Indiana Department of Transportation

Traffic Noise Analysis Procedure

2017

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Table of Contents

Introduction

This noise policy is effective July 1, 2017, and supersedes the previous version dated July 13, 2011. The Policy is based on Indiana Department of Transportation (INDOT) application of Federal Highway Administration (FHWA) standards. For more information on the most-recent federal standards, see http://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/index.cfm.

Purpose

This policy describes INDOT's implementation of 23 Code of Federal Regulations (CFR) 772. For situations that fall outside the scope of the policy or represent unusual circumstances, INDOT and the FHWA Indiana Division will coordinate to determine an appropriate resolution. An example of such unusual circumstances would be noise levels which exceed the Noise Abatement Criteria (NAC) by a large margin, possibly meriting abatement beyond what would otherwise be considered cost-effective.

Indiana Definitions

Approach: To be within 1.0 dB(A) of the appropriate noise abatement category. This applies to all of the noise abatement categories which have a noise abatement criteria value.

A-Weighted Sound Level (dB(A)): A measurement of noise energy that models human hearing and frequency sensitivity.

Benefited Receptor: Receptors are considered to be benefited when they receive at a minimum 5.0 dB(A) reduction in the future noise levels.

Cost-Effective: A barrier is determined to be cost-effective if a five decibel (5 dB(A)) reduction in noise levels can be achieved at a cost of no more than $25,000 per benefited receptor and if a majority of the nearby receptors (as defined herein) in a given common noise environment were not constructed prior to the roadway. Using current bid prices, this corresponds to approximately 833 square feet of noise barrier per receptor. The allowed cost is $30,000 per benefited receptor if a majority of the nearby receptors in a common noise environment were constructed prior to the roadway being constructed. This corresponds to approximately 1000 square feet of noise barrier per receptor using recent bid prices.

Common Noise Environment: 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. Common noise environments generally occur between two secondary noise sources, such as interchanges, intersections, cross-roads.

First Row Receptor: The first parcel that exhibits the qualities of a receptor that is directly adjacent to the roadway; there is no set distance requirement. Undeveloped land that is permitted or has a foundation under construction can be a first row receptor.

Impacted Receptor: Is a receptor that's predicted noise levels approach or exceed the noise abatement criteria (NAC) or the predicted traffic noise will substantially exceed the existing noise level.

Level of Service: A measure of congestion along a highway. Level of Service (LOS) ranges from A (congestion-free) to F (severely congested).

Noise-Compatible Planning: Control of development by ordinance or zoning that discourages noise-sensitive development adjacent to known, existing sources of objectionable noise.

Noise Reduction Design Goal: The noise reduction design goal for Indiana is 7dB(A) for a majority (greater than 50%) of the impacted first row receptors.

Permitted: An area is permitted when there is a definite commitment to develop land with an approved specific design of land use activities (as evidenced by the issuance of a building permit). In areas where no zoning or building permit process is in place, land is considered undeveloped unless foundations for new buildings are in place. Undeveloped lands that are permitted have the appropriate activity category and will be analyzed in the same methods as fully developed lands.

Substantial Noise Increase: An increase in noise levels for which the future noise levels exceed the existing noise levels (as predicted by FHWA TNM version 2.5) by 15.0 dB(A).

Applicability

This policy applies to all Type I Federal highway projects (as defined by 23 CFR 772) in the State of Indiana, which encompasses all Federal or Federal-aid Highway Projects authorized under title 23, United States Code, including: any highway project or multimodal project that requires FHWA approval regardless of funding sources; any Federal-aid projects that are administered by INDOT or Local Public Agencies (LPAs); and any projects on roadways leased from the State of Indiana to the private sector. It is also applicable to Type I projects on roadways that are part of the Interstate System. If this policy is used in any part for a non-Federal action projects, it must be used in its entirety. INDOT will reanalyze this policy on a regular basis, not to exceed a period of 5 years. A re-evaluation date will be added on the cover page of this policy when it is reanalyzed.

Traffic Noise Prediction

All future references to FHWA TNM refer to the program itself. All references to "traffic noise model" refer to the model created for a specific project.

Ambient Noise Measurements

For a general explanation of procedures for measuring ambient noise measurements, please see FHWA's guidance document titled "Measurement of Highway-Related Noise". Procedures specific to Indiana are described below.

Ambient noise measurements are not required at each receptor location. Instead, a representative sample of ambient noise measurements can be taken within the project area, with a minimum of one measurement for each common noise environment. During each noise measurement, all major sources of traffic noise in the project area should be taken into account.

For each ambient noise measurement taken, the noise analyst will validate the traffic noise model. To analyze this, the traffic counts from the noise measurement will be converted to an equivalent hourly rate for entry into the model. If this results in a noise output for the relevant receptor that is within 3 dB(A) of what is measured in the field, the noise model is considered valid for that ambient noise measurement. If all of the ambient measurements are within 3 dB(A) of the predicted value, the entire model is considered valid. If a noise measurement is not within 3 dB(A), the analyst will reevaluate the noise inputs to make certain the appropriate noise model components have been inputted. If the discrepancy is determined to not be due to data entry errors, the potential for external noise sources should be evaluated. If an external (non-roadway) noise source is identified, the traffic model should be adjusted based on the best estimate of the noise analyst of the influence of the external noise. Validation is not required if there are no dominant roadway noise sources within 800 feet of the ambient measurement location for a new alignment project.

Worst Traffic Noise Impact

For existing roadways, the worst (noisiest) traffic hour will be used for the analysis of existing and future conditions. The noisiest traffic hour will generally be the Design Hourly Volume (DHV). However, if the traffic-flow during the future DHV will not be above a Level of Service (LOS) D, an equivalent traffic volume that would produce a LOS C should be used.

Analysis of Traffic Noise Impacts

Every noise analysis completed will contain information on how traffic noise impacts are identified, the identification of noise sensitive areas and receptors, the identification of impacted receptors, and noise contours for undeveloped areas. The noise analysis will also contain an evaluation of noise abatement measures. The noise analyst will provide recommendations on the feasibility and/or reasonableness of potential noise abatement measures. The recommendations will be presented in the noise analysis and the statement of likelihood will be provided in the NEPA documentation.

Identification of Noise Sensitive Areas and Receptors

If a project is identified as Type I, the next step is to identify the area(s) with potential for noise impacts, the associated land uses in each area, the receptors of noise in each area, and the applicable NAC for each receptor identified. All receptors must be identified within 500 feet from each reasonable alternative (edge of the outside travel lane) identified in the NEPA evaluation. If during the identification of impacted receptors, it is shown that receptors are being impacted at 500 feet, the corridor of study will be extended to 800 feet from each reasonable alternative (edge of the outside travel lane). Noise analysis will not be conducted beyond 800 feet, as the model has not been demonstrated to be accurate beyond that distance.

Once identified, receptors are classified by land use and the appropriate Activity Category identified per the NAC (see Table 1 of Part 772). Under most situations, a single structure is considered a single receptor. Structures that contain multiple residential units (e.g. hotels, apartments) are considered to have one receptor per residential unit. For certain land uses (parks, trails, etc.), a separate algorithm (shown below) is used to translate usage data into an appropriate number of receptors, based on converting total usage to equivalent residential units. The number of average daily users is divided by the average number of people per household in Indiana (2.52 in 2010, the most recent census data available). If there are minor variations to this algorithm, the logic behind the change should be discussed with INDOT and explained in the noise analysis.

The placement of receptors is dependent on the type of receptors identified. For example for a single residence the receptor would be located at the outdoor common use area such as a deck or patio. For exterior non-residential receptors, placement of receptors would be at common use areas such as tables, benches, bleachers, pools, and others; for a linear feature such as a trail, receptors would be modeled at equal distances along the trail. For interior non-residential receptors, modifications to the algorithms below would be coordinated with FHWA, receptor placement would likely be distributed evenly throughout rooms within the building.

$$\frac{\text{Daily number of users}}{\text{2.52 people on average per household}} \times \text{Percentage of property within 500 feet} = \text{Number of receptors (rounded up)}$$

Example 1: A portion of a park is within 500 feet of a Type I project. The total area of the park is 42 acres with 6.3 acres within 500 feet of the project. The park is used by 70 people every day. Using the algorithm above you have the following filled in formula:

$$\frac{\text{70 users per day}}{\text{2.52 people on average per family}} \times \text{15\% within 500 feet} = \text{4.17 receptors (5 when rounded up)}$$

Example 2: A portion of a trail is within 500 feet of a Type I project. The total length of the trail is 15 miles with 1000 feet within the project. The total number of daily users is known for each 3-mile segment. The 3-mile segment within the project limits is used by 685 people per day.

$$\frac{\text{685 users per day}}{\text{2.52 people on average per family}} \times \frac{\text{1000 feet of trail within 500 feet}}{\text{15,840 length of the three-mile segment}} = \text{17.16 receptors (18 when rounded up)}$$

Determining Existing (Current) and Future Noise Levels

Each lane should be modeled as a separate roadway. All identified receptors should be modeled as discussed above. Terrain features, ground zones, building rows, berms, and barriers should be modeled as appropriate to the existing geometry. Trees and other dense vegetation should not be modeled unless the vegetation is evergreen and completely blocks all lines of sight to the roadway. For additional input guidance, refer to the FHWA TNM 2.5 FAQ. Fences, unless built specifically for noise abatement (structurally capable of absorbing or reflecting noise), should not be modeled. Changes to this methodology must be approved by INDOT Environmental Services Division.

For projects on new alignments, the existing traffic noise is determined from ambient noise measurements. For projects on existing alignments, the existing noise levels are determined from the noise model output of the noise model that shows the current conditions. If the noise from the ambient noise measurements is not completely traffic related, the influence from non-roadway sources (such as railroads, airports, and manufacturing plants) will be included to the traffic noise model output to determine the existing noise levels.

Future traffic noise levels are determined only from a future model using the most current approved FHWA TNM. Input data should reflect the future roadway alignment and traffic data. The non-roadway inputs from the existing model should remain the same as the existing noise model. Traffic noise impacts (or defined as impacted receptors) occur when predicted noise levels approach or exceed the NAC or the predicted traffic noise will substantially exceed the existing noise level. The term “approach or exceed” is in reference to future levels that are equal to or greater than 1 dB(A) below the appropriate NAC category. The term “substantially exceeds” applies to predicted traffic noise levels that exceed existing noise levels by 15 dB(A). If traffic noise impacts are identified in the noise analysis, noise abatement measures must be considered.

Analysis of Noise Abatement

Consideration of Noise Abatement Measures

Due to limitations on INDOT's ability to acquire property for mitigation or to mitigate sites off of State right-of-way, the most common form of abatement is the construction of noise barriers. Other forms of abatement will be evaluated on a case-by-case basis. INDOT will choose the most feasible and reasonable form of abatement.

Policy on use of Absorptive Noise Barriers

In most circumstances INDOT requires the usage of noise barriers which, at a minimum, are designed to absorb noise on the roadway-facing side. Reflective noise barriers (non-absorptive) may be allowed on structures, in areas where there are noise barriers on both sides of the road, or in areas where there are no Category A, Category B and Category C receptors on the other side of the roadway from the proposed barrier. If absorptive barriers are planned, the traffic noise model must be evaluated with the noise reduction coefficient (NRC) of 0.70 on the roadway side.

Consideration of Noise Abatement Measures for Non-Residential Receptors

Noise abatement measures are considered for non-residential receptors as well as residences. In determining whether noise abatement measures are reasonable, it is the opinion of the property owner (private or government entity that has jurisdiction) that determines the consideration. If a government entity has jurisdiction, the opinion will be requested from the head of the appropriate department.

Feasibility of Noise Abatement

Acoustic Feasibility: INDOT requires that noise barriers achieve a 5dB(A) reduction at a majority (greater than 50%) of the impacted receptors. If a barrier cannot achieve this acoustic goal, abatement is considered to not be acoustically feasible.

Engineering Feasibility: INDOT requires noise abatement measures to be based on sound engineering practices and standards and requires that any measures be evaluated at the optimum location. For instances in which the roadway is located on fill and is at a higher location than nearby receptors, a barrier will be evaluated near the shoulder. For instances in which the roadway is located below the nearby receptors, a barrier will be evaluated

near the edge of the right-of-way near the receptors. In addition, noise barriers require long, uninterrupted segments of barrier to be feasible. If there are existing access points and/or driveways, it is typically not feasible to construct effective noise barriers for the roadway due to sight distance and access. However, in some cases, changing access points in project design may improve safety and decrease conflicts resulting in noise abatement being feasible.

Engineering feasibility also takes into account topography, drainage, safety, barrier height, utilities, and access/maintenance needs (which may include right-of-way considerations). In situations where engineering considerations make noise barriers not feasible, the noise analysis will explicitly state the reasons (topography, drainage, safety, etc.).

Reasonableness of Noise Abatement Measures

Consideration and Obtaining Views of Residents and Property Owners

All communication with the public regarding the potential for noise abatement must be coordinated with INDOT's Office of Public Involvement.

If a public hearing is required per the INDOT Public Involvement Manual, the following steps will be taken:

A survey will be mailed to each benefited resident. If the property owner is different from the current resident, both the resident and the property owners are surveyed. The concerns and opinions of the property owner and the unit occupants will be balanced with other considerations in determining whether a barrier is appropriate for a given location.

This survey will include a pre-stamped, self-addressed return postcard, a brief project description of the project and barrier locations under consideration. It will also include a pamphlet on the basics of traffic noise. The decision making process (described below) and pertinent information on the upcoming public hearing will be provided. The survey can be returned via mail or returned in person at the public hearing. All responses expressing opinions for or against barriers must be expressed in writing to INDOT, by letter, email or the response postcard. Extra surveys will be available at the hearing if any are lost or misplaced.

If a public hearing is not required per the INDOT Public Involvement Manual, a survey will be mailed as described above. It will include a set deadline for return of the survey. If the total respondents to the survey do not total a majority (more than 50%) of the benefited receptors and affected property owners, then a second survey will be mailed out to solicit the views of those who did not respond. If a majority of benefited receptors still do not respond, no third survey is required. FHWA and INDOT Project Management will discuss the results of the surveys and determine the next course of action if a majority of benefited receptors do not respond. Failure to respond to the survey by the benefited receptor will not be assumed to count either for or against noise abatement.

Consideration of noise barriers can cause conflicts in mixed-use developments, as barriers to protect residences may block line of sight to adjacent businesses. If a barrier is proposed directly adjacent to the property line of a business, the business will be solicited for input to determine whether they have any concerns about line of sight. If a mutually satisfactory compromise cannot be reached between business(es) and residences, barriers may be terminated at the property line dividing the two areas. These conflicts can be minimized by noise-compatible planning (see coordination with local government officials).

Cost-Effectiveness

To determine cost effectiveness, the estimated cost of constructing a noise barrier (including installation and additional necessary construction such as foundations or guardrails) will be divided by the number of benefited receptors (those who would receive a reduction of at least 5 dB(A)). A base material and design cost of $25,000 or less per benefited receptor is currently considered to be cost-effective. Development in which a majority (more than 50%) of the receptors was in place prior to the initial construction of the roadway in its current state (functional classification) will receive additional consideration for noise abatement. The cost-effectiveness criteria used for these cases will be 20% greater (currently $30,000 per benefited receptor). INDOT is currently evaluating

other methods of addressing complaints about traffic noise beyond traditional noise barriers. If this study identifies viable alternatives to barriers, the policy will be amended to provide additional flexibility accordingly.

Placing noise barriers on structures creates additional challenges, since reinforcement of the structure may be necessary to support the increased load. In these situations, other options should be assessed to determine whether cost-effective abatement can be provided without requiring complicated and expensive structural modifications. These could include lighter-weight barriers, shorter barriers, or other considerations. Any variations will be evaluated in coordination between the FHWA division office and INDOT's Divisions of Structural Services, Environmental Services and Construction Management.

INDOT Design Goal for Noise Abatement

INDOT's goal for substantial noise reduction is to provide at least a 7.0 dB(A) reduction for benefited first row receptors in the design year. However, conflicts with adjacent lands may make it impossible to achieve substantial noise reduction at all benefited first row receptors. Therefore, the noise reduction design goal for Indiana is 7dB(A) for a majority (greater than 50%) of the benefited first row receptors.

Collection and Reporting of Constructed Noise Barrier Data

A spreadsheet of noise barriers that have been constructed can be found on the FHWA Webpage at https://www.fhwa.dot.gov/environment/noise/noise_barriers/inventory/

Documentation of Noise Analysis Results

The environmental document will identify locations where noise impacts are predicted to occur, where noise abatement is feasible and reasonable, and locations with impacts that have no feasible or reasonable noise abatement alternatives. Additionally, the environmental document will document future noise levels on undeveloped land presented as contours and/or by typical noise level cross-section. This information will be complete to the extent that design information on the alternative(s) (under study in the environmental document) is available at the time the study is completed. Projects may eventually have a narrower scope, updated survey information, or another project change that affects the future noise environment. As such, noise abatement during the NEPA stage is not an absolute commitment by INDOT. All Type I projects will undertake a re-evaluation of the noise analysis and noise models once design of the roadway project has progressed to a near final stage to determine if noise abatement still meets the feasibility and reasonability standards set forth in this policy. Additional public involvement will be completed as necessary.

Statement of Likelihood

Type I projects for which abatement is proposed will include the following statement in the noise remarks of the NEPA document and in the conclusion of the noise analysis. Information in italics must be provided for each common noise environment:

> "Based on the studies completed to date, the State of Indiana has identified (*number*) impacted receptors and has determined that noise abatement is likely, but not guaranteed, at (*number*) locations. Noise abatement at these locations is based upon preliminary design costs and design criteria. Noise abatement in these locations at this time has been estimated to cost (*Total Cost for Each Common Noise Environment*) and will reduce the noise level by a minimum of 7 dB(A) at a majority of the identified impacted receptors. A re-evaluation of the noise analysis will occur during final design. If during final design it has been determined that conditions have changed such that noise abatement is not feasible and reasonable, the abatement measures might not be provided. The final decision on the installation of any abatement measure(s) will be made upon the completion of the project's final design and the public involvement processes.
>
> The viewpoints of the benefited residents and property owners were sought and were considered in determining the reasonableness of highway traffic noise abatement measures for proposed highway construction projects. INDOT will incorporate highway traffic noise consideration in on-going activities for public involvement in the highway program."

For all Type I projects where noise impacts have been identified but noise abatement is not proposed, the following text should be included in the NEPA document and the noise analysis:

> "Based on the studies thus far accomplished, the State of Indiana has not identified any locations where noise abatement is likely. Noise abatement measures that were studied at these locations were based upon preliminary design costs and design criteria. Noise abatement has not been found to be (*feasible and/or reasonable*) based on (*insert reason*). A re-evaluation of the noise analysis will occur during final design. If during final design it has been determined that conditions have changed such that noise abatement is feasible and reasonable, the abatement measures might be provided. The final decision on the installation of any abatement measure(s) will be made upon the completion of the project's final design and the public involvement processes.
>
> The viewpoints of the benefited residents and property owners are a major consideration in determining the reasonableness of highway traffic noise abatement measures for proposed highway construction projects. These viewpoints have been determined and addressed during the environmental phase of project development. The will and desires of the public are an important factor in dealing with the overall problems of highway traffic noise. INDOT will incorporate highway traffic noise consideration in on-going activities for public involvement in the highway program, i.e., and will reexamine the residents' and property owners' views on the desirability and acceptability of abatement during project development."

Third-Party Funding

When desired, third-party entities (such as local government entities or neighborhood associations) may contribute towards the cost of noise barriers if special aesthetic treatments or functional enhancements are desired beyond the basic textures or colors or features offered by INDOT. All third-party funding must be directed through the local government entities. Third-party funding cannot be used to determine feasibility and reasonableness of noise barriers.

Information for Local Government Officials

INDOT will include the best estimate of future noise levels on undeveloped land in the noise study as well as the environmental document. Upon completion of the environmental document phase, the noise study will be provided directly to the county's planning unit. If the project is located in a municipality that has a planning unit, a noise study will also be provided to the municipality's planning unit.

Outreach to Local Government Officials on Noise-Compatible Land Use Planning

INDOT understands that it is in a unique position to provide outreach to local government and county planning units. INDOT also understands that it is the local government or county that has the power to regulate land development. INDOT is willing to help the local government by providing expert guidance on noise-related issues. This can include recommendations on setbacks, how to interpret noise studies that have been provided for FHWA projects, and other general noise concerns so that noise impacts are minimized for areas that are being developed.

Construction Noise

In addition to noise from traffic, construction activities themselves can produce increased noise of a temporary nature. INDOT will be sensitive to local needs and may make adjustments to work practices in order to reduce inconvenience to the public.

Type II Program

INDOT as a highway agency has not chosen to implement a Type II program to construct noise barriers independently of added-capacity projects.

Removal of Noise Barriers

If a party wishes to have an existing noise barrier removed (or partially removed), they must demonstrate that protection of receptors will not be compromised by removal of the barrier or barrier segment(s). This demonstration may either be through conducting a noise analysis (coordinated with INDOT, at the requestor's cost) or by demonstrating that noise-sensitive receptors are no longer present in the area that is being protected. Removal of any barriers will also be at the cost of the requestor. If barriers are to be removed, then INDOT and the affected party must coordinate to ensure that removal is conducted in a safe manner.

References

23 CFR 772 (2010). "Procedures for Abatement of Highway Traffic Noise and Construction Noise." Accessed April 7, 2017. http://edocket.access.gpo.gov/2010/pdf/2010-15848.pdf

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