)* (Section 4.1.6)

The benefits of any noise abatement measure considered for implementation must be evaluated against other social, economic and environmental impacts and the ability to achieve the purpose and need of the project. The following items should be considered as part of the evaluation:

- Noise abatement benefits
- Cost of abatement
- Absolute noise levels

- Change in noise levels
- Development along the highway
- Environmental impacts of constructing abatement measures
- Viewpoints from benefited receptors

4.1.1 Construction of Noise Barriers

The construction of noise barriers should generally be evaluated within highway right-of-way and may consist of the following:

Earth berms

Noise walls

Combination of earth berm and noise wall

Earth berms have been cited to reduce traffic noise by approximately 3 dB(A) more than vertical noise walls of the same height.[3] However, earth berms can require a substantial amount of right-of-way to construct. At least a 3:1 slope on earth berms is required within the right-of-way for maintenance purposes. Combining earth berms with noise walls provides an opportunity to incorporate earth berms up to the height that can be achieved within the available right-of-way. The noise wall can then be constructed on top of the berm to the height necessary to achieve a substantial noise reduction.

4.1.2 Traffic Management Measures

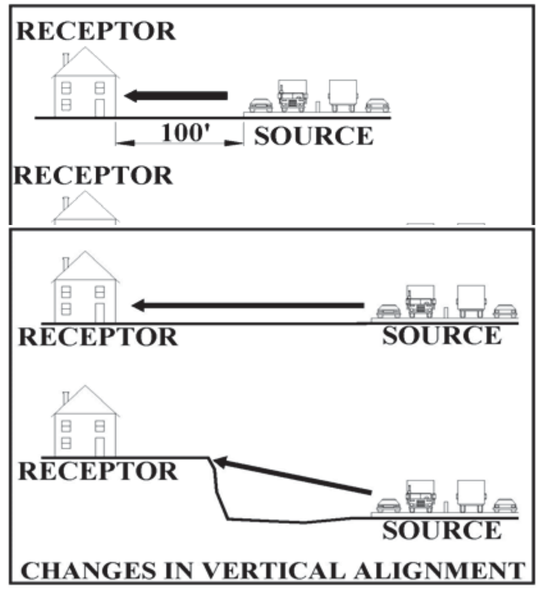
> **Engine Braking –** Engine braking has been identified in some areas as an annoyance. While the prohibition of engine braking may eliminate some of this noise source, it is typically not substantial enough to lower the overall noise level.

This abatement measure includes traffic control devices and the installment of highway signs for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive land designations. Exclusive land designations by local officials may include zoning land adjacent to highways for commercial uses or more noise tolerant uses. However, prohibition of certain vehicle types, such as medium or heavy trucks, or speed restrictions may have adverse impacts on the designated uses of the roadway or create unreasonable hardship on the motoring public or local businesses. Prohibition of commercial vehicular traffic on interstate highways and state marked routes is not permitted by Federal regulations.

Reduction of speed has the potential to reduce traffic noise levels. Generally, a reduction of 20 miles per hour would be needed to reduce the traffic noise level by 5 dB(A). Speed reductions of this magnitude may have adverse impacts on the ability to achieve the purpose of the project, such as increased traffic capacity. Speed limits must adhere to established design guideline and policies.

4.1.3 Alteration of Horizontal and Vertical Alignments

Adjusting the roadway alignment requires advanced planning. This abatement measure is generally considered for new alignment projects. Movement of the roadway away from a sensitive receptor would be required to reduce traffic noise levels. Generally, every doubling of distance reduces the traffic noise levels between 3 dB(A) (hard site) and 4.5 dB(A) (soft site). For instance, moving the roadway from 100 feet to 200 feet away from a receptor location would reduce the traffic noise levels between 3 dB(A) and 4.5 dB(A).



Alteration of the vertical alignment would reduce the traffic noise levels if the adjustment were to take advantage of the topographic features or elevated structures. For example, lowering the roadway into a depressional area may provide sufficient shielding to reduce the traffic noise levels.

4.1.4 Acquisition of Property Rights for Construction of Noise Barriers

Noise barriers are typically constructed within the right-of-way. Site constraints or limited right-of-way may prohibit the construction of noise walls within existing right-of-way. In this situation, acquisition of additional right-of-way may be undertaken to provide sufficient area to construct a noise barrier.

The cost of right-of-way acquisition for the purpose of noise barrier construction should be included within the cost-effective evaluation of noise abatement if acquisition is needed solely for noise barrier construction. The evaluation of noise walls is presented in Section 4.2.

4.1.5 Acquisition of Undeveloped Land for Buffer Zones

The acquisition of undeveloped land for buffer zones is limited to Type I projects with Federal funding participation. Buffer zones can create compatible land use planning along roadways. This measure primarily relates to the purchase of undeveloped land to preclude future noise impacts. The buffer zone width required to mitigate noise impacts is based on the roadway traffic volumes. It is often not a practical solution due to the width of buffer zone that must be purchased. In many cases, the land along existing roadways is already developed. The purchase of a noise easement is not eligible for Federal-aid participation.

> Acquisition of undeveloped land should generally be considered for projects where future proposed improvements are anticipated that may cause impacts. The cost of acquisition should be weighed against the cost of a noise barrier.

4.1.6 Noise Insulation

This measure can be considered for Activity Category D land use facilities listed in Table 2-1 where there are no exterior areas with frequent human use and an impact has been determined based on the interior noise impact evaluation (Section 3.7.1).

The noise abatement evaluation for impacted Activity Category D land use facilities based on the interior NAC should first be evaluated using noise barriers. Noise insulation will only be considered for Activity Category D if noise barriers are determined to be not feasible or not reasonable and there is a noise impact based on an interior evaluation. If the only reason the noise barrier is not considered reasonable is due to the outcome of the solicitation of benefited receptor viewpoints, the consideration of noise insulation should be discussed with the IDOT Noise Specialist and FHWA.

As an example, if a noise barrier is determined to be feasible, and achieves the reasonableness criteria of the noise reduction design goal and the cost-effective evaluation, the desire of the benefited receptors will be solicited. If the overall viewpoint indicates a desire for the noise barrier, the noise barrier will be recommended for implementation. However, if the receptor viewpoints indicate an overall lack of desire for the noise barrier, sound insulation will only be considered as a possible noise abatement measure on a case-by-case basis. Noise insulation measures should be discussed with IDOT and FHWA during project development or at coordination meetings.

The cost of noise insulation may be included in Federal-aid participating project costs with the Federal share being the same as that for the system on which the project is located. Estimated build costs for noise insulation shall be developed on a project specific basis. Post-installation maintenance and operational costs for noise insulation are not eligible for Federal-aid funding. Noise insulation will be deemed cost-effective using the same cost reasonableness evaluation used for noise barriers.

4.2 Noise Barriers

Noise barriers are typically the most practical noise abatement measure due to their cost effectiveness and ability to be implemented on right-of-way and along existing roadways. Noise barriers include noise walls, earth berms or a combination of both. Noise barriers reduce noise levels by impeding transmission of noise, absorbing noise or reflecting it back toward the noise source. Noise that still reaches a receptor has been either transmitted through the noise barrier or forced to take a longer path to reach the receptor than if no barrier were present.

Abatement measures such as traffic management, alteration of alignment or purchase of land for use as a buffer zone usually do not provide substantial noise reductions or are not found to be feasible and reasonable due to cost, right-of-way requirements or do not meet the purpose and need of the proposed project. While these are viable noise abatement measures for Federal-aid participation Type I projects, noise barriers are the only abatement measure that is required to be evaluated when impacts are identified. The criteria presented herein are therefore presented in the context of noise barriers, but would also apply to other noise abatement measures, including noise insulation, if they are proposed for implementation as part of the project.

4.2.1 Noise Barrier Evaluation Criteria

IDOT policy identifies general criteria that must be met before a noise barrier shall be recommended for implementation. These include the following:

1. Noise barriers shall be evaluated to address the identified traffic noise impacts;

2. Noise barriers shall be feasible (can be built and can achieve the traffic noise reduction feasibility criterion of at least 5 dB(A) for at least one **impacted** receptor);

3. Noise barriers shall be cost effective (may not exceed the allowable noise abatement cost);

4. Noise barriers shall achieve the noise reduction design goal of at least 8 dB(A) for at least one **benefited** receptor; and

5. Noise barriers shall be deemed desired by a majority of the benefited receptors.

4.2.1.1 Feasibility

Feasibility generally addresses the engineering aspects of implementing a noise barrier. This includes considerations for safety, drainage, and utilities which are discussed further in Section 4.2.7. A noise abatement measure must achieve the traffic noise reduction feasibility criterion of at least 5 dB(A) for at least one **impacted** receptor for it to be considered a feasible noise abatement measure. The objective is not to just reduce traffic noise levels below the NAC.

TRAFFIC NOISE REDUCTION FEASIBILITY CRITERION The objective of the traffic noise abatement evaluation is to obtain a traffic noise reduction (5 dB(A) or more) for at least one impacted receptor. The objective is not to just reduce traffic noise levels below the NAC.

Consequently, a noise barrier evaluated for an impacted receptor with a projected traffic noise level of 68 dB(A) should reduce the noise level to at least 63 dB(A), not 66 dB(A). A reduction of 2 dB(A) from 68 dB(A) to 66 dB(A) would not be a perceivable change in noise levels and therefore not a prudent expenditure. Similarly, a noise wall providing abatement to a receptor with a projected traffic noise level of 76 dB(A) would be designed to reduce noise levels to at least 71 dB(A). While still above the NAC, this noise wall would be considered feasible as it achieves traffic noise reduction feasibility criterion.

In most situations, noise abatement provided for exterior areas will also mitigate interior areas. If an interior noise impact is identified, the first abatement measure to be considered should be the same as for exterior noise impacts. Sound insulation shall only be considered on a case-by-case basis for Activity Category D land use facilities, after all other abatement measures have been deemed not feasible or reasonable. If the noise barrier is determined to be reasonable and feasible, it would be recommended for implementation. If the noise barrier was not determined to be feasible or reasonable, then other abatement measures may be considered (*i.e.,* sound insulation for Activity Category D land use) on a case-by-case basis.

4.2.1.2 Reasonableness

The reasonableness evaluation for noise abatement consists of three parts: the noise reduction design goal, economic reasonability and the viewpoints of the benefited receptors. Each component of the reasonableness evaluation is presented below.

Noise Reduction Design Goal

The noise reduction design goal requires at least an 8 dB(A) traffic noise reduction for at least one **benefited** receptor location. While the receptor achieving the noise reduction design goal does not need to be an impacted receptor, in most scenarios, they may be the same. The noise reduction design goal should be achieved for as many receptors as possible while still achieving the economic reasonability criterion.

Economic Reasonability

Economic reasonability is the cost-effective evaluation of the noise barrier. This considers the overall cost of the noise barrier, the number of benefited receptors, and the cost effectiveness (cost per benefited receptor).

Overall Noise Wall Cost

The estimated build cost for noise barriers should be determined using the current standard unit cost approved by IDOT. The current unit cost used by IDOT to determine the estimated build cost for noise barriers is $25 per square foot. This unit cost is based on actual IDOT Phase III construction costs (materials and installation) and engineering design. The cost of right-of-way acquisition for the purpose of noise barrier construction should also be included if acquisition is needed solely for noise barrier construction. This unit cost and the allowable cost will be evaluated every five years by IDOT and will be based on actual construction costs. Estimated build costs for other noise abatement measures being evaluated should be based on estimated Phase I costs.

The area of a noise wall is based on the noise wall length and height. A staggered noise wall height will require calculating the area for each noise wall section. The total noise wall area is the summation of all wall sections. Calculation of the area of an earth berm is not as direct. Cost of berms shall be calculated on a case-by-case basis.

***TNM* Tip:** *TNM* typically provides the total noise wall area and cost if the unit noise wall cost is input into the noise barrier input. The area calculations made by *TNM* should be checked for accuracy.

Number of Benefited Receptors

A benefited receptor is considered any sensitive receptor (see Section 3) that receives at least a 5 dB(A) traffic noise reduction as a result of the noise barrier, regardless of whether the receptor was identified as impacted. As an example, a single-family residence would be considered one benefited receptor if it receives at least a 5 dB(A) traffic noise reduction. In the case of multi-unit dwellings (*i.e.,* condominiums, townhouses, apartments and duplexes), each unit should be counted as one receptor.

Residential Benefited Receptors

The evaluation of residential receptors requires the prediction of the number of benefited residences that would be afforded at least a 5 dB(A) traffic noise reduction. For single-family residences, each house represents one benefited receptor. For multi-family residences, each unit (*i.e.,* apartment) afforded at least a 5 dB(A) traffic noise reduction would represent one benefited receptor. A unit can also be considered benefited if the residents of that unit have access to an exterior common use area that would receive a 5 dB(A) traffic noise reduction. While it is not the objective of the noise abatement design to mitigate above the ground floor locations, in certain circumstances, such as when the roadway is elevated and the second floor is level with the roadway, second floor units can be counted as benefited receptors if the noise barrier provides at least a 5 dB(A) traffic noise reduction at the second floor elevation.

Non-Residential Land Uses (Potential Benefited Receptor Units)

The number of benefited receptors for various receptors requires consideration of the type of units benefited. Generally, the primary focus of the evaluation is to reduce traffic noise levels for frequent human use outdoor areas. Table 4-1 provides guidance for evaluating potential benefited receptors.

Table 4-1 – Potential Benefited Receptor Units*

Receptor Type	Potential Benefited Receptor Unit(s)
Single-family Residence	Each residential unit
Multi-family Residence	Each residential unit with access to the exterior common area or with exterior use areas, such as a patio or balcony
Nursing Home	Each residential unit with access to the exterior common area
School	Each classroom
Hospital	Each hospital room with a bed(s)
Hotel/Motel	Each hotel/motel room
Cemetery	Each point of anticipated gathering (*i.e.* bench, information board)
Places of Worship	Each point of anticipated gathering (*i.e.* bench, patio, gazebo)
Parks	Each gazebo, group of picnic tables, playground
Trails and Trail Heads	Each point of anticipated gathering (*i.e.* bench, information board)
Libraries	Each point of anticipated gathering (*i.e.* bench, patio, gazebo)
Business	Each business unit
Undeveloped Lands	Each unit with a building permit

* To be considered benefited, each receptor unit location must receive at least a 5 dB(A) traffic noise reduction to be considered as part of the cost-effective evaluation.

Cost Effectiveness

The estimated build cost of each noise abatement measure may not exceed the allowable noise abatement cost based on a cost per benefited receptor comparison. The base value for the allowable noise abatement cost shall be $24,000 per benefited receptor. The estimated build cost of noise abatement per benefited receptor is determined by dividing the overall estimated build cost by the number of benefited receptors.

Other reasonableness factors shall be considered to potentially adjust the allowable noise abatement base value cost of $24,000 per benefited receptor to account for project-specific factors. Consideration of reasonableness factors can be used to adjust the allowable noise abatement base cost of $24,000 per benefited receptor. These three reasonableness factors include:

- the absolute noise level of the benefited receptors in the design year build scenario before noise abatement;
- the incremental increase in noise level between the existing noise level at the benefited receptor and the predicted build noise level before noise abatement; and
- the date of development compared to the construction date of the highway.

The base value of $24,000 per benefited receptor will be adjusted considering these three factors and based on Table 4-2. Only one value from each of the three factors may be used for each receptor, resulting in a potential maximum allowable noise abatement cost of $37,000 per benefited receptor. If the estimated build cost of noise abatement per benefited receptor is less than the adjusted allowable noise abatement cost per benefited receptor, then the noise abatement measure achieves the cost-effective reasonableness criterion.

Table 4-2
FACTORS FOR ADJUSTING THE ALLOWABLE NOISE ABATEMENT COST PER BENEFITED RECEPTOR BASE VALUE OF $24,000 USING OTHER REASONABLENESS FACTORS

Absolute Noise Level Consideration

Predicted Build Noise Level Before Noise Abatement	Dollars Added to Base Value Cost per Benefited Receptor
Less than 70 dB(A)	$0
70 to 74 dB(A)	$1,000
75 to 79 dB(A)	$2,000
80 dB(A) or greater	$4,000

Increase in Noise Level Consideration

Incremental Increase in Noise Level Between the Existing Noise Level and the Predicted Build Noise Level Before Noise Abatement	Dollars Added to Base Value Cost per Benefited Receptor
Less than 5 dB(A)	$0
5 to 9 dB(A)	$1,000
10 to 14 dB(A)	$2,000
15 dB(A) or greater	$4,000

New Alignment / Construction Date Consideration

Project is on new alignment OR the receptor existed prior to the original construction of the highway	Dollars Added to Base Value Cost per Benefited Receptor
No for both	$0
Yes for either	$5,000

Note: No single optional reasonableness factor shall be used to determine that a noise abatement measure is unreasonable.

A detailed example of the evaluation is provided in Appendix C. The following is a brief example of a cost effective analysis based on a noise wall benefiting 10 receptors.

Assume the build noise level for all receptors is 70 dB(A), the increase in noise between existing and build scenarios is 6 dB(A), and that all homes were built after the original highway was constructed.

Area of noise wall = 1,000 ft. long x 10 ft. high = 10,000 sq. ft.
Estimated build cost of noise wall = 10,000 sq. ft. x $25 per sq. ft. = $250,000
Estimated build cost per benefited receptor = $25,000 / benefited receptor

Base allowable cost per benefited receptor = $24,000 / benefited receptor
Adjustment for noise levels 70 to 74 dB(A) = $24,000 + $1,000 = $25,000 / benefited receptor
Adjustment for increases 5 to 10 dB(A) = $25,000 + $1,000 = $26,000 / benefited receptor
Adjustment of construction date = $0
Final adjusted allowable cost per benefited receptor = $26,000 / benefited receptor

In this example, the estimated build cost per benefited receptor ($25,000) is less than the adjusted allowable cost per benefited receptor ($26,000) and therefore achieves the economic reasonability criterion. The example assumes that at least one impacted receptor achieves a 5 dB(A) traffic noise reduction to be considered feasible and at least one of the benefited receptors achieves at least an 8 dB(A) traffic noise reduction to achieve the noise reduction design goal.

The noise wall evaluation for this example should also investigate the possibility of modifying the noise wall configuration to determine if additional receptors could become benefited or if additional traffic noise reductions could be provided to those receptors already considered benefited. Generally, the evaluation should provide traffic noise reductions to as many impacted receptors as possible and/or provide as much noise reduction as possible while remaining within the economic reasonability criterion.

In some situations, achieving at least an 8 dB(A) traffic noise reduction at all impacted receptors may not achieve the cost effective evaluation as presented in this section. Alternative noise barrier heights and lengths should be considered such that at least one benefited receptor behind the noise barrier achieves the 8 dB(A) traffic noise reduction. If the remaining receptors are still afforded at least a 5 dB(A) traffic noise reduction, they would still be considered benefited receptors (defined as experiencing at least a 5 dB(A) reduction in noise due to abatement measures). Alternative noise barrier configurations should be considered in an effort to abate as many receptors as possible while remaining within the cost effective criterion.

Viewpoints of Benefited Receptors

The third component of reasonableness is obtaining the viewpoints of benefited receptors. The viewpoints of benefited receptors shall be solicited for noise abatement measures (*e.g.,* noise barriers) determined to be feasible, cost-effective and achieving the noise reduction design goal. The viewpoints of benefited receptors shall be solicited to determine the desire for implementation of the noise abatement measure. Benefited receptors include property owners (including non-residential properties) **<u>and</u>** renters/leasers residing on the benefited property.

While the desire is to obtain as many responses as possible, the goal is to obtain responses from at least one-third (33%) of the benefited receptors for each noise abatement measure (*i.e.,* for each noise barrier being considered). If responses from one-third of the benefited receptors are not received after the first attempt, a second attempt shall be made. The Districts may want to consider delivering the second attempt for viewpoint solicitation by certified mail or other form of certified delivery. The desire for the proposed noise abatement can be determined after viewpoints from at least one-third of the responses have been received or after two attempts have been made to obtain the responses. If after the second attempt there are still less than one-third of the responses received, the tally can be conducted based on the responses received.

Once the responses have been collected, the viewpoints must be tallied. In order for a proposed noise abatement measure to be implemented, greater than 50% of the benefited receptors responding must be in favor of the proposed abatement measures. Viewpoints will be tallied for each individual abatement measure (*i.e.,* for each noise barrier being considered). A response from first row benefited receptors (receptors sharing a property line with the highway right-of-way) will be counted and weighted as two responses. Benefited receptors not in the first row will count as one vote. The purpose of providing more weight to the front row receptors is to give them additional consideration for the proposed noise barriers. In the case of rental properties, the tenant shall always count as one response and the owner shall always count as one response per benefited unit.

The proposed abatement measures will be presented as likely to be implemented (provided they are deemed feasible and reasonable for noise reduction and cost-effectiveness) as part of the public involvement process to determine if the benefited receptor viewpoints support the noise abatement measure implementation. The following is an example of the process. A more detailed example is provided in Appendix C.

> As an example, there were 10 benefited receptors used in the cost-effective evaluation example. The goal would be to obtain responses from at least 4 benefited receptors (10 x 33% = 3.3 rounded to 4). Of those four (4) responses received, three (3) of the responses would need to be in favor of the proposed noise abatement measure in order for it to be considered for implementation on the project. If two (2) were in favor of the noise abatement and 2 were opposed, the noise abatement measure would not be recommended for implementation as there was no majority in favor of the noise abatement measure.
>
> This assumes that all responses were received from the same row where each vote was weighted equally. Using the same example, assume there were five (5) responses received, with two (2) from the front row (shared property line with the ROW) and three (3) from the second row. If the two (2) front row receptors were opposed to the wall and the three second row receptors were in favor of the wall, the noise wall would not be implemented as the two first row votes each carry the weight of two "no" votes (for a total of 4 "no" votes) and the three second row "yes" votes only count as three "yes" votes. The majority vote is therefore carried by the 4 "no" votes.

Below is a letter template that Districts may use as the first attempt to obtain the viewpoints from benefited receptors. If a second attempt is required due to insufficient responses from the first attempt, this letter can be modified to accomplish that effort.

> (*Date*)
> (*Name*)
> (*Address*)
>
> Re: Viewpoint Solicitation – First Notice
> Noise Barrier Implementation
> (*Project Name*)
> (*Project Limits*)
>
> Dear (*Property Owner or Resident Name*):
>
> The Illinois Department of Transportation (IDOT) is currently conducting environmental (Phase I) preliminary engineering studies for proposed improvements to *(project name)*. The improvements include *(project description).*
>
> As part of the Phase I Study for this project, traffic noise was evaluated for the proposed roadway improvements. Construction is anticipated to begin in (*anticipated date of construction or indication of funding availability*) and last approximately (*number*) year(s). The traffic noise analysis indicated that noise levels in your area warrant the consideration of noise abatement. The abatement for these traffic noise impacts includes a noise barrier to reduce traffic noise at your location. Based on the noise abatement analysis, a noise barrier approximately *(height)* high and *(length)* long may be implemented as part of this project. The proposed noise barrier would be a (*identify: noise wall, earth berm or combination of both*).
>
> IDOT is requesting your viewpoint regarding your desire for the noise barrier proposed near your location. This letter has been provided to all property owners and tenants who would be considered "benefited" (would receive a noise reduction of 5 dB(A) or greater) by the noise barrier.

Your viewpoint is being solicited as part of the upcoming (*identify: public hearing or meeting*) for the proposed project. The meeting information is included with this letter. If you are not able to attend the meeting to provide your views, please contact us using the telephone number or the email address included in the public hearing/meeting announcement. Please include your full name and address with any correspondence you provide, including any input provided at (*identify: public hearing or meeting*) for the proposed project.

We appreciate your views and look forward to hearing from you. IDOT has provided an information sheet for you to consider during your decision-making process. Please know that IDOT will consider all viewpoints received from "benefited" property owners or tenants. Based on the consideration of the viewpoints, the noise barrier may or may not be considered for implementation in the project. If you have additional questions, please call *(project manager)* at *(project manager phone number)*. For additional information regarding traffic noise, regulations and policy, noise analyses, or noise abatement, we encourage you to access IDOT's *Noise Training Modules* at the IDOT internet site http://www.dot.il.us. Click on the "Environment" link and then the "Traffic Noise" link to access this information.

Sincerely,

Cost Averaging

Cost averaging of noise abatement among common noise environments (CNEs) may be used when conducting the reasonableness evaluation. For a single noise abatement measure to be considered as part of a cost averaging evaluation, the estimated build cost of noise abatement per benefited receptor may not exceed two times the adjusted allowable noise abatement cost per benefited receptor.

Using the previous example provided to demonstrate the reasonableness factors, the estimated build cost per benefited receptor was $25,000, which was less than the adjusted allowable cost per benefited receptor of $26,000. This noise wall can therefore be included in the cost averaging approach. In this example, the CNE could be part of the cost averaging calculation as long as the estimated build cost was $52,000 or less ($26,000 per benefited receptor X 2).

Noise abatement measures achieve the cost reasonableness criterion if the common CNE collective average estimated build cost of noise abatement per benefited receptor is less than the collective average adjusted allowable cost per benefited receptor. For purposes of the cost averaging approach, it is recommended to base the determination on the weighted average for both the estimated build cost of noise abatement and the adjusted allowable cost per benefited receptor. The following is a simple example of the process. A more detailed example is provided in Appendix C.

After each CNE has been evaluated independently, the CNEs are ranked in order of increasing ratio of the estimated build cost per benefited receptor to the adjusted allowable cost per benefited receptor. This method ranks them in order of increasing cost effectiveness based on the ability to achieve the economic reasonability criterion. The CNEs with values greater than 2.0 are removed from the evaluation, as these will be the ones for which the estimated build cost is more than double the adjusted allowable cost per benefited receptor.

Once the CNEs are in order of increasing ratio of the estimated build cost per benefited receptor to the adjusted allowable cost per benefited receptor, the cumulative cost per benefited receptor is calculated for both the estimated build cost and the adjusted allowable cost. In the scenario in Table 4-3, based on the cumulative costs, noise walls for CNEs 8, 2, 1, and 3 would achieve the cost effective evaluation, as the cumulative estimated build cost per benefited receptor ($27,810) is less than the cumulative adjusted allowable cost per benefited receptor ($29,879). The build cost for the next noise walls (CNE 7 and CNE 6) exceed the allowable cost and therefore would not be recommended for implementation as part of the proposed project.

EXAMPLE COST AVERAGING TABLE

CNE No. (A)	No. Benefited Receptors (B)	Noise Wall Cost (C)	Estimated Build Cost per Benefited Receptor (D) = (C) / (B)	Adjusted Allowable Cost per Benefited Receptor (E)	Ratio of Est. Build/ Adjust. Allowable (F) = (D) / (E)	Cumulative Estimated Build Cost/Benefited (G)	Cumulative Adjusted Allowable Cost/Benefited (H)	Result of Determination (I)
8	40	$962,500	$24,063	$32,000	0.75	$24,063	$32,000	Cost-Effective Stand Alone
2	160	$4,200,000	$26,250	$30,000	0.88	$25,813*	$30,400**	Cost-Effective Stand Alone
1	95	$2,800,000	$29,474	$32,000	0.92	$26,992	$30,915	Cost-Effective Stand Alone
3	52	$1,687,500	$32,452	$24,000	1.35	$27,810	$29,879	Cost-Effective Cumulative
7	45	$2,250,000	$50,000	$32,000	1.56	$30,357	$30,122	Not Cost-Effective
6	2	$122,500	$61,250	$35,000	1.75	$30,514	$30,147	Not Cost-Effective
~~5~~	~~4~~	~~$227,500~~	~~$56,875~~	~~$27,000~~	~~2.11~~	Not part of evaluation as estimated cost is more than 2 times the adjusted allowed cost		Not Cost-Effective
4	~~12~~	$962,500	~~$93,750~~	~~$36,000~~	~~2.60~~			Not Cost-Effective

* ($24,063 x 40 + $26,250 x 160) / (40 + 160) = $25,813
** ($32,000 x 40 + $30,000 x 160) / (40 + 160) = $30,400

COLUMN G General Equation (Column Letter $_{\text{Row Number}}$): $(E_1 \times B_1 + E_2 \times B_2 \ \dots + E_x \times B_x) / (B_1 + B_2 \ \dots + B_X)$
COLUMN H General Equation (Column Letter $_{\text{Row Number}}$): $(D_1 \times B_1 + D_2 \times B_2 \ \dots + D_x \times B_x) / (B_1 + B_2 \ \dots + B_X)$

Noise walls for CNE areas 8, 2 and 1 would be considered cost-effective when considered individually. The adjusted allowable cost per benefited receptor is less than the estimated build cost per benefited receptor for each of these areas. When the cost averaging approach is used, CNE area 3 would also be considered cost effective as the adjusted allowable cost per benefited receptor is less than the estimated build cost per benefited receptor based on the cumulative costs of CNE areas 8, 2, 1, and 3. The cost-effectiveness of the CNE areas 8, 2, and 1 allow for the consideration of other areas for noise wall implementation that do not achieve the cost effective criterion on an individual basis.

4.2.2 Noise Barrier Materials

Noise barriers have been constructed of earth, masonry, concrete, and composite materials. These barrier materials must meet certain transmission loss characteristics.

Density

Earth berms, due to their inherent thickness and material, are sufficiently dense to effectively reduce sound transmission. Other types of noise barrier materials must be of sufficient density (at least four pounds per square foot minimum) to be able to effectively reduce sound transmission through the barrier.[6] Since density will vary for different materials, the transmission loss characteristics of a material must be tested before further testing protocol required by IDOT is considered.

Transmission Loss

Transmission loss is the sound level reduction provided by a material as sound passes through it. Noise wall materials are required to achieve a sound transmission loss equal to or greater than 20 dB in all one-third octave bands from 100 hertz to 5000 hertz, inclusive. Noise wall manufacturers are required to provide this data to IDOT before further testing protocol is considered. Specialty items and materials that are not covered by ASTM, AASHTO, or other IDOT specifications must have the prior approval of the Illinois Highway Development Council (IHDC). Contact the Engineer of Technical and Product Studies at the Bureau of Materials and Physical Research for additional information on the IHDC process.

Noise Reduction Coefficient (NRC)

Noise walls are typically identified as either absorptive or reflective (non-absorptive). The absorptive capacity of the wall material is specified by the NRC, which can range from 0.00 to 1.00, with 1.00 representing 100 percent absorption. To be considered absorptive by IDOT, the NRC must be at least 0.80 on the roadway side of a noise wall and at least 0.65 on the side of the wall away from the roadway.

4.2.3 Noise Barrier Location

Barrier Location on Right-of-Way

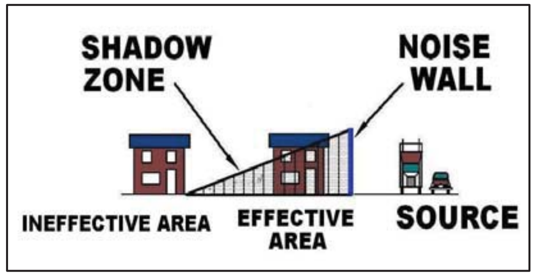
The construction of noise barriers is typically within highway right-of-way. Noise barriers are most effective when located close to the receptor or close to the noise source. While both options can be considered, the location of the noise barrier along the right-of-way typically provides sufficient open space between the roadway and noise barrier to satisfy clear zone requirements. It also allows for maintenance access and does not require additional land acquisition. Therefore, locating noise barriers within the highway ROW is generally preferable. Noise barriers located along the roadway typically require safety features such as guardrails or jersey barriers to satisfy safety requirements (See Section 4.2.7). Sight distance or safety requirements also need to be considered to ensure they are feasible. It is recommended to discuss these issues at District coordination meetings.

Barrier Location off Right-of-Way

Noise barrier lengths may be reduced in some cases if the noise barrier is designed to wrap around the ends of the CNE rather than extending parallel to the roadway four times the distance between the noise wall and the last receptor, as discussed in Section 4.2.4. Bending the noise barrier back toward the receptor creates a greater degree of visual separation while reducing the overall noise barrier length. If this approach creates a feasible and reasonable noise barrier measure (as discussed in Section 4.2.1), additional land acquisition or property owner agreements with adjacent landowners may be considered. Agreements or environmental commitments to execute this should be obtained prior to final design.

Noise Barrier Zone of Effectiveness

Noise barriers are normally most effective in reducing noise for areas within 200 feet of the highway, which is the shadow zone of the noise barrier. Areas beyond this may receive some traffic noise reduction; however, this is usually not a substantial noise reduction and may not even be a perceivable change from the condition without the noise barrier.



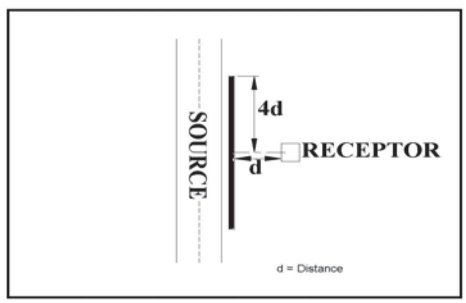
Other Considerations

In addition to the clear zone requirements, other site constraints to noise barriers must be considered, such as utilities, line-of-sight, and drainage (as discussed in Section 4.2.7). These feasible measures should be identified as possible constraints in the early stages of project development. The final noise barrier design will be completed when final engineering is completed.

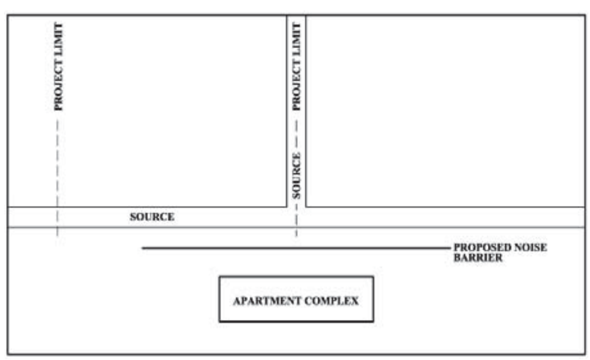
4.2.4 Noise Barrier Length

TNM should be used to refine the noise barrier length and height to assure that a substantial noise reduction will be achieved. Noise barriers must be long enough and high enough to sufficiently block the view of the traffic noise sources. Barriers that are not long enough or high enough will allow too much sound to travel around the end or over the top of the noise barrier to provide a substantial noise reduction.

To estimate the required length of noise wall to provide a substantial noise reduction, the noise wall must extend four (4) times in each direction the distance between the noise wall and receiver. For example, if there is a single residence located 60 feet from the proposed barrier location, the barrier must extend 240 feet in each direction, or total length of 480 feet.



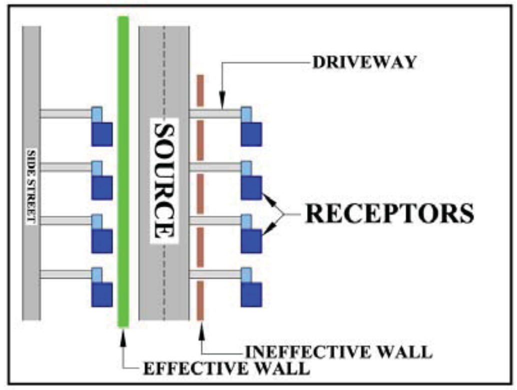
Barrier Termini



BARRIER TERMINI

Traffic noise abatement must be considered for impacted areas within the project limits. If a logical terminus of the noise barrier can be determined for contiguous sensitive land uses that originate within the project limits, the noise barrier can be extended beyond the project limits for the purpose of maintaining continuity. For example, if the project limits terminate in the middle of an apartment complex, the other half of the apartment complex outside the project limits can be evaluated for traffic noise abatement. The noise barrier must achieve the feasible and reasonable criteria for it to be recommended for implementation (see Section 4.2.1). If the full noise barrier length does not achieve the feasible and reasonable criteria, the noise barrier implementation shall be evaluated on a case-by-case basis.

Breaks in Noise Barriers



Designing a continuous noise wall may not be practical for all projects. Breaks in the noise wall are required to maintain driveway openings, intersecting streets, alleys, public safety access, and pedestrian and/or bicycle accommodations and therefore are not recommended. Any breaks reduce the effectiveness of the noise barrier and may prevent achieving the noise reduction design goal.

4.2.5 Noise Barrier Height

As discussed in the introductory paragraph to this section, a noise barrier can reduce noise levels by increasing the noise path length between the noise source and the receptor. Increasing the barrier height, therefore, causes the sound wave to take a longer noise path. As the sound wave path length increases, the noise levels at the receptor decrease.

General Noise Barrier Heights

A noise barrier needs to be at least tall enough to break the line of sight between the noise source and the receptor. Generally, the height of a truck exhaust is 8 to 12 feet. After the line of sight is broken, each additional two feet of noise barrier height will reduce the traffic noise level by approximately 1 dB(A). However, continuously increasing the noise wall height will result in less and less improvement in the noise reductions. For example, increasing a noise wall from 12 feet to 16 feet (increase of four feet) may provide an additional 2 dB(A) reduction. However, increasing the same wall from 26 feet high to 30 feet high may only provide an additional 0.5 dB(A) reduction.

Maximum Barrier Height

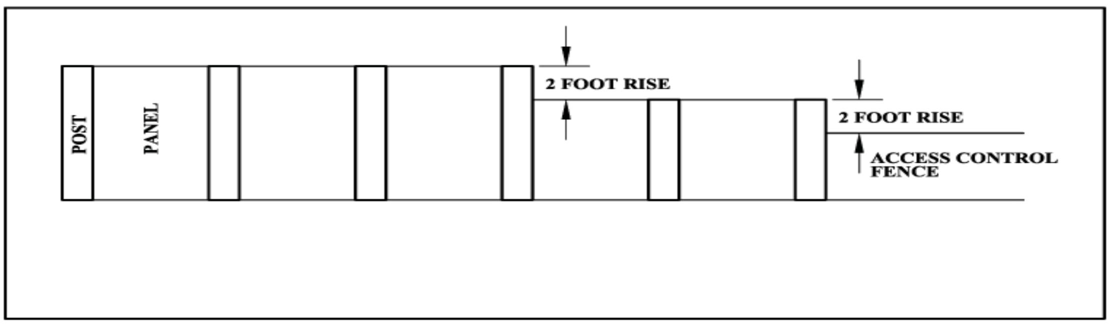
Increasing the noise wall height should be limited to the level necessary to achieve the acoustical feasibility criteria and the noise reduction design goal as required. IDOT does not have a maximum wall height limitation. However, FHWA indicates that noise walls are typically limited to 25 feet in height for structural and aesthetic reasons.[3] Noise walls of this height are typically not cost-effective and should be considered as having potential structural limitations or inconsistencies with local ordinances.

Aesthetic Considerations

FHWA guidance suggests that noise walls become visually dominating when the height exceeds one-fourth the distance between the noise wall and the receptor. For example, if the proposed noise wall location is 80 feet from the receptor, the noise wall height should not exceed 20 feet (80 feet x ¼). While this is not a height restriction, it should be considered in the design process.

Noise Barrier Height Changes

As noise wall heights have a direct impact on the overall noise wall cost, minimizing the wall height will reduce the overall noise wall cost. Placement of the noise wall along elevated ground locations will maximize the use of natural topography and minimize noise wall heights. Depending upon the type of barrier system utilized, vertical transitions in noise barriers can be accomplished in a variety of manners, including equal height steps with consistent spacing and random height steps spaced at irregular intervals. To avoid having to cast non-rectangular panels, and for aesthetic reasons, such steps normally are designed to be located at the posts. Step changes in the wall height should not be greater than two feet unless sufficient economic, engineering, and acoustic justification is provided.



NOISE BARRIER HEIGHT CHANGES

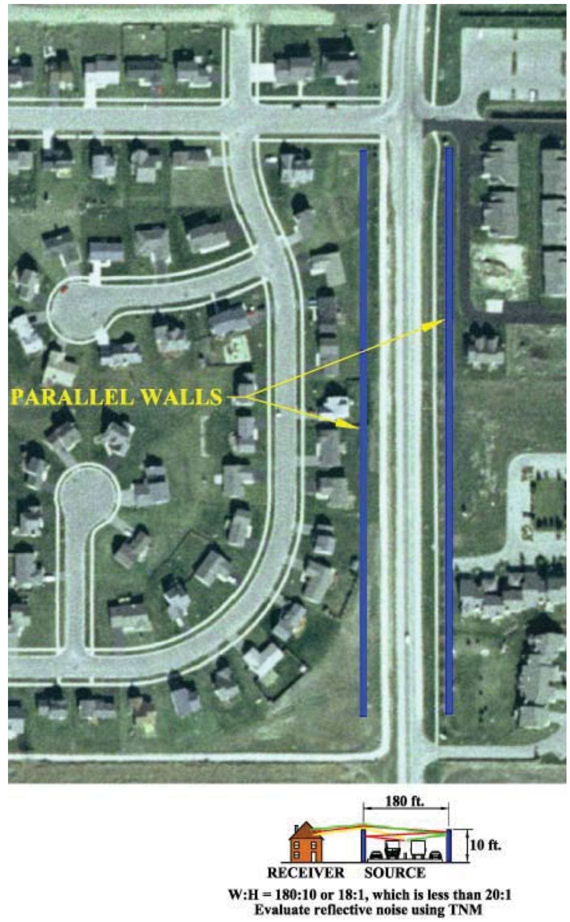
The height of a noise wall for the purpose of communicating with the designers in contract plan preparation should be referenced to the "pavement grade line" (PGL). It should be specified as "minimum height above the PGL". Other heights, such as height above the ground at the right-of-way, *etc.* may also be appropriate for use in the public involvement and CSS processes. The noise barrier shall tie into adjacent features (*i.e.,* access control fences) whenever feasible.

4.2.6 Parallel Noise Walls

Multiple sound wave reflections between parallel noise walls can theoretically reduce the noise wall performance, thereby inhibiting the ability to attain the acoustical feasibility criteria or the noise reduction design goal. Reflections from earth berms are generally not a concern due to the non-reflective nature of the landscaped or grass-covered earth berms. Construction of noise walls on both sides of the roadway should be designed with width-to-height ratios of at least 10:1, with a 20:1 ratio being preferred. The width is the distance between the two noise walls and the height is the average wall height above the roadway. For example, two barriers each 10 feet tall should be placed at least 100 feet apart, preferably 200 feet apart.

The reduction in performance due to multiple noise reflections can be evaluated using the parallel barrier analysis sub-program of TNM. The analysis will predict the reduction in the insertion loss (the actual noise level reduction derived from the construction of the barrier) due to the multiple reflections. This modeling effort is strongly recommended for parallel barrier conditions of less than 10:1 (width:height) and should be considered for conditions between 10:1 and 20:1. Alternatives to mitigating any noise wall performance reductions include the following:

- Using absorptive noise wall materials (NRC at least 0.80 on roadway side; at least 0.65 on other side),
- Increasing the noise wall height to overcome the insertion loss degradation, and
- Altering the noise wall configuration to increase the width-to-height ratio.



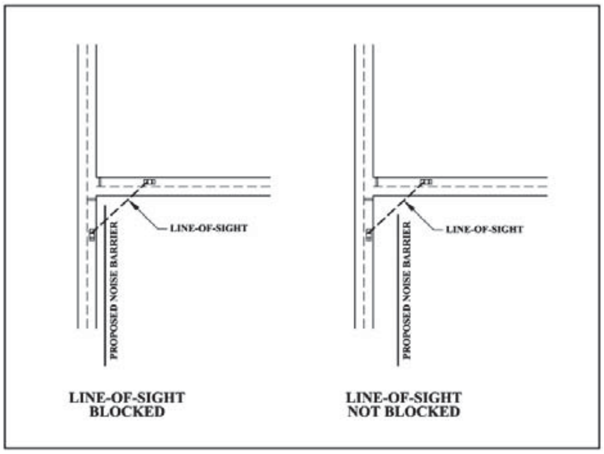
For purposes of the traffic noise analysis documentation, parallel barrier conditions shall be identified and the width-to-height ratios provided. The results of any parallel barrier analysis shall be included in the appropriate Technical Memorandum/Report, NEPA document, or Project Report. For parallel barrier situations, the noise wall configuration shall be provided for both a reflective (non-absorptive) noise wall material and an absorptive noise wall material, as there may be height differentials between barrier types that should be identified.

4.2.7 Design Consideration

Safety

There are two noise barrier design elements that must be considered for safety, including maintaining the clear zone and maintaining the line of sight. A noise barrier needs to be located outside of the clear zone so that errant vehicles have sufficient opportunity to recover, thus reducing the potential for collision with the noise wall. Along interstate highways, the width of the clear zone is typically 60 feet from the edge of pavement. When desirable clear zones cannot be maintained, or the barrier is placed along the edge of pavement due to site constraints, a safety barrier such as a guardrail or Jersey barrier must be designed as part of the noise wall.

Traffic noise walls located along the roadway may impede the removal of snow and ice. This should be considered during the feasibility analysis, along with the potential for the noise wall to create continuous shadowing conditions that may cause excessive icing.



The line of sight for highway design refers to the visibility of approaching vehicles in the vicinity of on-ramps, off-ramps, and intersecting streets. A noise barrier cannot block the line of sight. The line of sight for ramps is a function of the stopping sight distance, which is a function of the design speed and ramp curvature. For intersections, the line of sight is a function of the time required for a stopped vehicle to make a left-turn maneuver and stopping sight distance.[4]

Maintenance

Noise barrier maintenance factors include maintenance of the noise barrier itself and of the adjacent areas. Generally, earth berms should have slopes no steeper than 3:1 to allow for mowing. Noise walls need to be repaired in the event of damage or deterioration. Landscaping planted near the wall will similarly need maintenance. Placement of the noise wall along the right-of-way line will generally require the abutting property owners to maintain the land up to the noise wall on the receptor side of the noise wall. Agreements with local entities may be necessary to maintain the land for areas where the property owner is other than a resident.

Graffiti on noise walls may be a problem in some areas. Noise wall materials that can be readily repainted or readily washed should be considered in these areas. Landscaping in front of the noise wall may deter graffiti as well as enhance the visual perception of the noise wall.

Drainage and Utilities

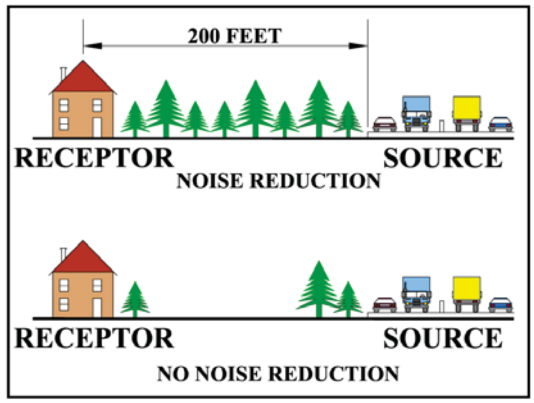
Noise barrier construction cannot conflict with drainage design elements or utilities. The design and/or location of these elements are typically determined in the final engineering design. The traffic noise documentation shall identify any known elements to be considered in the final noise wall design.

4.3 Right-of-Way/Pavement Treatment Considerations

Landscaping (vegetation), pavement design and sight screens are often referenced as potential alternatives to noise abatement measures. However, while these may be incorporated into project, IDOT does not offer these options as traffic noise abatement measures and they are not acceptable by FHWA or federal-aid eligible.

4.3.1 Landscaping (Vegetation)

Landscaping is not recognized by the FHWA as a traffic noise abatement measure; however, landscaping can provide traffic noise reductions if it is sufficiently wide, dense and tall such that it cannot be seen through or over. Generally, the vegetation needs to be between 100 and 200 feet in width, 16 to 18 feet tall, and with dense understory growth to obtain a perceivable noise reduction of 5 dB(A). It is generally not feasible to plant this number of trees or have available sufficient right-of-way for this to be a prudent abatement measure.



Landscaping along the right-of-way that at least creates a visual barrier can provide aesthetic benefits and psychological relief even if noise levels are not reduced. Implementation of landscaping as an alternative to noise abatement for an impacted receptor can be considered on a case-by-case basis. However, it must be documented that the public has accepted this as an alternative and understands that it is being provided for visual, privacy or aesthetic purposes only and will not be effective in abating traffic noise impacts.

4.3.2 Pavement Design

Quiet pavements have been identified by some states as a way to reduce traffic noise up to 3 to 4 dB(A). FHWA only recognizes this measure as eligible for federal funding if the state has an approved Quiet Pavement Research Program. IDOT does not currently have an approved program.

As pavement texture varies with time, the performance of this measure is difficult to predict for noise abatement. For example, asphalt pavement breaks apart, while concrete textures wear down over time. In addition, noise created at the tire and pavement interface is only one of several traffic noise sources that include engine, exhaust and auto body vibrations. Therefore, altering the pavement material does not result in substantial noise reductions.

4.3.3 Sight Screens

Sight screens are typically implemented into a project design for the purpose of creating a visual barrier between the sensitive land use area and the roadway. Similar to landscaping, a sight screen provides psychological relief. However, barrier materials need to have substantial density (approximately 4 pounds per square foot or greater) and no openings to provide a perceivable traffic noise reduction if it is long enough and tall enough. Typically, most sight screens to not meet these criteria and consequently do not reduce traffic noise levels.

5. CONSTRUCTION NOISE

5.1 Applicability

Construction noise must be considered as part of the development of any transportation facility. Roadway construction is often conducted in proximity to residences and businesses and should be controlled in order to avoid excessive construction noise impacts. The latest version of the *Standard Specifications for Road and Bridge Construction*[5], Article 107.35, specifies construction noise restrictions.

5.2 Construction Noise Evaluation

Construction noise varies greatly depending on the equipment being used, the condition of the equipment, and the activities being conducted. Noise levels also depend on the time and duration of the construction activity. Noise from construction equipment is primarily from the engine and exhaust that may consist of both stationary and mobile sources. Mobile construction equipment rarely travels at high speeds where wind noise and tire noise are critical.

The need for a construction noise analysis and potential construction noise monitoring shall be evaluated on a case-by-case basis. Longer duration projects, projects with loud equipment and projects with loud operations with sensitive receptor locations nearby should be considered for a construction noise analysis.

The FHWA has developed the FHWA Roadway Construction Noise Model (FHWA RCNM) Version 1.0[6]. This model is not required on Federal-aid projects; however, it is a screening tool that can be used during project development for the prediction of construction noise. The FHWA RCNM incorporates an extensive construction equipment noise database and these parameters can be modified according to each user’s needs.

5.3 Construction Noise Abatement

Abatement of construction noise can be accomplished by construction staging, sequencing of operations, or alternative construction methods. Typically, the construction methods to be used for a project are determined in the final engineering design. The NEPA document should therefore identify the potential for construction noise impacts and reference the following abatement measures, as appropriate.

Construction Staging

- Construct noise barriers that were identified as feasible and reasonable, during the initial construction phases to reduce construction noise. Noise barriers, include installing permanent or temporary noise walls, temporary stock piles, or equipment enclosures for noisy equipment, such as shields or heavy curtains.
- Route construction traffic away from sensitive receptors.
- Operate equipment as far from sensitive receptors as feasible.

Sequence of Operations

- Conduct louder operations during the day and not during the night, when people are much more sensitive to noise.
- Conduct multiple loud construction operations at one time. The total noise level from multiple activities will not substantially increase the noise level. However, it will reduce the total duration of that noise level.

Alternative Construction Methods

- Evaluate alternative pile driving methods, as this is a major noise contributor.
- Evaluate quieter demolition methods.
- Use special muffler systems or enclose equipment, *i.e.,* curtains.

5.4 Construction Noise Documentation

The following construction noise statement should be included in the NEPA document or Project Report:

> "Trucks and machinery used for construction produce noise which may affect some land uses and activities during the construction period. Residents along the alignment will at some time experience perceptible construction noise from implementation of the project. To minimize or eliminate the effect of construction noise on these receptors, mitigation measures have been incorporated into the Illinois Department of Transportation's Standard Specifications for Road and Bridge Construction as Article 107.35."

During project development, if construction noise issues are raised by the public, the districts should discuss the need for a quantitative construction noise assessment with the IDOT Noise Specialist. If the project warrants a quantitative construction noise assessment, the documentation shall include the following:

- Identification of potential receptors that may be affected by construction noise.
- Determination of potential construction noise levels using the FHWA RCNM.
- Determination of abatement measures to be included in the contract plans and specifications.

5.5 Vibration Impacts During Construction

Highway traffic traveling on a roadway has the potential to be a source of vibration. Vibration associated with roadway traffic is typically caused by heavy trucks traveling over discontinuities in the pavement, such as potholes or expansion joints; however, traffic, including heavy trucks, rarely generates vibration levels that cause damage to structures. Many highway improvement projects will typically address these discontinuities, thereby reducing the potential for vibration issues.

Similar to construction noise, construction vibration is dependent on the equipment being used, the condition of the equipment and the activities being conducted. Construction vibration impacts generally do not approach levels that can damage nearby structures. The exception that should be considered is the potential for historic structure impacts.

FHWA has not developed vibration impact assessment methodologies. However, the USDOT Federal Transit Administration (FTA) has developed vibration assessment guidelines as part of the Transit Noise and Vibration Impact Assessment methodology.[7] Construction vibration should be assessed when there is potential for vibration impacts from construction activities, as determined on a case-by-case basis. Construction activities typically associated with vibration include pile driving, blasting, pavement breaking, or earth moving in close proximity to sensitive receptors.

5.5.1 Vibration Monitoring

Vibration is commonly described using the oscillatory motion of particles, including displacement, velocity and acceleration; however, most equipment used to measure vibration directly measures velocity or acceleration of particles and not displacement. Vibratory motion is typically reported as a peak particle velocity (PPV) or peak particle acceleration (PPA). PPV is often used as the descriptor for evaluating vibration impacts. Vibration monitoring is typically performed using two types of equipment, a seismometer (measures velocity) or an accelerometer (measures acceleration). Seismometers are typically larger in size than accelerometers and can be placed directly on the ground. They are also more sensitive to low levels of vibration. Accelerometers are smaller than seismometers but have a larger frequency range. Accelerometers are usually not placed directly on the ground and must be mounted in some way.

5.5.2 Vibration Abatement

Potential abatement measures that could be considered include the following:

Construction Staging

- Route construction traffic away from sensitive receptors.
- Operate equipment as far from sensitive receptors as feasible.

Sequence of Operations

- Conduct vibration operations during the day and not during the night, when people are much more sensitive to vibration.
- Conduct vibration operations one at a time - vibration levels may be much less if generated independently.

Alternative Construction Methods

- Evaluate alternative pile driving methods, as this is a major vibration generator - the pile driving technique will likely depend on geological conditions.
- Evaluate demolition methods that reduce impact.
- Do not use vibratory equipment for soil stabilization or packing near sensitive receptors.

6. TRAFFIC NOISE REPORTING

This section presents the necessary documentation required when summarizing the noise analysis results in NEPA documents. Additionally, this section presents the information that needs to be shared with the public and local officials.

6.1 Technical Memorandum/Report

The Traffic Noise Technical Memorandum/Report should include information regarding the receptor selection, noise monitoring (if applicable), noise modeling methodology, noise modeling results, impact analysis, and abatement analysis. The TNM files for the scenarios reported in the environmental document and/or the Traffic Noise Memorandum/Report shall be provided in electronic format (*i.e. on a CD or flash drive*) with the documentation. An example Traffic Noise Memorandum/Report outline is provided in Appendix A.

Include the following likelihood statement in both the technical memorandum/report and the NEPA document or project report when noise walls are deemed feasible and reasonable:

> “Based on the traffic noise analysis and noise abatement evaluation conducted, highway traffic noise abatement measures are likely to be implemented based on preliminary design. The noise barriers determined to meet the feasible and reasonable criteria are identified in Table (reference table). If it subsequently develops during final design that constraints not foreseen in the preliminary design occur, or public input substantially changes reasonableness, the abatement measure may need to be modified or removed from the project plans. A final decision on the installation of abatement measure(s) will be made upon completion of project’s final design and the public involvement process.”

6.2 NEPA Documents

NEPA documents describe various classes of action and the associated documentation required in the NEPA process.

A noise analysis shall be performed for all Type I projects. For all levels of environmental evaluation, the number of representative receptors shall be sufficient to adequately capture all of the sensitive land uses along the proposed improvement. These environmental evaluation categories include the following:

1) *Categorical Exclusion (CE)* – for an action that does not individually or cumulatively have a significant environmental impact.

2) *Environmental Assessment* – for an action in which the significance of the environmental impact is not clearly established.

3) *Environmental Impact Statement (EIS)* – for an action that has the potential to significantly affect the environment.

Projects classified as Type III should be documented in NEPA environmental documents or Phase I engineering reports, as appropriate. The following paragraph should be included:

> "The referenced project meets the criteria for a Type III project established in 23 CFR Part 772. Therefore, the proposed project requires no traffic noise analysis or abatement evaluation. Type III projects do not involve added capacity, construction of new through lanes, changes in the horizontal or vertical alignment of the roadway, or exposure of noise sensitive land uses to a new or existing highway noise source. A noise analysis would be required if changes to the proposed project result in reclassification to a Type I project."

In addition to the noise analysis results, see Section 5.4 for construction noise language.

If a noise analysis is required, the environmental document should summarize the following:

(a) A brief description of CNEs (residences, businesses, schools, parks, *etc.*), including information on the number and types of activities which may be affected. This should include developed lands and undeveloped lands for which development is permitted. The location of the predicted noise impacts should be identified and depicted on maps as appropriate.

(b) The extent of the impact (in decibels) at each CNE. This includes a comparison of the predicted build noise levels to both the FHWA NAC and the existing noise levels. When there is a substantial increase in traffic noise levels, defined as an increase greater than 14 dB(A) over existing levels, a table for this comparison is recommended.

(c) Noise abatement measures which have been considered for each common noise environment and those measures that are feasible and reasonable and that would likely be incorporated into the proposed project should be included. Estimated costs, decibel reductions and height and length of barriers should be shown for all abatement measures. In addition, the results of the solicitation of the viewpoints from benefited receptors should be summarized. Where noise abatement measures are determined to feasible and reasonable, the following statement of likelihood or similar wording should be included.

> "Based on the traffic noise analysis and noise abatement evaluation conducted, highway traffic noise abatement measures are likely to be implemented based on preliminary design. The noise barriers determined to meet the feasible and reasonable criteria are identified in Table (reference table ID). If it subsequently develops during final design that constraints not foreseen in the preliminary design or public input substantially change, the abatement measures may need to be modified or removed from the project plans. A final decision on the installation of abatement measure(s) will be made upon completion of the project's final design and the public involvement process."

(d) Noise impacts for which no abatement measure is reasonably available and the reasons why.

Noise Impacts
A table to present the results of the existing and future build and no-action traffic-generated noise levels should be used to identify predicted changes. Table 6-1 illustrates an example.

TABLE 6-1
EXAMPLE NOISE ANALYSIS RESULTS SUMMARY TABLE

***Receptor* (keyed to a map)**	**Type**	**Represents**	**NAC* dB(A)**	**Existing dB(A)**	**Predicted Year**			**Impacted**
					Build dB(A)	**No-Action dB(A)**	**Build Increase Over Existing dB(A)**	
1	Res	12 homes	67	65)	66	67	1	Yes
2	Comm	3 businesses	72	70	74	70	4	Yes
Etc.								

**Noise Abatement Criterion*

Noise Abatement
Results of the noise abatement analysis must be presented for receptors where the predicted noise level approaches, meets or exceeds the NAC or where a substantial increase is predicted. Table 6-2 illustrates an example.

TABLE 6-2
EXAMPLE NOISE ABATEMENT SUMMARY TABLE

Rec. #	***Barrier* Height**	***Barrier* Length**	**Total Cost**	**Noise Reduction Potential dB(A)**	**Estimated Build Cost per Benefited Receptor**	**Allowable Cost per Benefited Receptor**	**Likely to be Implemented**	**If No, Reasons Why**
1	18 feet	800 feet	$	8	$/benefited Rec.	$/benefited Rec.	No	Majority of benefited receptor viewpoints opposed noise wall.

6.3 Coordination with the Public

As part of the public involvement process, the results of the traffic noise analysis should be presented at the public meeting/hearing for any proposed noise barriers or other noise abatement measures. The information is typically presented on project exhibits and should include evaluated noise barrier locations, noise barriers likely to be implemented as part of the project design or locations of other proposed noise abatement measures. Supporting traffic noise analysis information (*i.e.* traffic noise memorandum/report) should be available for review at the public meeting or hearing.

The depiction of noise abatement measures should be depicted on exhibits and may fall under one of the following two descriptions:

- Noise Abatement Measure Likely to be Implemented
- Noise Abatement Measure Likely to be Implemented Pending Viewpoints of Benefited Receptors

Additional noise abatement measures that are not feasible or reasonable may be depicted on exhibits using one of the four following descriptions:

- Noise Abatement Measure not Feasible
- Noise Abatement Measure not Reasonable (does not achieve noise reduction design goal)
- Noise Abatement Measure not Reasonable (does not achieve cost effectiveness criteria)
- Noise Abatement Measure not Reasonable (majority of benefited receptors do not desire the abatement measure)

The purpose of sharing the traffic noise analysis information is to solicit comments from local officials, property owners and residents adjacent to the project area, with particular emphasis given to benefited receptors. The public meeting or hearing is one of the recommended mechanisms to obtain the viewpoint from at least one-third of the benefited receptors. Every effort should be made to identify the intent and need of getting documented feedback from the benefited receptors. This may include identifying benefited receptors on the exhibits.

Section 4.2.1.2 includes a section on “Viewpoints of Benefited Receptors” as part of the reasonableness evaluation and an example evaluation is provided in Appendix C. Section 4.2.1.2 presents the methodology to solicit the information and a template letter that could be used to request viewpoints on the proposed noise abatement measure. Additionally, the section presents a methodology to determine the majority viewpoint for each abatement measure with a potential to be implemented. The solicitation of viewpoints is not required for a noise abatement measure that does not achieve the feasibility criteria or the reasonableness criteria based on the noise reduction design goal or cost-effectiveness.

The level of public involvement will vary from one project to another and is influenced by the type of project, level of noise impacts that may result as well as proposed abatement measures, and general interest shown by the public. Comments may be solicited from the public by a variety of methods, including the following:

- Public meetings
- Public hearings
- Letters
- Newspaper advertisements
- Telephone, door-to-door or mail surveys
- Flyers and/or posters
- Website
- Telephone hotline

If a project is likely to result in noise impacts, an extra effort should be made to involve the public and more specifically, benefited receptors at the earliest stage reasonable. The timing of this involvement will vary from project to project; however, it should generally occur when traffic noise impacts and proposed abatement measures have been identified.

The views of benefited receptors, including whether they find a proposed abatement measure acceptable or desirable, are a major consideration in determining the reasonableness of that proposed abatement measure. Comments from the benefited receptors regarding noise wall texture and color will also be considered; however, all design features are ultimately decided upon by IDOT.

In order for any proposed noise wall comment from benefited receptors to be taken into consideration, it must be submitted in writing in letter format, e-mail or recorded at a public meeting or public hearing.

6.4 Coordination with Local Officials

The purpose of coordinating with local officials is to provide information and promote compatible land development and land use planning adjacent to proposed highway projects. Compatible land use planning is an important tool for preventing future noise impacts. The traffic noise study results should be presented to the local officials having jurisdiction within the study area and they should be involved in the planning process as early as possible. In addition to the information presented in the Technical Noise Memorandum/Report, local officials shall be provided with the following:

- Estimated future noise levels (for various distances from the proposed highway improvement) for undeveloped lands or properties in the immediate vicinity of the project that are not permitted or for agricultural lands that are zoned. Specifically, distances from the edge of pavement to the traffic noise impact limits should be provided for the undeveloped lands. This may be accomplished using noise contours. It is recommended that this information be sent directly to the local officials.

- Information that may be useful to local communities to protect future land development from becoming incompatible with anticipated highway traffic noise levels.

The FHWA has developed a document entitled *Entering the Quiet Zone: Noise Compatible Land Use Planning* that could be recommended to the local officials to inform them of noise compatible planning concepts.[9] This document can be obtained from the FHWA website at:
http://www.fhwa.dot.gov/environment/noise/noise_compatible_planning/federal_approach/land_use/quitezon.pdf

REFERENCES

[1] U.S. Department of Transportation (USDOT), *Noise Fundamentals Training Document – Highway Noise Fundamentals*, September 1980.

[2] USDOT, Federal Highway Administration (FWHA), *Highway Traffic Noise: Analysis and Abatement Guidance*, June 2010, January 2011, as revised.

[3] FHWA, *Keeping the Noise Down, Highway Traffic Noise Barriers* [Brochure].

[4] AASHTO Highway Subcommittee on Design Task Force for Environmental Design, *Guide on Evaluation and Abatement of Traffic Noise*, 1993.

[5] IDOT, Standard Specifications for Road and Bridge Construction, Article 107.35, Construction Noise Restrictions, January 1, 2007.

[6] USDOT, FWHA, *Roadway Construction Noise Model User's Guide*, FHWA-HEP-05-054, January 2006.

[7] USDOT, Federal Transit Administration (FTA), *Transit Noise and Vibration Impact Assessment* (FTA-VA-90-1003-06), May 2006.

[8] USDOT, FHWA, Technical Advisory T6640.8A, *Guidance for Preparing and Processing Environmental and Section 4(f) Documents*, October 30, 1987.

[9] FHWA, *Entering the Quiet Zone: Noise Compatible Land Use Planning* [Brochure prepared by Texas Southern University, 2002].

<u>Other Selected References and Sources for Additional Information:</u>

Harris and Crede, *Shock and Vibration Handbook*, 5th Edition, 2002.

USDOT, FHWA, Measurement of Highway Related Noise FHWA-PD-96-046, DOT-VNTSC-FHWA-96-5, May 1996.

USDOT, FHWA, *Noise Fundamentals Training Document - Highway Traffic Noise Sources*, September 1980.

USDOT, FHWA, Technical Advisory T6160.2, *Analysis of Highway Construction Noise*, October 30, 1987.

GLOSSARY

23 CFR 772. (Title 23, Code of Federal Regulations, Part 772) "Procedures for Abatement of Highway Traffic Noise and Construction Noise": FHWA regulations for highway traffic noise analysis and abatement during the planning and design of federally aided highway projects.

Abatement. Any positive action taken to reduce the impact of highway traffic noise.

Absolute Noise Levels. The predicted design-year noise level at the receptor without noise abatement.

Absorptive Noise Wall. Noise walls that tend to absorb noise.

Attenuation. The reduction of an acoustic signal.

Average Daily Traffic (ADT). The total traffic volume during a given period divided by the number of days in that period. Current ADT volumes can be determined by continuous traffic counts or periodic counts.

A-Weighted Levels. Adjustment or weighting of sound frequencies to approximate the way that the average person hears sounds. This weighting system assigns a weight that is related to how sensitive the human ear is to each sound frequency. Frequencies that are less sensitive to the human ear are weighted less than those for which the ear is more sensitive. A-weighted sound levels are expressed in decibel units "dB(A)".

Barrier. A solid wall or earth berm located between the roadway and receptor location which provides noise reduction.

Benefited Receptor. The recipient of an abatement measure that receives a noise reduction of 5 dB(A) or greater. A benefited receptor does not need to be an impacted receptor.

Build Condition. Projected traffic volumes using the proposed roadway configuration.

Clear Zone. Area adjacent to a roadway which is void of objects.

Common Noise Environment (CNE). A group of receptors within the same Activity Category that are exposed to similar noise sources and levels; traffic volumes, traffic mix, and speed; and topographic features. Generally, CNEs occur between two secondary noise sources, such as interchanges, intersections, or cross-roads.

Context Sensitive Solutions (CSS). An approach that seeks effective multi-modal transportation facilities which fit into and reflect a project's surroundings; its "context".

Date of Public Knowledge. The date of environmental approval of the Categorical Exclusion (CE), the Finding of No Significant Impact (FONSI) for an Environmental Assessment (EA), or the Record of Decision (ROD) for an Environmental Impact Statement (EIS), as defined in 23 CFR Part 771.

Decibels (dB). Units for measuring sound. Decibels are logarithmic units.

Design Hourly Volume (DHV). The 30th highest hourly volume in a year.

Design Year. The future year used to estimate the probable traffic volume for which a highway is designed. For NEPA, IDOT uses the latest approved traffic projections from the appropriate Metropolitan Planning Organization (MPO). For locations outside the planning area of an MPO, the design year traffic volumes shall be consistent with the traffic projections used for design.

dBA. Decibels measured using the A-weighted scale.

Engine Braking. The act of using the energy-requiring compression of an internal combustion engine to slow down a vehicle which typically results in noise pollution.

Existing Noise Levels. The worst hourly noise level resulting from the combination of natural and mechanical sources and human activity usually present in a particular area.

Facility or Existing Highway. Any of the freeways, expressways, or various classes of roads and streets that make up the highway system under the jurisdiction of IDOT.

Feasibility. The combination of acoustical and engineering factors considered in the evaluation of a noise abatement measure. The acoustical criterion for feasibility requires a minimum 5 dB(A) traffic noise reduction at a minimum of one impacted receptor location.

FHWA. Federal Highway Administration.

Frequencies. The number of cycles of a periodic motion in a unit of time. Noise frequencies are measured in Hertz (Hz).

FTA. Federal Transit Authority.

Fully Controlled-Access State Highway. A highway under IDOT jurisdiction with no at-grade intersections and no driveway access points.

Hard Site. Hard ground conditions, such as asphalt or concrete, that tend to reflect noise.

Heavy Trucks. All vehicles having three or more axles and designed for the transportation of cargo.

Hertz (Hz). The unit of frequency; one Hertz has a periodic interval of one second.

Impact. Condition occurring when predicted traffic noise reaches a level that requires a consideration of noise abatement measures.

Impacted Receptor. The recipient that has a traffic noise impact.

Insertion Loss. The actual benefit (noise level reduction) derived from the construction of a noise barrier.

L_{dn} (Day/Night average sound level). Average sound exposure over a 24-hour period is often presented as a day-night average sound level (L_{dn}). L_{dn} values are calculated from hourly L_{eq}

values, with the Leq values for the nighttime period (10:00 p.m. to 7:00 a.m.) increased by 10 dB to reflect the greater disturbance potential from nighttime noises.

L_{eq}. The equivalent steady-state sound level, which in a stated period of time, contains the same acoustic energy as the time-varying sound level during the same time period, with $L_{eq}(h)$ being the hourly value of L_{eq}.

Level of Service (LOS). A qualitative system used to measure the effectiveness of a roadway to transport vehicles.

Line of Sight (Barrier) An obstruction, generally a solid wall or an earth berm, located between a noise source and a receiver.

Line of Sight (Traffic). The line of vision between a receptor and a noise source.

Line Source. Many single noise sources close together (*i.e.,* multiple vehicles on a roadway).

L_{max}. The maximum sound level measured over a time period.

L_{min}. Lowest sound level measured in a given environment over a specified period of time.

Logarithmic. A logarithm is a short hand way to represent large numbers. A logarithmic scale increases consecutive numbers by a factor of 10. For example; log 1,000 = 3; log 10,000 = 4; log 100,000 = 5, *etc.*

Medium trucks. All vehicles having two axles and six wheels designed for the transportation of cargo.

Multifamily Dwelling. A residential structure containing more than one residence. Each residence in a multifamily dwelling shall be counted as one receptor when determining impacted and benefited receptors.

National Environmental Policy Act (NEPA). NEPA requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

No-Action Condition. Modeling future (design year) traffic volumes using the existing roadway configuration.

Noise Abatement. Measures taken to mitigate or reduce traffic noise impacts (*i.e.,* construction of berms or noise walls, shifting roadway alignment, *etc.*).

Noise Abatement Criteria (NAC). Noise impact thresholds for considering noise abatement for various land uses. Defined in 23 CFR Part 772.

Noise Barrier. A physical obstruction (*i.e.* stand alone noise walls, noise berms (earth or other material), and combination berm/wall systems) that is constructed between the highway noise source and the noise sensitive receptor(s) that lowers the noise level at the receptor location.

Noise Reduction Coefficient (NRC). A scalar representation of the sound absorbing capability of a material. An NRC of 0 indicates perfect reflection; an NRC of 1 indicates perfect absorption.

Noise Reduction Design Goal. The optimum desired dB(A) noise reduction determined from calculating the difference between future build noise levels with abatement, to future build noise levels without abatement. The noise reduction goal is at least 8 dB(A) for at least one benefited receptor location.

Octave Band. A group of frequencies whose lower boundary is one-half of the upper boundary. In acoustics, the first eight octave bands are identified by their center frequencies of 63, 125, 250, 500, 1,000, 2,000, 4,000, and 8,000 Hertz.

Parallel Noise Walls. Proposed noise walls that are located across from one another on opposite sides of a highway.

Peak Hourly Traffic. The highest hourly traffic volume of the day.

Peak Particle Acceleration (PPA). Maximum instantaneous particle acceleration associated with a vibratory event.

Peak Particle Velocity (PPV). Maximum instantaneous particle velocity associated with a vibratory event.

Permitted. A definite commitment to develop land with an approved specific design of land use activities as evidenced by the issuance of a building permit.

Point Source. One single noise source (*i.e.,* one vehicle).

Property Owner. An individual or group of individuals who hold(s) a title, deed, or other legal documentation of ownership of a property or a residence.

Reasonableness. The combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure.

Receptor. A discrete or representative location of a CNE(s), for any of the land uses listed in Table 2-1.

Reflective Barriers. Barriers that tend to reflect noise.

Residence. A dwelling unit. Either a single family residence or each dwelling unit in a multifamily dwelling.

Sight Screen. A structure that blocks the sight of a highway or roadway, *i.e.,* a solid fence. A sight screen would not be considered a noise abatement measure.

Soft Site. Soft ground conditions, such as grass, that tends to absorb noise.

Statement of Likelihood. A statement provided in the NEPA environmental document based on the feasibility and reasonableness analysis completed at the time the environment document is being approved.

Stopping Sight Distance. Sum of the brake reaction distance (the distance traveled between the time the driver sees an obstruction to when the break is applied) and the braking distance (the distance traveled while braking the vehicle to a stop).

Substantial Construction. The granting of a building permit by the local governing entity with permitting authority, prior to right-of-way acquisition or construction approval for the highway.

Substantial Noise Increase. One of two types of highway traffic noise impacts. For an IDOT project, this is defined as an increase in noise levels of greater than 14 dB(A) in the design year over the existing noise level.

TNM. Traffic Noise Model. FHWA's computer program for highway traffic noise prediction and analysis.

Traffic Noise Impacts. Design year build condition noise levels that approach or exceed the Noise Abatement Criteria (NAC) listed in Table 2-1 for the future build condition; or design year build condition noise levels that create a substantial noise increase over existing noise levels. For purposes of the IDOT policy, approach is defined as within 1 dB(A) of the NAC.

Transmission Loss (TL). The accumulated decrease in acoustical intensity as an acoustic pressure wave propagates outwards from a noise source.

Type I Project.

- The construction of a highway on new location; or,
- The physical alteration of an existing highway where there is either:
  - + *Substantial Horizontal Alteration*. A project that halves the distance between the traffic noise source and the closest receptor between the existing condition to the future build condition; or,
  - + *Substantial Vertical Alteration*. A project that removes shielding, exposing the line-of-sight between the receptor and the traffic noise source. This is done by either altering the vertical alignment of the highway or by altering the topography between the highway traffic noise source and the receptor; or,
- The addition of a through-traffic lane(s). This includes the addition of a through-traffic lane that functions as a HOV lane, High-Occupancy Toll (HOT) lane, bus lane, or truck climbing lane; or,
- The addition of an auxiliary lane, except for when the auxiliary lane is a turn lane; or,
- The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange; or,
- Restriping existing pavement for the purpose of adding a through-traffic lane or an auxiliary lane; or,

- The addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot or toll plaza.

If a project is determined to be a Type I project under this definition then the entire project area as defined in the NEPA environmental document is a Type I project.

Type II Project. A Federal or Federal-aid highway project for noise abatement on an existing highway. IDOT does not maintain a Type II program.

Type III Project. A Federal or Federal-aid highway project that does not meet the classifications of a Type I or Type II project. Type III projects do not require a noise analysis.

Undeveloped Lands. Those tracts of land or portions thereof that do not contain improvements or activities devoted to frequent human habitation or use (including low-density recreational use) and for which no such improvements or activities are permitted.

USEPA. United States Environmental Protection Agency.

Worst Hourly Traffic Noise. The noise level resulting from the highest hourly volume a facility can handle while maintaining stable flow. This traffic volume will be either the design hourly volume or the maximum volume that can be accommodated under Level of Service C (*i.e.,* where high traffic volumes begin to restrict speed and drivers' maneuverability).

Appendix A

TRAFFIC NOISE MEMORANDUM/REPORT OUTLINE

1. INTRODUCTION
   - 1.1 Project Description
   - 1.2 Existing Land Use
   - 1.3 Zoning and Comprehensive Land Use Plan Designations

2. NOISE BACKGROUND AND REGULATIONS
   - 2.1 Noise Background
   - 2.2 Federal Regulations
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   - 4.2 Monitoring Results

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   - 5.2 Traffic Composition
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7. ABATEMENT ANALYSIS (if impacts identified
   - 7.1 Abatement Measures
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       - Noise Reduction Design Goal
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8. CONSTRUCTION NOISE
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   - 8.2 Construction Noise Abatement (If applicable)

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FREQUENTLY ASKED QUESTIONS

1. When does a traffic noise impact occur?

In Illinois, traffic noise impacts are interpreted to occur in the following situations:

- Design year traffic noise levels are predicted to approach (within 1 dB(A)), meet, or exceed the Noise Abatement Criteria (NAC).

OR

- Design year traffic noise levels are predicted to substantially increase (greater than 14 dB(A)) over existing noise levels.

(See Section 2.3.2)

2. When is a traffic noise analysis required?

A noise analysis is required for state or federal highway construction or reconstruction projects that have been determined to meet the definition of a Type I project. These projects have the potential to increase traffic noise.

(See Section 3.2)

3. Is every house analyzed for noise impacts?

Every house in close proximity to the roadway is considered in the noise analysis, either directly or indirectly by representation in an area. Noise receptors are used to represent areas that are similar in land use, proximity to roadway, and basic topography. Predicting noise levels at every house is not necessary when similar location and topography would provide like noise levels. The selected representative receptor generally represents the worst-case (*i.e.* it is the closest to the roadway) of all receptors included in the area and noise levels can be expected to be similar for all receptors within the group. The representative area is called a Common Noise Environment (CNE).

(See Section 3.4)

4. Are noise levels evaluated for floors above the ground level (*i.e.* 2nd or 3rd floor, *etc.*)?

Noise Abatement Criteria (NAC) are generally developed for activities occurring outdoors where frequent human activity occurs. Typically, this would be a ground level activity area with the most direct exposure to the traffic noise source. However, due to topography of either the roadway or the receptor, the ground floor may be shielded from the roadway outside of the line of sight and therefore a higher floor (*i.e.,* 2nd or 3rd level floor) may have the potential for greatest impact. A higher floor will only be evaluated if frequent outdoor human activity occurs, such as on a balcony, or the receptor is being evaluated as Activity Category D.

(See Section 3.4)

5. Is the number of occupants taken into consideration when determining the number of receptors?

The number of receptors is not related to the number of occupants. For example, one single-family home is counted as one receptor, regardless of how many people live there. Other land uses may be dependent on the number of units with the facility such as the number of classrooms in a school.

(See Section 3.4 and 4.2.1.2)

6. If a receptor is located beyond 500 feet from the project area, should it be included in the noise analysis?

Although 500 feet is used as the initial screening distance for receptors, sensitive receptors, such as nursing homes or schools, located further than 500 feet should be included on a case-by-case basis if the potential exists for them to be impacted by the project.

Factors to consider when evaluating receptors greater than 500 feet include terrain and other structures between the receptor and the roadway that may be blocking the line-of-sight. For example, if a church is located 600 feet from the roadway and there is only open field in between, it should be included in the noise analysis; however, if there are several rows of homes in between the church and the roadway, it would not have to be included.

(See Section 3.4)

7. Is weather accounted for when measuring noise levels?

Weather conditions can have some effect on noise measurement readings. Noise measurements should not be taken if the wind speed exceeds 12 m.p.h. A wind screen on the noise monitor should be used at all times to reduce wind effects. Other site conditions necessary during the monitoring include dry pavement and no snow cover. The conditions during monitoring should always be recorded for comparison and review purposes. In the computer traffic noise model, the default weather used for analyses is 50% relative humidity and 20°C (68°F) temperature.

(See Section 3.5.2)

8. Why isn't noise monitoring results used instead of modeling results when determining impacts?

Monitored noise levels represent a snapshot of existing conditions. This means the monitored noise levels reflect weather and traffic conditions for that time period only. In addition, noise monitoring detects all noise sources present at the monitoring location, which may result in higher traffic noise levels that would not only be from the roadway.

As part of the noise analysis process, noise levels are predicted for both the existing and future conditions. The computer model is used to consistently predict future traffic noise levels at peak traffic which is a worst-case condition.

(See Section 3.5)

9. What is the source of the traffic data used in the computer model?

There are two types of traffic data that can be used in traffic noise modeling:

1) Peak Hourly Traffic; and
2) Average Daily Traffic (ADT) - The total traffic volume during a given period divided by the number of days in that period. Current ADT volumes can be determined by continuous traffic counts or periodic counts.

Existing volumes are typically generated from actual traffic counts. Design volumes are typically projected by the District or a Metropolitan Planning Organization. These design volumes are based on typical traffic growth rates, planned development and projected growth for the area.

(See Section 3.6.1)

10. Can IDOT prohibit trucks along roads or reduce speed limits? Won't that reduce noise levels?

Both of these options may reduce noise levels; however, the use of these options depends on the use of the road. If the road is a main route into and out of a city, or if there are commercial and industrial businesses along the route, a prohibition of trucks would result in adverse economic impacts. Also, by law, truck traffic cannot be prohibited on State marked routes and Interstates.

Lowering speed limits may slightly reduce traffic noise levels, but the speed reduction would lower the capacity of the roadway, thereby increasing delays, air pollutant emissions, and the overall cost of transporting goods and services. Speed limits are determined by the roadway design and speed studies.

(See Section 4.1.2)

11. Would a berm be as effective as a noise wall in reducing noise levels and how does its effectiveness compare to noise walls?

Earth berms are just as effective as noise walls. Studies have shown that earth berms actually reduce noise levels to a greater extent than noise walls. This is partially due to the soft surface of the berm (*i.e.* grass) providing more absorption. In addition, the flat top of the berm diffracts sound waves twice, resulting in more attenuation. However, the use of berms depends on the space available. For maintenance reasons, IDOT requires at least a 3:1 slope on berms. For example a 12-foot berm with a 3:1 slope would be approximately 72 feet wide at the base. The available area for abatement would need to accommodate this base width.

(See Section 4.1.1)

12. Can trees/vegetation be planted to help reduce noise levels?

Vegetation, such as a dense growth of evergreens, would need to be at least 200 feet in width and 18 feet high to reduce noise levels by 5 to 10 dB(A). In most cases, 200 feet of space between the roadway and receptors is not available. Vegetation/trees can potentially help screen the highway traffic from view.

(See Section 4.3.1)

13. Why isn't noise abatement designed to reduce noise levels below the NAC?

The Noise Abatement Criteria (NAC) identifies the noise level at which noise abatement should be evaluated. It is not a noise abatement goal. The objective of noise abatement is to achieve a noise reduction that will result in a noticeable difference from the unabated traffic noise levels and can be implemented in a cost effective way. A reduction of 5 dB(A) is considered to be "readily perceptible" to the human ear. Under typical noise abatement evaluations, a substantial noise reduction is considered to be an 8 dB(A) traffic noise reduction. As part of the noise abatement evaluation, noise abatement measures must reduce noise level by at least 5 dB(A) for at least one **impacted** receptor to be considered feasible, and by at least 8 dB(A) for at least one **benefited** receptor to be considered reasonable. For example, the following table demonstrates the noise reduction goals in order to meet the criteria.

Location	Future Noise Level	NAC	Noise Reduction Design Goal	Target Noise Level
Site 1	69 dB(A)	67 dB(A)	8 dB(A)	61 dB(A)
Site 2	78 dB(A)	67 dB(A)	8 dB(A)	70 dB(A)

(See Section 4.2.1.2)

14. Why aren't noise barriers proposed in some cases?

A noise barrier may be proposed when a noise impact occurs and the noise barrier is determined to be feasible and reasonable. A noise barrier is determined to be feasible if it achieves at least a 5 dB(A) traffic noise reduction for at least one impacted receptor. Issues, such as driveway access and elevation of the receptor, may prevent achievement of a 5 dB(A) reduction, and therefore it may not be feasible.

A noise barrier must also be reasonable, which includes three criteria. It must first meet the noise reduction design goal of achieving at least an 8 dB(A) reduction for at least one benefited receptor. Secondly, the estimated build cost per benefited receptor must be less than the allowable cost per benefited receptor. The base allowable cost per benefited receptor is $24,000 per benefited receptor. The allowable cost may be adjusted based on the absolute noise level, the change in noise level and the construction date of the receptor relative to the roadway facility. For example, if a noise barrier will benefit 10 residences, and the total cost of the noise barrier is $240,000, then the cost per benefited receptor would be $24,000 and the noise barrier would be considered economically reasonable.

The third reasonableness factor is the consideration of the benefited receptor viewpoints. The viewpoints need to be considered for noise abatement measures that are determined to be feasible and achieve the first two reasonableness factors. If the majority of the viewpoints are in favor of the noise barrier, then the noise barrier would be considered "likely to be implemented".

If a noise barrier is not considered feasible or reasonable for an area, the noise barrier abatement measure will not be implemented as part of the project.

Other feasibility factors that influence if a noise barrier will be proposed include whether or not sufficient right-of-way is available for the safe placement of the barrier, impacts to the line-of-sight of approaching vehicles in the vicinity of on-ramps, off-ramps, and intersecting streets and/or interference with utilities and/or drainage design elements.

(See Sections 4.2.1.2)

15. What is the cost of a noise wall?

The average unit cost of noise wall construction used for the noise wall evaluation is $25 per square foot. This cost is based on Illinois construction costs and walls built. In areas where there are utilities or drainage issues that may need to be addressed, additional costs may be incurred. Typical noise walls cost $1,500,000 per mile.

The unit cost is re-evaluated by IDOT at least every five years and is based on actual costs incurred by IDOT from the previous years.

(See Section 4.2.1.2)

16. How did IDOT determine the base value of $24,000 per benefited receptor as economically reasonable?

IDOT considers $24,000 per benefited receptor as a reasonable base value with a threshold of 5 dB(A) reduction of noise defining benefited residence.

(See Section 4.2.1.2)

17. Can the base value of $24,000 per benefited receptor be adjusted based on site specific conditions?

IDOT allows for the adjustment of the base value allowable cost per benefited receptors based on the absolute build noise level, the change in noise level between the existing condition and the build noise level, the whether or not the receptor was present before the construction of the roadway facility proposed for improvement. Based on the adjustments, the maximum allowable cost per benefited receptor is $37,000 per benefited receptor.

(See Section 4.2.1.2)

18. When is sound insulation viable?

FHWA/IDOT only participates in sound insulation for land uses with Activity Category D, which does not include residential units. An interior noise analysis for these land uses would be conducted if it has been determined that there are no exterior human use activity areas present or that the exterior human use areas are sufficiently shielded from the traffic noise source.

Sound insulation may be considered for Activity Category D land uses if an impact has been identified on the interior and after all other noise abatement measures have been determined to be not feasible or reasonable. If it is determined that alternative noise abatement measure other than sound insulation would be feasible and reasonable based on all the criteria other than the viewpoints of the benefited receptor, IDOT will only consider sound insulation on a case-by-case basis.

(See Section 4.1.6)

19. How do you determine the noise impacts and feasibility of noise abatement of special types of land uses, such as schools or parks?

IDOT uses a "Representative Receptor Unit" for determining the number of receptors potentially impacted and/or benefited by a project. The evaluation then proceeds the same as for a residential receptor.

Potential Benefited Receptor Units*

Receptor Type	Potential Benefited Receptor Unit(s)
Single-family Residence	Each residential unit
Multi-family Residence	Each residential unit with access to the exterior common area or with exterior use areas, such as a patio or balcony
Nursing Home	Each residential unit with access to the exterior common area
School	Each classroom
Hospital	Each hospital room with a bed(s)
Hotel/Motel	Each hotel/motel room
Cemetery	Each point of anticipated gathering (*i.e.* bench, information board)
Places of Worship	Each point of anticipated gathering (*i.e.* bench, patio, gazebo)
Parks	Each gazebo, group of picnic tables, playground
Trails and Trail Heads	Each point of anticipated gathering (*i.e.* bench, information board)
Libraries	Each point of anticipated gathering (*i.e.* bench, patio, gazebo)
Business	Each business unit
Undeveloped Lands	Each unit with a building permit

* To be considered benefited, each receptor unit location must receive at least a 5 dB(A) traffic noise reduction to be considered as part of the cost-effective evaluation.

(See Section 4.2.1.2)

20. Can alternative materials or designs to IDOT standard noise barriers be used?

Based on testing and research results, IDOT has currently approved three types of materials for noise barriers:

1. Barrier walls using concrete;

2. Barrier walls using composite materials; and
3. Earth berms.

Other materials may be considered if they meet IDOT's criteria for noise abatement wall materials. The noise wall material must achieve a sound Transmission Loss (TL) (*i.e.,* a reduction in sound transmitted through the material) equal to or greater than 20 dB in all one-third octave bands from 100 hertz to 5000 hertz, inclusive. Testing for TL shall be in accordance with ASTM E90 "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions." Specialty items and materials that are not covered by ASTM, AASHTO, or other IDOT specifications must have the prior approval of the Illinois Highway Development Council (IHDC). Contact the Engineer of Technical and Product Studies at the Bureau of Materials and Physical Research for additional information on the IHDC process. "Non-standard" noise wall designs, such as alternative patterns for a concrete wall, may be considered, but any costs exceeding that of a "standard" noise wall must be funded by the local sponsor.

(See Section 4.2.2)

21. Does a noise wall absorb noise or does noise bounce off the wall?

This depends on the type of noise wall constructed. An absorptive noise wall is designed to absorb sound and keep it from reflecting off the noise wall. The absorptive capacity of the wall material is specified by the NRC, which can range from 0.00 to 1.00, with 1.00 representing 100 percent absorption. To be considered absorptive by IDOT, the NRC must be at least 0.80 on the roadway side of a noise wall and at least 0.65 on the side of the wall away from the roadway.

A reflective wall is a wall not composed of an absorptive material and consequently, sound reflects off the wall back toward the source. The reflected sound level is significantly less than the sound level coming directly from the noise source. This is due to the additional distance the reflected sound travels, thereby dissipating the sound (reducing noise energy). Generally, the increase in sound levels due to reflections is not perceivable and therefore negligible.

(See Sections 4.2.2 and 4.2.6)

22. When is it appropriate for parallel barriers to be proposed?

Parallel barriers can be proposed; however, it is strongly recommended that the reduction in performance due to multiple noise reflections be evaluated using the parallel barrier analysis sub-program of TNM. For parallel barrier situations, the noise wall configuration shall be provided for both a reflective (non-absorptive) noise wall material and an absorptive noise wall material, as there may be height differentials between barrier types that should be identified. Construction of noise walls on both sides of the roadway should be designed with width-to-height ratios of at least 10:1, with a 20:1 ratio being preferred. The width is the distance between the two noise walls and the height is the average wall height above the roadway.

(See Section 4.2.6)

23. How long does the noise wall need to be?

Generally to be effective, the noise wall should extend 4 times the distance between the receptor and the noise wall. In other words, if the distance between the house and the noise wall was 50 feet, the noise wall would need to extend 200 feet beyond the receptor in each direction.

(See Section 4.2.4)

24. Why can't a taller wall be built to get greater noise reduction?

The barrier height is just one element that affects the traffic noise reduction achieved. A noise wall that breaks the line of sight between the traffic noise source and noise receiver reduces traffic noise up to 5 dB(A). Each additional two feet of noise wall improves the traffic noise reduction by approximately 1 dB(A); however, beyond a certain height, incremental changes in height do not provide additional perceptible reduction in noise level (see the table below). This occurs because the wall has already intercepted a high percentage of noise energy.

A noise barrier should not be designed at a height beyond that which is necessary to obtain the targeted level of noise reduction.

Reduction in Sound level	Degree of Attainability
5 dB(A)	Easily Attained
10 dB(A)	Attainable
15 dB(A)	Very Difficult
20 dB(A)	Nearly impossible

(See Section 4.2.5)

25. When should interior noise be evaluated?

Interior noise should only be evaluated when it has been determined that there are no exterior activities that could be potentially impacted by traffic noise. Interior noise impact analysis applies to Activity Category D.

(See Section 3.7.1)

26. How does IDOT address construction noise?

Construction noise is an inevitable result of project construction but IDOT considers ways to eliminate and/or minimize noise. IDOT may evaluate construction noise to see:

- if there is sufficient need for recommending construction of barriers prior to completion of remaining portions of project construction
- if provisions for any of the following measures should be used requiring special construction measures:
  - work hour limits
  - equipment muffler requirements
  - location of haul roads
  - elimination of "tail gate banging," reduction of backing up for equipment with alarms

  - use of “sound curtains”
  - placing material stockpiles to form temporary noise barriers
  - positioning equipment as far as practical from sensitive areas
- if the duration of contract period should be limited (calendar date of completion)
- if construction during special events, such as outdoor concerts and athletic events, should be limited

(See Section 5)

27. What are some of the positive and negative attributes of noise wall construction?

- Positive Attributes
  - Easier conversation
  - Better sleeping conditions
  - Windows open more often
  - Outside more in summer
  - More privacy
- Negative Attributes
  - Restricted view
  - Feeling of confinement
  - Loss of air circulation
  - Loss of sunlight and lighting
  - Eyesore if barrier not maintained
  - Graffiti
  - Maintenance requirements

28. Can noise contour lines generated in TNM be used to determine traffic noise impacts and/or in the noise abatement analysis?

Using noise contour lines to determine noise impacts or for the noise abatement analysis is not recommended as they provide only an approximation of the noise levels. Typically, noise contour lines are only used for planning purposes. This would be an acceptable method to depict the information needed to share with local officials for undeveloped lands. The contours would allow for the depiction of the areas anticipated to be impacted based on the various NAC.

(See Section 3.7.5)

29. If a benefited receptor is a rental property, whose input is sought when determining the desire for noise abatement?

As part of the reasonableness evaluation, the viewpoints of benefited receptors are required for the evaluation. In the case of rental properties, both the property owner and renter are solicited as input. Each renter in a benefited unit would provide one “vote” while the property owner would provide one vote per benefited unit.

(See Section 4.2.1.2)

30. Is a noise analysis required for a Type III Project?

A traffic noise analysis or abatement evaluation is not required for a Type III project. Type III projects do not involve added capacity, construction of through lanes, changes in the horizontal or vertical alignment of the roadway, or exposure of noise sensitive land uses to a new or existing highway noise source.

(See Section 3.2)

31. During the CSS process for the project, the stakeholders indicated that they did not want a noise wall. Does IDOT solicit the viewpoints from project stakeholders, or only from benefited receptors?

Public input on traffic noise and traffic noise abatement received through the public involvement process including CSS, is encouraged. However, when it comes to the viewpoint solicitation process as part reasonableness evaluation, only the viewpoints of the benefited receptors are considered. This is as per the FHWA regulations provided in 23 CFR Part 772.

(See Section 4.2.1.2)

32. If a noise wall is determined to be feasible and reasonable for a land use under Activity Category D, but the benefited receptor(s) determine that they don't want the noise wall, does sound insulation need to be evaluated?

If the noise abatement evaluation for Activity Category D determines that a noise wall would be feasible (achieves a 5-dBA traffic noise reduction at the impacted receptor) and reasonable (achieves an 8-dBA traffic noise reduction for a benefited receptor AND is cost-effective), but the viewpoint solicitation indicates a lack of desire for the noise wall, the availability of sound insulation as a viable option for noise abatement would need to be discussed with IDOT and FHWA.

(See Section 4.1.6)

33. I have a Type I project that the primary land uses are commercial (Land Use Category E,) along the proposed improvement. Am I required to perform a traffic noise assessment for commercial properties?

Yes. Even though the area is primarily commercial activities, traffic noise impacts need to be evaluated based on the NAC for Land Use Category E if there are exterior use areas. If noise impacts are identified, then a noise abatement evaluation needs to be conducted. Noise abatement found to be feasible and reasonable should then be presented to the commercial properties to determine the desire for noise abatement. This should be conducted through the viewpoint solicitation process.

(See Section 2.3.1)

34. My project consists of a bridge replacement only. During project development, due to geometric deficiencies, the road profile needed to be raised, therefore, raising the bridge profile. This profile change resulted in exposing the line-of-sight between a receptor and the traffic noise source. Is this a Type I project?

Yes. This project would meet the definition of a Type I project since the raised profile has exposed receptors to the traffic noise. A noise analysis would be required for this project.

(See Section 2.3.1)

35. The proposed project consists of resurfacing a 2.5 mile stretch of road and adding 2 new lanes of roadway along half mile stretch within the full 2.5 mile project. There are no sensitive land uses along the half-mile stretch where the add-lanes are proposed, but there are residential land uses along the section proposed for resurfacing only. Do I perform a traffic noise assessment for the add lanes section only or for the entire 2.5 miles of the project?

Though resurfacing a roadway, if taken alone, is not considered a Type I project, the project needs to be considered as a whole. If any portion of a project is Type I, the entire project corridor must be treated as a Type I project. Since the lane additions would be considered Type I, the entire project is considered a Type I project and therefore, a traffic noise assessment is required to be performed for the entire 2.5 mile project.

(See Section 2.3.1)

36. If a project is primarily Activity Category B with intermittent Activity Category D land uses (Activity Category C with no exterior use areas), would the noise analysis suffice if it just evaluated the Activity Category B areas?

No, the noise analysis needs to evaluate all activity categories within the defined project limits.

(See Section 2.3.1)

Example Project #1

- IDOT proposed add-lane project.
  - Noise analysis may be necessary as this is a Type I project.
  - After reviewing Figure 1 for Land Use Categories A, B, C, D, E, and G, a noise analysis is necessary as residential areas (Category B) are within the project limits – *Noise Analysis Required.*

Figure 1
Project Location Map

Receptor Selection

- The project limits contain two distinct common noise environments (CNE 1 and CNE 2) within 500 feet of the existing and proposed roadway alignments.
  - A representative receptor is chosen for each CNE, depicted in Figure 2.

Noise Level Predictions

- Traffic noise levels for the existing, no-build, and build scenarios were predicted according to the methodology described in Section 3, summarized in Table 1.

Figure 2
Receptor Location Map

Table 1
Traffic Noise Prediction Results

Receptor / CNE	Existing Noise Level, dB(A)	No-Build Noise Level, dB(A)	Build Noise Level, dB(A)	Increase from the Existing to Build Scenario, dB(A)	Impact Distinction
R1 / CNE 1	63	64	65	2	No Impact
R2 / CNE 2	65	67	**70**	5	**Impact**

Traffic Noise Impact Identification

- Receptor R1 is not an impact as it does not approach, meet, or exceed the FHWA noise abatement criterion for Land Use Category B.
- Receptor R2 is an impact as it exceeds the FHWA noise abatement criterion.
  - A noise abatement analysis is required.

Abatement Analysis

- For abatement analysis purposes, the individual receptors for the CNE 2 are identified, depicted in Figure 3.
  - Abatement analysis is performed for CNE 2 by considering the identified individual receptors.
- ***Feasibility criterion*** checked first:

- Wall can be built that provides at least a 5 dB(A) traffic noise reduction at an impacted receptor (7 dB(A) for R2) and possible to build– *Feasibility Criterion passed.*

- ***Reasonability criterion*** checked next:
  - The receptors identified as benefited (at least a 5 dB(A) traffic noise reduction) within the CNE must not exceed the allowable noise abatement cost. Optional reasonableness criterion is applied to adjust the base value of $24,000 per benefited receptor.
  - Wall can be built that provides at least an 8 dB(A) traffic noise reduction at a benefited receptor (7 benefited receptors of 8 dB(A) or greater) – *Noise Reduction Design Goal passed*.
    - Shown in Figure 4.
  - For each benefited receptor, the build noise level, increase in traffic noise between the existing and build scenarios, and the dates the homes were built in relation to when the roadway was built must be determined. These factors are defined in Figure 5 and Figure 6 and summarized in Table 2.

Figure 3
R2 CNE Individual Receptors

Table 2
CNE 2 Adjusted Allowable Cost per Benefited Receptor Calculations

Benefited Receptor Number within CNE 2	Build Noise Level, dB(A)	Increase in Noise, Existing to Build, dB(A)	Homes Built Before Roadway, Yes/No	Traffic Noise Factor	Noise Increase Factor	Homes Built Before Roadway Factor	Reasonableness Factors Cost Adjustments	Total Adjusted Allowable Cost per Receptor
3	67	4	No	$0	$0	$0	$0	$24,000
4	67	4	No	$0	$0	$0	$0	$24,000
5	67	4	No	$0	$0	$0	$0	$24,000
6	67	4	No	$0	$0	$0	$0	$24,000
7	67	4	No	$0	$0	$0	$0	$24,000
8	67	4	No	$0	$0	$0	$0	$24,000
9	67	4	No	$0	$0	$0	$0	$24,000
13	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
14	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
15	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
16	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
17	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
18	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
19	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
20	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
21	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
22	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
23	69	4	No	$0	$0	$0	$0	$24,000
24	69	4	No	$0	$0	$0	$0	$24,000
25	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
26	70	5	No	$1,000	$1,000	$0	$2,000	$26,000
Average	**---**	**---**	**---**	**$571**	**$571**	**$0**	**$1,142**	**$25,143**

Figure 4
Noise Reduction, dB(A)

- The cost per benefited receptor for the feasible noise wall is compared to the average allowable cost per benefited receptor to determine reasonability. The cost of the noise wall is calculated at $25 per square foot of noise wall, detailed in Table 3.

Table 3
CNE 2 Traffic Noise Abatement Results

Wall Length, feet	Wall Height, feet	Total Wall Square Footage	Total Noise Wall Cost	Total Benefited Receptors	Noise Wall Cost Per Benefited Receptor	Allowable Cost Per Benefited Receptor
1,500	12	18,000	$450,000	21	$21,429	$25,143

- Since the noise wall cost per benefited receptor is less than allowable cost per benefited receptor, the noise wall is reasonable to construct – <u>*Reasonability criterion passed.*</u>
- Since the noise wall meets all the feasibility and two of the reasonability criteria, the final reasonableness factor requires the viewpoints of the benefited receptors to be obtained.

Figure 5
Build Noise Level, dB(A)

- ***Viewpoints of Benefited Receptors*** checked last:
  - The feasible and reasonable noise wall being considered for Receptor R2 was presented to the benefited receptors to solicit their viewpoints. The results of the survey are detailed in Table 4.

Table 4
CNE 2 Benefited Receptor Survey Results

R2 Benefited Receptor Number within CNE 2	Share ROW	Voting Points	Vote (Yes/No/NA)	"Yes" Points	"No" Points
3	No	1	NA	---	---
4	No	1	NA	---	---
5	No	1	Yes	1	---
6	No	1	Yes	1	---
7	No	1	No	---	1
8	No	1	NA	---	---
9	No	1	Yes	1	---
13	Yes	2	No	---	2
14	Yes	2	No	---	2
15	Yes	2	No	---	2
16	Yes	2	Yes	2	---
17	Yes	2	Yes	2	---
18	Yes	2	NA	---	---
19	Yes	2	NA	---	---
20	Yes	2	NA	---	---
21	Yes	2	NA	---	---
22	Yes	2	Yes	2	---
23	No	1	NA	---	---
24	No	1	NA	---	---
25	Yes	2	No	---	2
26	Yes	2	Yes	2	---
Total	**12**	**33**	**12/21 voted > 33%**	**11**	**9**

NA = "Not Applicable" since no response was submitted by the benefited receptor

Figure 6
Noise Level Increase, dB(A)

   - Greater than 50% of voted points were in favor of the proposed noise wall – *Viewpoint criterion passed.*

- Since the noise wall being considered for Receptor R2 meets the feasibility, reasonability, and viewpoint solicitation criterion, this proposed noise wall is likely to be implemented as part of the project. Based on this evaluation, the likelihood statement found in Section 6.1 should be included.

Example Project #2

- Identical project to Example #1 – _Noise Analysis Required_

Receptor Selection

- See Example #1.

Noise Level Predictions

- New traffic noise levels for the existing, no-build, and build scenarios were predicted according to the methodology described in Section 3, summarized in Table 1, this time resulting in an impact at both representative receptors R1 and R2.

Table 1
Traffic Noise Prediction Results

Receptor / CNE	Existing Noise Level, dB(A)	No-Build Noise Level, dB(A)	Build Noise Level, dB(A)	Increase from the Existing to Build Scenario, dB(A)	Impact Distinction
R1 / CNE 1	63	64	**75**	12	**Impact**
R2 / CNE 2	65	67	**70**	5	**Impact**

Traffic Noise Impact Identification

- Receptor R1 is an impact as it exceeds the FHWA noise abatement criterion.
- Receptor R2 is an impact as it exceeds the FHWA noise abatement criterion, identical to Example #1.
  - A noise abatement analysis is required.

Figure 1
CNE 1 Receptors

Abatement Analysis

- An abatement analysis was performed for CNE 2 represented by receptor R2 in Example #1.
  - The proposed noise wall for CNE 2 represented by receptor R2 meets the feasibility, reasonability, and viewpoint solicitation criterion, the proposed noise wall is likely to be implemented as part of the project.
- For abatement analysis purposes, the individual receptors for CNE 1 are identified, depicted in Figure 1.
  - Abatement analysis is performed for CNE 1 represented by R1 considering the identified individual receptors.
- ***Feasibility criterion*** checked first:
  - Wall can be built that provides at least a 5 dB(A) traffic noise reduction at an impacted receptor (5 dB(A) at R1) and possible to build – _Feasibility Criterion passed_
- ***Reasonability criterion*** checked next:
  - The receptors identified as benefited (at least a 5 dB(A) traffic

noise reduction) within the CNE must be checked for the optional reasonableness criterion to properly adjust the base value of $24,000 per benefited receptor.

- Wall can be built for R1 that provides at least a 8 dB(A) traffic noise reduction at a benefited receptor (3 benefited receptors of 8 dB(A) or greater) – *Noise Reduction Design Goal passed*
  - Summarized in Figure 2
- For each benefited receptor, the build noise level, increase in traffic noise between the existing and build scenarios, and the dates the homes were built in relation to when the roadway was built must be determined. These factors are defined in Figure 3 and Figure 4 and summarized in Table 2.

Figure 2
Noise Reduction, dB(A)

Table 2
R1 Adjusted Allowable Cost per Benefited Receptor Calculations

Benefited Receptor Number	Build Noise Level, dB(A)	Increase in Noise, Existing to Build, dB(A)	Homes Built Before Roadway, Yes/No	Traffic Noise Factor	Noise Increase Factor	Homes Built Before Roadway Factor	Reasonableness Factors Cost Adjustments	Total Adjusted Allowable Cost per Receptor
7	73	11	Yes	$1,000	$2,000	$5,000	$8,000	$32,000
8	73	11	Yes	$1,000	$2,000	$5,000	$8,000	$32,000
9	73	11	Yes	$1,000	$2,000	$5,000	$8,000	$32,000
10	73	11	Yes	$1,000	$2,000	$5,000	$8,000	$32,000
11	73	11	Yes	$1,000	$2,000	$5,000	$8,000	$32,000
12	73	11	Yes	$1,000	$2,000	$5,000	$8,000	$32,000
18	74	12	No	$1,000	$2,000	$0	$3,000	$27,000
19	75	12	No	$2,000	$2,000	$0	$4,000	$28,000
20	75	12	No	$2,000	$2,000	$0	$4,000	$28,000
21	75	12	No	$2,000	$2,000	$0	$4,000	$28,000
22	74	12	No	$1,000	$2,000	$0	$3,000	$27,000
23	73	11	No	$1,000	$2,000	$0	$3,000	$27,000
24	74	12	Yes	$1,000	$2,000	$5,000	$8,000	$32,000
25	74	12	Yes	$1,000	$2,000	$5,000	$8,000	$32,000
26	75	12	Yes	$2,000	$2,000	$5,000	$9,000	$33,000
27	75	12	Yes	$2,000	$2,000	$5,000	$9,000	$33,000
28	75	12	Yes	$2,000	$2,000	$5,000	$9,000	$33,000
29	75	12	Yes	$2,000	$2,000	$5,000	$9,000	$33,000
30	75	12	Yes	$2,000	$2,000	$5,000	$9,000	$33,000
31	75	12	Yes	$2,000	$2,000	$5,000	$9,000	$33,000
32	75	12	Yes	$2,000	$2,000	$5,000	$9,000	$33,000
Average	---	---	---	**$1,476**	**$2,000**	**$3,571**	**$7,048**	**$31,048**

Figure 3
Build Noise, dB(A)

- The cost per benefited receptor for the feasible noise wall is compared to the average allowable cost per benefited receptor to determine reasonability. The cost of the noise wall is calculated at $25 per square foot of noise wall, detailed in Table 3.

Table 3
R1 Traffic Noise Abatement Results

Wall Length, feet	Wall Height, feet	Total Wall Square Footage	Total Noise Wall Cost	Total Benefited Receptors	Noise Wall Cost Per Benefited Receptor	Allowable Cost Per Benefited Receptor
1,400	19	26,600	$665,000	21	$31,667	$31,048

- Since the noise wall cost per benefited receptor is more than allowable cost per benefited receptor, the noise wall is not reasonable to construct – <u>*Reasonability criterion **failed***</u>

- ***Cumulative Noise Wall Assessment*** checked:
  - Since the noise wall meets the feasibility criteria but fails the reasonability criteria, the noise wall can be analyzed cumulatively with the reasonable and feasible receptor R2 noise wall (detailed in Example #1). This cumulative analysis is detailed in Table 4, below.

Figure 4
Increase in Noise, dB(A)

Table 4
Cumulative Traffic Noise Abatement Results

Receptor / CNE Analyzed	Wall Length, feet	Wall Height, feet	Total Wall Square Footage	Total Noise Wall Cost	Total Benefited Receptors	Noise Wall Cost Per Benefited Receptor	Allowable Cost Per Benefited Receptor	Ratio (Allowable Cost over Actual Cost of Noise Wall)
R2 / CNE 2	1,500	12	18,000	$450,000	21	$21,429	$25,143	0.85
R1 / CNE 1	1,400	19	26,600	$665,000	21	$31,667	$31,048	1.02
Cumulative	**2,900**	**---**	**44,600**	**$1,115,000**	**42**	**$26,548**	**$28,096**	**0.94**

  - Since the cumulative allowable cost per benefited receptor is more than the cumulative noise wall cost per benefited receptor, both noise walls are now reasonable and are likely to be implemented, dependent on the viewpoints of the benefited receptors.

- ***Viewpoints of Benefited Receptors (R1/CNE 1 and R2/CNE 2)*** checked last:
  - The survey for receptor R2/CNE 2 is detailed in Example Project #1. The survey resulted in a noise wall that is likely to be implemented.
  - The feasible and reasonable noise wall for receptor R1/CNE 1 was presented to the benefited receptors to solicit their viewpoints. The results of the survey are detailed in Table 5.

Table 5
R1/CNE 1 Benefited Receptor Survey Results

R1/CNE 1 Benefited Receptor Number	Share ROW	Voting Points	Vote (Yes/No/NA)	"Yes" Points	"No" Points
7	No	1	Yes	1	---
8	No	1	Yes	1	---
9	No	1	NA	---	---
10	No	1	Yes	1	---
11	No	1	Yes	1	---
12	No	1	NA	---	---
18	No	1	NA	---	---
19	Yes	2	NA	---	---
20	Yes	2	No	---	2
21	Yes	2	NA	---	---
22	No	1	NA	---	---
23	No	1	Yes	1	---
24	Yes	2	No	---	2
25	Yes	2	NA	---	---
26	Yes	2	NA	---	---
27	Yes	2	No	---	2
28	Yes	2	NA	---	---
29	Yes	2	NA	---	---
30	Yes	2	NA	---	---
31	Yes	2	NA	---	---
32	Yes	2	NA	---	---
Total	**12**	**33**	**8/21 voted > 33%**	**5**	**6**

NA = "Not Applicable" since no response was submitted by the benefited receptor

  - Over 1/3 of benefited receptors responded
  - Less than 50% of voted points were in favor of the proposed wall – *Viewpoint criterion* ***failed***

- Since the proposed noise wall meets the feasibility and reasonability criterion, except for the viewpoint solicitation criterion, the proposed noise wall ***will not be implemented*** as part of the project.