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3.10 NOISE IMPACTS

3.10.1 Introduction

The Mid-States Corridor project will include construction of a combination of new/upgraded multi-county transportation facility from the Ohio River north to I-69. The construction of a new facility, whether on new alignment or utilizing an upgrade of an existing facility, will include changes in access and impacts to local communities. A facility of this type will alter the existing travel patterns and decrease overall travel times in the study area, while potentially increasing some trip times depending on location and final access changes.

Transportation-related noise impacts are a growing concern. The transportation system within the State of Indiana continues to grow and expand to meet the economic and social needs of the State. As the population grows and economic development continues, the transportation system expands and the traffic volumes increase. The communities adjacent to these facilities will continue to be subjected to higher levels of highway-related noise. The increase in levels of highway-related noise is an environmental concern, especially in high density urban settings and outlying urban/suburban areas where large numbers of residential properties along high volume Interstates and highways are routinely affected.

The Indiana Department of Transportation (INDOT) Traffic Noise Analysis Procedure (July 1, 2017) (“Procedure”) was utilized for the noise analysis. The analysis addresses the intents of this policy, as appropriate for a Tier 1 Environmental Impact Statement (EIS). The Procedure is INDOT’s application of Federal Highway Administration (FHWA) highway traffic and construction noise regulations. The Procedure incorporates application of FHWA standards under 23 Code of Federal Regulations (CFR) Part 772 “Procedures for Abatement of Highway Traffic Noise and Construction Noise.” FHWA recognizes the potential for such adverse off-site effects associated with Type I projects. The Mid-States Corridor qualifies as a Type I project because it: (1) proposes to either construct a highway on a new location or (2) significantly changes the vertical or horizontal alignment and/or number of through-traffic lanes of an existing highway. The INDOT/FHWA policy analyzes noise impacts, as well as reasonable and feasible mitigation, for projects with a defined location and right-of-way.

3.10.2 INDOT Noise Procedures

The FHWA requires that all state departments of transportation have an approved policy to identify and address highway traffic noise impacts. The INDOT Traffic Noise Procedure was developed to implement the requirements of 23 CFR 772 Procedures for Abatement of Highway Traffic Noise and Construction Noise and the noise-related requirements of the National Environmental Policy Act of 1969 and became effective July 1, 2017. The structure of the policy is based on FHWA’s “Highway Traffic Noise Analysis and Abatement: Policy and Guidance” (USDOT, December 2011) and focuses on seven principal elements briefly explained below.

- Definition of impact criteria and identification of noise-sensitive land uses
- Determination of existing noise levels
- Prediction of future traffic noise levels
- Identification of traffic noise impacts
- Identification and consideration of abatement
- Construction noise
- Coordination with local government officials



The Tier 1 EIS assessment addresses these elements at a level as appropriate for a Tier 1 EIS. It allows for a basic comparison of noise impacts of alternatives to the extent appropriate at a Tier 1 EIS level. The subsequent Tier 2 NEPA study will implement the INDOT Traffic Noise Procedure impacts with regards to site specific impacts. The intent of this Tier 1 assessment is to address the primary elements to assist with the selection of a preferred alternative.

3.10.3 Methodology

Typically, a highway noise study is designed to quantitatively analyze specific areas for noise impacts along one or more proposed alternatives, each of which possess a clearly defined alignment with known horizontal and vertical geometry and the occupied areas adjacent to the proposed roadway. The goal of the Tier 1 EIS study is to select a corridor to move forward to a Tier 2 EIS study. This noise analysis has been undertaken at a level appropriate to compare working alignments between alternatives. The Tier 2 NEPA noise analyses will further evaluate noise impacts by specifically identifying noise receptors of potential noise mitigation.

For the purposes of assessing potential highway noise impacts sound levels are usually measured and expressed in decibels (dB). The decibel scale is logarithmic and expresses the ratio of the sound pressure unit being measured to a standard reference level. Most sounds heard in the environment do not consist of a single frequency, but rather a broad band of frequencies differing in intensities. The intensities of each frequency accumulate to generate the overall sound level. The method commonly used to quantify environmental sounds consists of evaluating all of the frequencies of a sound according to a weighing system with respect to human impacts. This weighting system reflects that human hearing is less sensitive at low frequencies and at extremely high frequencies than at the mid-range frequencies. This is called “A” weighting, and the decibel level measured is called the A-weighted sound level (dB(A)). The system of “A” weighting most closely represents the response of the human ear to sound comprised of differing frequencies.

Noise is generally defined as unwanted or annoying sound. Noise sensitive receptors are locations that may be subject to interference from noise. Although the A-weighted noise level may adequately indicate the level of environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise includes a combination of noise from distant sources, creating a relatively steady background noise in which no particular source is identifiable. To smooth out the short-term peaks in traffic noise, a statistical noise descriptor called the equivalent hourly sound level (Leq (h)) is commonly used. The Leq (h) describes a noise sensitive receptor’s cumulative exposure from all noise-producing events spread out evenly over a one-hour period.

A Technical Memorandum (Memo) was developed to set parameters used for the evaluation of noise impacts and comparison of those impacts by alternative for a Tier I level study for the Mid-States Corridor project. **See Appendix JJ – Noise Analysis Appendix** for a copy of the Memo.

The Memo describes how the intent of the INDOT Traffic Noise Procedure is addressed. A highway noise impact analysis will be conducted that is both accurate and at the level needed to meet the object of the noise evaluation, without all details required in a formal noise analysis. This comparison of alternative noise impacts is appropriate for a Tier I EIS.

The purpose of the Tier 1 EIS noise impact analysis is to provide data to inform alternative selection, as such noise analyses have been undertaken at a level appropriate to compare alternatives. The analysis will be accurate and can be used for comparison of noise impacts between alternatives but will not satisfy requirements of typical INDOT noise analysis. The subsequent Tier 2 NEPA study will have an approved alignment and will implement INDOT’s noise policy with regards to site-specific impacts in more detail.



The detailed Tier 2 studies may result in conclusions dissimilar to the findings of this Tier 1 assessment. Variability in the Tier 2 analysis is possible if the alignments change to avoid significant resources such as Section 106 resources and wildlife.

The Tier 1 Level noise analysis was performed using the FHWA Traffic Noise Model (TNM) Version 2.5 software to predict noise impacts in the vicinity of highways. The model spatially simulates the 3-D geometry of the proposed roadway and receptor location relative to the roadway, and accepts variable input concerning traffic volume, vehicle speed, vehicle composition (cars, trucks, etc.) and surrounding landscape cover. Although the Tier 1 EIS alternatives lack specific design detail, the TNM 2.5 model was utilized to perform a generic analysis to predict noise levels along the proposed alignments.

The Mid-States Corridor Tier 1 noise analysis included a straight-line TNM 2.5 model for every alignment, disregarding the vertical component of the roadway and terrain and using assigned traffic volumes and truck percentages. Available traffic data and Average Daily Traffic (ADT) truck percentages were used to obtain hourly heavy and medium truck volumes. Other assumptions included:

- No terrain lines, ground zones, tree zones or building rows
- Simple distance speed, traffic volume and traffic distance
- Using GIS points for receptor locations
- Limiting receptor classification to Category B and C NAC sites
- Peak hour and daily traffic volumes from traffic model split by cars and truck

The model was constructed to represent the typical section of the proposed roadway and utilized receptors placed at 25-foot intervals perpendicular to the roadway. The results of the model were then used to identify the distance from the edge of pavement where the model predicts future sound levels of 66 dB(A) Leq. Once the distance to the 66 dB(A) level was found for each segment along the working alignment, an ArcGIS shapefile was created demonstrating this buffer around the working alignment. All properties within that limit were then identified as potential impacts for the alternative.

Impacts are evaluated on how many receptors are impacted per alignment and the number of anticipated impacted receptors along each alignment. Focus will be on the areas with concentrated impacts instead of isolated and small clusters. Potential mitigation for a Tier 1 type analysis will compare the relative potential of alternatives to require abatement. These locations are confined to residential areas where professional judgment, landscape terrain and aerial photos were used to identify locations where noise abatement potentially would be needed. Subsequent detailed Tier 2 studies may conclude that some of these areas do not meet the feasible and reasonableness criteria for noise barrier wall abatement and/or may reveal other areas not identified that do meet the requirements. There are limitations on the proposed Tier 1 noise analysis procedures, but this approach is considered sufficient for impact comparison between alternatives.

Locations where the proposed roadway would constitute an encroachment adjacent to developed areas involving human occupation were identified. There are five Activity Categories which classify land use and define impact thresholds for assessing noise impacts and potential noise abatement. Each Activity Category has a corresponding Noise Abatement Criteria (NAC) and an Hourly A-Weighted Sound Level criteria in Decibels (dB(A)). **Table 3.10-1** describes each category.



Table 3.10-1: FHWA Noise Abatement Criteria		
Activity Category	Activity NAC Leq(h)	Activity Description
A	57 dBA (exterior)	Land on which serenity and quiet are of extraordinary significance and serve an important public need. The preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 dBA (exterior)	Residential
C	67 dBA (exterior)	Active sport areas, amphitheatres, 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 dBA (interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools and television studios
E	72 dBA (exterior)	Hotels, motels, offices, restaurants/bars and other developed lands, properties or activities not included in Category A-D

Table 3.10-1: FHWA Noise Abatement Criteria

The roadway set-up in the TNM model was based on the typical cross-section for the Super-2 and expressway alternatives. With such a basic analysis the following data input variables and general conditions were assumed and incorporated into the model:

- Flat terrain
- Receptors vertically situated at-grade with the roadways
- Balanced bi-directional traffic volumes (i.e., northbound = southbound)
- All traffic volumes and percent trucks calculated via values from the traffic shapefile
- Design Hourly Volume (DHV) and percent trucks generated by variables produced from the traffic shapefile. A new TNM run created whenever these values changed along the alternative.
- All vehicle speeds = 60 mph (free flow speed) for Super-2 alternatives, 66 mph (free flow speed) for expressway alternatives
- Default ground type = lawn
- Relative humidity = 50 percent
- Temperature = 68 F

Buffers were created to correspond to the TNM results for 66 dB(A). At this noise level, land uses that are categorized as Activity Category B and C are considered approaching the Noise Abatement Criteria (NAC), and therefore are an impacted receptor. The TNM model included receptors at 25-foot intervals from 50 to 500 feet from the edge of pavement. The results were then adjusted to determine the distance from the centerline at which noise impacts are anticipated.

The 66 dB(A) Leq(h) buffer was then used to identify impacted receptors for each alternative and each proposed roadway template. This screening method was conducted to only determine NAC impacts; therefore, there may be additional impacts due to substantial increases, an increase of 15 dB(A), from the existing noise level. All NAC Category B and C properties within that 66 dB(A) limit were identified as potentially impacted.



3.10.4 Analysis

Typically, the risk of noise impacts from any of the study alternatives will increase in situations where the facility encroaches upon land in which higher densities of human occupation occur. As with most highway projects of this size and nature, single family residences will be the primary receptor class of concern with regards to NAC impact and the potential for abatement. In instances where alignments pass through or are adjacent to urban and suburban settings, the possibility of exterior and/or interior noise impacts at parks, playgrounds, picnic areas, apartments, motels/hotels, libraries, hospitals and office buildings becomes more evident.

With new alignment alternatives, the location of the alignment within the corridor will be critical in determining which receptors are adversely impacted by highway noise. A simple shift in alignment of a few hundred feet or so away from a densely populated neighborhood may be all that is required to abate a potential noise impact. In other cases, it will become necessary to evaluate the cost effectiveness of noise barrier walls to attenuate noise levels at a cluster of sensitive receptors. Each of the proposed alternatives have some portion of their alignment traversing through remote rural areas. New alignment through such areas could result in “substantial” (>15 dBA) increases over existing ambient levels.

Potential noise impacts for each alternative working alignment were determined by the number of receptor sites within the predicted Category B NAC zone. The Category B NAC was selected because it is routinely used to assess exterior impacts at residential properties, the most common activity category encountered. In general, the risk of noise impacts from any of the study alternatives naturally increases in situations where the facility encroaches upon land in which higher densities of human occupation occur.

The 12-county Study Area is in a primarily rural area of Southern Indiana; however, potential noise impacts were limited to Daviess, Dubois, Lawrence, Martin, and Orange counties. Due to the rural setting, potential receptor locations were spread out with sparse density of houses. All properties impacted are identified by alternative and county and are summarized in **Table 3.10-2**. A series of local improvements have been incorporated into each alternative. A total of 18 have been developed; however, the number associated with each alternative varies. These local improvements consist mostly of added travel lanes that are intended to reduce congestion and improve the performance of the existing roadways during and after the construction of the Mid-States Corridor project. The impacts from the local improvements are addressed further in **Appendix JJ**.

Impacted Receptors By Alternative												
COUNTY	B2	B3	C2	C3	M2	M3	O2	O3	P2Ew	P3Ew	P2Ee	P3Ee
Daviess	12	10	7	5	0	0	0	0	7	6	5	4
Dubois	43	43	47	46	55	54	67	66	53	53	53	53
Greene	0	0	0	0	0	0	0	0	2	2	2	2
Lawrence	0	0	0	0	8	6	1	1	0	0	0	0
Martin	0	0	0	0	11	12	0	0	15	13	11	10
Orange	0	0	0	0	0	0	14	13	0	0	0	0
Pike	5	5	0	0	0	0	0	0	0	0	0	0
Total	60	58	54	51	74	72	82	80	77	74	71	69

Table 3.10-2: Noise Impacts by Alternative



Alternative B

The Alternative B variations include the expressway Alternative B2 and Super-2 Alternative B3, each including Local Improvements 1 through 3 and 10 through 12. Both variations follow the same route. This alternative primarily is situated in agricultural lands and avoids penetrating larger communities. Alternative B2 has a total of 60 impacted receptor locations within Dubois, Daviess and Pike counties. Alternative B3 has a total of 58 impacted receptor locations within Dubois, Daviess and Pike counties.

Alternative C

The Alternative C variations include expressway Alternative C2 and the Super-2 Alternative C3, each including Local Improvements 1 through 5. The Super-2 and expressway variations follow the same route. This alternative primarily is situated in agricultural and forested lands and avoids penetrating larger communities. Alternative C2 has a total of 54 impacted receptor locations within Dubois and Daviess counties. Alternative C3 has a total of 51 impacted receptor locations within Dubois and Daviess counties.

Alternative M

The Alternative M variations include expressway Alternative M2 and Super-2 alternative M3, each including Local Improvements 1 through 7, 13 and 1). The Super-2 and expressway variations follow the same route. This alternative primarily is situated in agricultural and forested lands and avoids larger communities. These variations have a range of 72-74 impacted receptor locations within Dubois, Lawrence and Martin counties.

Alternative O

The Alternative O variations include expressway Alternative O2 and Super-2 Alternative O3, each including Local Improvements 1 through 5 and 15 through 18. The Super-2 and expressway variations follow the same route. This alternative primarily is situated in agricultural and forested lands and avoids larger communities. These variations have a range of 80-82 impacted receptor locations within Dubois, Lawrence and Orange counties.

Alternative P

Alternative P includes four different variations. These include an expressway Alternative P2 and Super-2 Alternative P3. Each has an east and west bypass of Loogootee. All variations include Local Improvements 1 through 9. This alternative is primarily situated in agricultural and forested lands and avoids larger communities. Because of the number of variations, this alternative has a wider range of impacts. A range of 69-77 impacted receptor locations were identified within Daviess, Dubois, Greene and Martin counties (with the eastern Loogootee bypass producing fewer impacts).

Overall, the range of impacted receptors was consistent for the M, O, and P expressway and Super-2 Alternatives. Alternative B had a similar number of impacted receptors between the expressway and Super-2 alternatives, but it had as much as 27 percent fewer impacted receptors than Alternatives M, O and P. Alternative C had a similar number of impacted receptors for the expressway and Super-2 variations. Impacted receptors were as much as 38 percent fewer than Alternatives M, O and P, and as much as 15 percent fewer than Alternative C. Dubois County had substantially higher numbers of impacted receptors for each alternative compared to other counties. A detailed description of alternatives and figures for impacted receptors per alternate are listed in **Appendix JJ**.



3.10.5 Noise Effects on Wildlife

Wildlife exposure to acute and or chronic noise can result in physiological changes or behavioral responses depending on the particular species and the characteristics of the exposure. These characteristics include sound frequency, duration, intensity and pattern of exposure. Elevated noise levels can impact the health and well-being of wildlife. Animals use sound for a variety of reasons, including to navigate, find food, attract mates, and avoid predators. Noise makes it difficult for them to accomplish these tasks, which affects their ability survive. Wildlife exposure to acute and/or chronic noise can result in physiological changes or behavioral responses depending on the particular species and the characteristics of the exposure, including sound frequency, duration, intensity, pattern of exposure, etc.

Hearing loss in a species could result in its inability to locate prey, loss of capability to detect and avoid predators or hearing distress or warning calls, loss of ability to hear mating signals and the inability of a mother to recognize the cries of its young (Francis and Barber, 2013). Chronic, moderate noise level exposure may result in minor hearing loss or influence processes that are hormonally regulated due to noise-induced stress responses (Francis and Barber, 2013). Even in the absence of hearing loss, frequency dependent signal-masking by introduced man-made noise sources also has the potential to affect a species' ability to perform the previously mentioned functions.

Wildlife has additional non-auditory physiological responses linked to noise exposure. These include increased heart rate, changes in metabolism and greater use of energy reserves, changes in biochemical blood levels, ion concentrations in urine and hormone balance shifts. These can affect an animal's ability to withstand additional stress and/or result in mating and reproduction dysfunction threatening propagation of the population (Francis and Barber, 2013). Highway noise intrusions within specific habitats can locally influence species distribution patterns. In most instances, sensitive species will simply avoid or abandon previously occupied suitable habitats when occasional noise, such as sonic booms, or persistent noise, such as highway traffic, is introduced. Previous studies have shown significant reductions in breeding bird densities within 250 meters of a road due to a reduction in habitat quality resulting from highway noise (McGregor, 2000). It has also been shown that highway noise can interfere with the acoustic-linked mating systems of certain frogs and toads (Barrass, 1993).

Because each species' reaction and degree of severity to noise stimulation is unique, a general assessment of the impacts to wildlife due to traffic noise from the various Mid-States alignments will vary. Some of the proposed alternatives would introduce highway noise into habitats currently not subjected to sound stimuli, which could potentially induce stress or interfere with communication and detection mechanisms of local wildlife.

Growth in roadway networks can result in chronic noise exposure in most terrestrial areas, including wilderness sites. Excessive noise can be annoying to animals, but it can also affect their ability to survive. Communication, mating behavior, hunting and survival instincts of animals are altered by excessive noise. Increased noise levels reduce the distance and area over which acoustic signals can be perceived by animals. There can be substantial changes in foraging and anti-predator behavior, reproductive success, density and community structure in response to noise. Some birds can respond to elevated noise levels by altering the frequency structure of their songs. Traffic noise can affect an animal's physiology and behavior, and if it becomes a chronic stress, noise can be injurious to an animal's energy budget, reproductive success and long-term survival. Animals that have developed high sensitivity hearing to hunt, mate and survive cannot function where high levels of noise interfere with their senses.

Because each species reaction and degree of severity to noise stimulation is unique, a general assessment of the impacts to wildlife due to traffic noise from the Mid-States Corridor alignments will vary. Each of the proposed alternatives would introduce highway noise into habitats currently not subjected to that level of sound stimuli, which could potentially induce stress or interfere with communication and detection mechanisms of local wildlife.



3.10.6 Mitigation

This Tier 1 analysis confined mitigation analysis to identifying residential sites for which mitigation measures, such as noise barriers, may be appropriate. It was prepared using professional judgment, area contours and aerial photos to identify residential areas for potential noise abatement. Noise mitigation efforts involve identifying noise impacted receptors, e.g., homes, that warrant consideration for noise mitigation, evaluating potential measures for mitigating noise impacts on those receptors and incorporating reasonable and feasible noise mitigation measures into the project in accordance with the Procedure.

According to the Procedure's feasibility criteria, a barrier will need to be evaluated on both acoustic feasibility and engineering feasibility. Analysis will need to be evaluated at all impacts to determine if each impacted receptor can receive a five dB(A) noise reduction. INDOT requires that noise barriers achieve a five dB(A) reduction at more than 50 percent of the impacted receptors. If a barrier cannot achieve this acoustic goal, abatement is considered not acoustically feasible.

INDOT also requires noise abatement measures to be based on sound engineering practices and standards and be evaluated at the best location. Based on the roadway elevation and location of receptors that can either be near the shoulder or near the edge of the right-of-way closer to the receptors. In addition, noise barriers require long, uninterrupted segments of barrier to be feasible. If there are existing access points and driveways, it is typically not feasible to construct effective noise barriers for the roadway due to sight distance and access and breaks in the noise barrier wall. However, in some cases, changing access points in the project design may improve safety and decrease conflicts resulting in noise abatement being feasible. Engineering feasibility also considers topography, drainage, safety, barrier height, utilities and access/maintenance needs that can include easement and right-of-way considerations.

According to INDOT's reasonable criteria, public involvement is also required to determine whether a barrier is desired and appropriate for a given location. Consideration of the design goal and cost effectiveness for noise barriers is also necessary. The design goal is for over 50 percent of benefitted first row receptors to receive at least a 7.0 dB(A) noise reduction. These criteria will be evaluated in the subsequent Tier 2 study. Cost effectiveness is the estimated cost of constructing a noise barrier divided by the number of benefitted receptors, those who would receive a reduction of at least five dB(A). A cost of \$25,000 or less per benefitted receptor is currently considered to be cost-effective unless a majority of homes were present prior to the roadway being constructed if the alternative is new alignment. Most are anticipated to fall under the allowed cost of \$30,000 per benefitted receptor that would be determined in the subsequent Tier 2 studies. The Tier 1 noise impact analysis has identified residential sites that were impacted. According to INDOT's feasibility criteria, a barrier will need to be evaluated at all impacts to determine if each impacted receptor can receive a five dB(A) noise reduction. This will be conducted in the Tier 2 phase. Due to the rural setting of the project area and sparse density of houses the distance between impacted receptors is so great that the cost of the wall would exceed the maximum \$25,000 - \$30,000 cost per benefitted receptor and not meet INDOT's cost-effective reasonableness criteria. Therefore, no location was identified during Tier 1 where a barrier was likely to meet INDOT's cost-effectiveness criteria; however, any potential for noise abatement will be further analyzed in Tier 2.

The subsequent Tier 2 studies will evaluate the feasibility and reasonableness of noise mitigation measures. The detailed Tier 2 study would be based on a more complete design and may conclude that some of these areas do meet the feasible and reasonableness criteria for noise barrier wall abatement.



3.10.7 Summary

The Tier 1 analysis shows that each of the alternatives studied has the potential to impact single family residences based on the Category B Noise Abatement Criteria of 66 dB(A). Overall, the range of impacted receptors were consistent for the M, O and P Alternatives. The number of impacts for the Alternative B variations was slightly less. Alternative C is expected to have the least impact on residential receptors. Alternative O2 had the highest number of impacted receptors. For all the counties containing impacts, Dubois County had a significantly higher number of predicted impacted receptors. Alternative P, the preferred, had a range of 69-77 impacted receivers depending on the variation. The No-Build Alternative would not create new alignment, thus would not change the relationship of distance between the highway traffic source and any existing receptors.

Impacted locations would require consideration of noise abatement during the Tier 2 study. Due to the rural setting of the project area and sparse density of houses, where impacts occur the cost of the wall would likely exceed the maximum \$25,000 - \$30,000 cost per benefited receptor and not meet INDOT's cost-effective reasonableness criteria.