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Traffic Noise Modeling of Short Safety Barriers

PRESENTED BY
Dana Lodico, PE, INCE Bd. Cert.

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TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

*Project work conducted at Illingworth & Rodkin, Inc.

Introduction

This study evaluated modeling methods for their ability to calculate the noise reduction of short barriers.

OUTLINE OF PRESENTATION

- Background
- Methodology
- Case Study Model Validation
- Theoretical Modeling
- Conclusions

Background

SOLID CONCRETE SAFETY BARRIERS

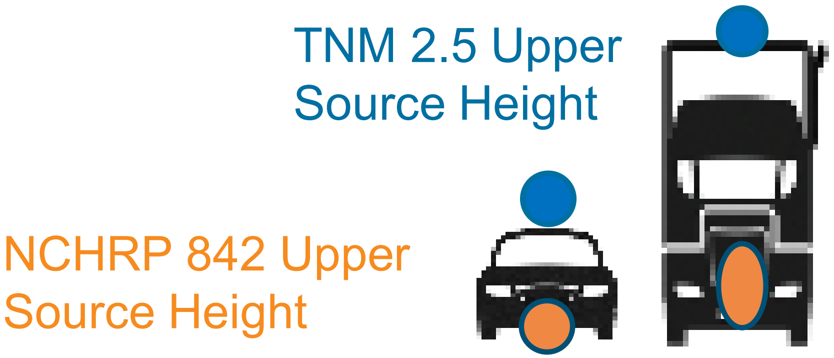
- Commonly constructed for safety
- Provide noticeable traffic noise reduction (ODOT, Caltrans)
- FHWA software (TNM 2.5) can underpredict insertion loss of short barriers
  - vehicle noise source heights; calculation methodology?

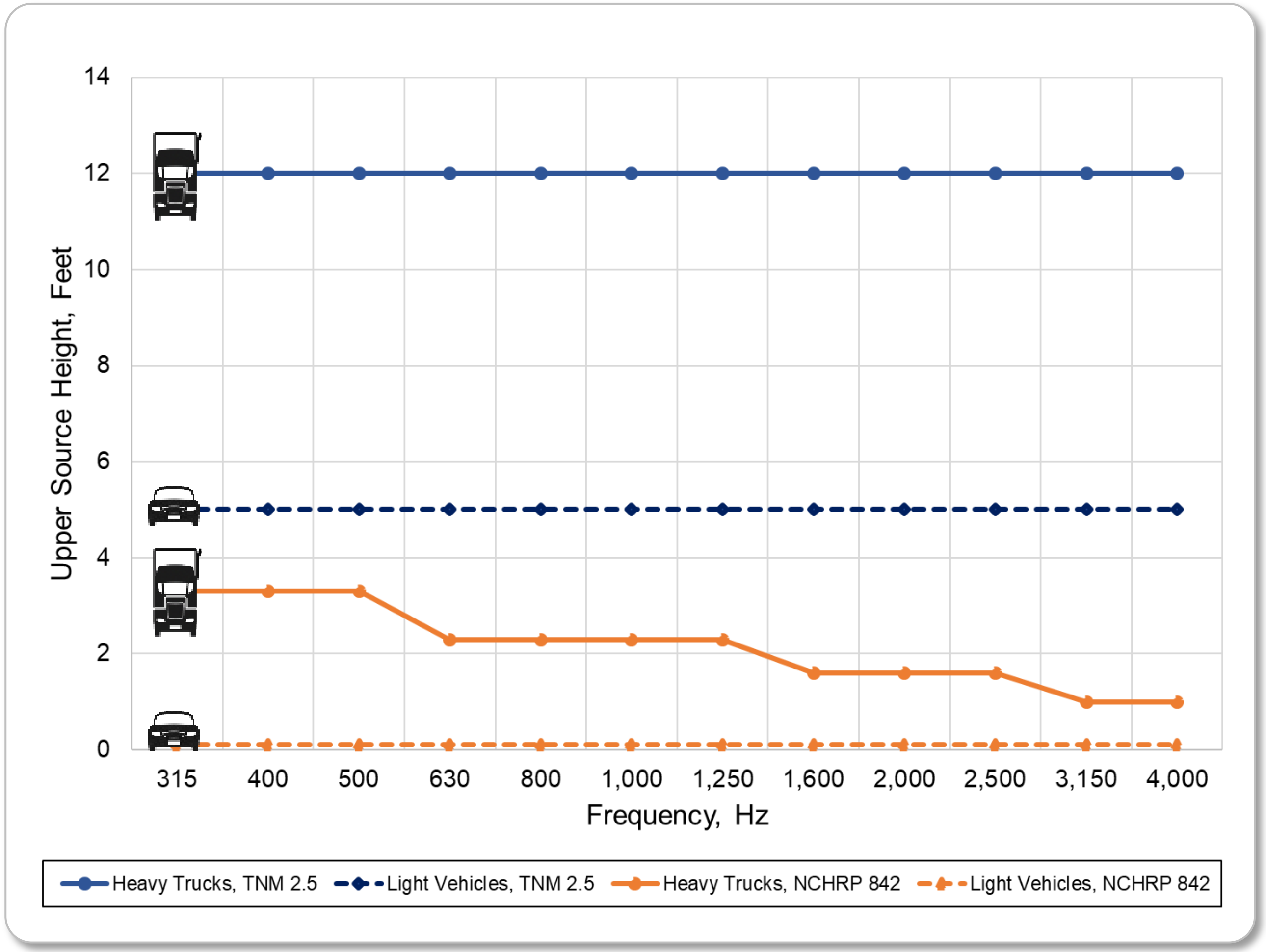
Purpose: ***Identify modeling parameters to improve prediction of noise reduction behind short barriers.***

Background

VEHICLE NOISE SUB-SOURCE HEIGHTS

- TNM sub-source heights are based on 1990s methodology
- Based on more recent research, most vehicle noise is generated close to the pavement surface (NCHRP 842, etc.)





Methodology

- TNM 2.5 source heights & energy distributions altered using SoundPLAN code
- Models developed using TNM 2.5 and TNM implemented in SoundPLAN
- TNM implemented in SoundPLAN may approximate TNM 3.0 (further study needed)

Model Number	Software Package	Noise Source Height			Multiplier, m*		
		Lower	Upper, Trucks	Upper, Other	Lower	Upper, Trucks	Upper, Other
1	TNM 2.5	0 feet	12 feet	5 feet	A	C	B
2	TNM 2.5 Implemented in SoundPLAN	0 feet	12 feet	5 feet	A	C	B
3		0 feet	2.3 feet	0.33 feet	A	A	A
4		0 feet	3 feet	0.33 feet	A	A	A
5		0 feet	3 feet	0.33 feet	A	B	A

**Multipliers are used to adjust measured reference levels to free-field conditions. Three Multipliers are used in TNM 2.5 (A, B, and C).*

Case Study Validation Methodology

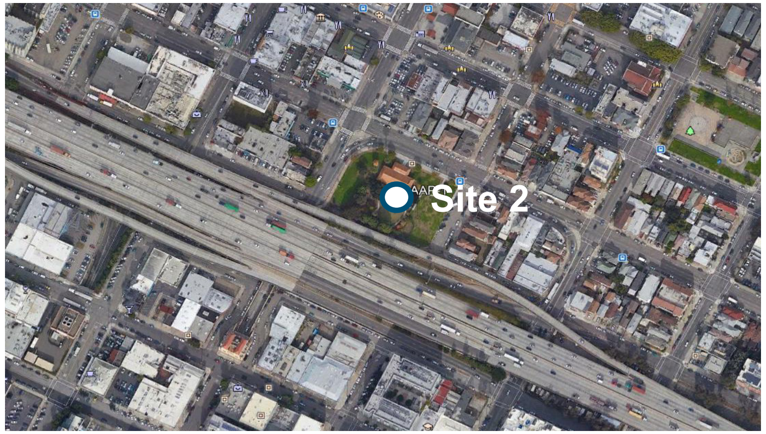
Validation to field measurements ensures virtual simulations are representative of real-life conditions.

CASE STUDY VALIDATION

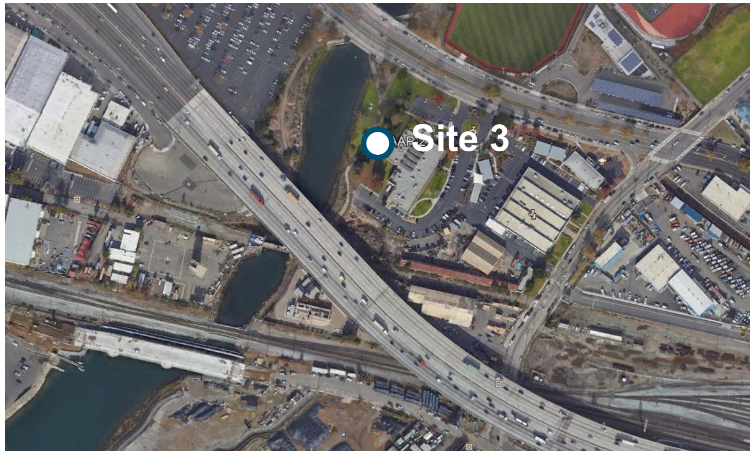
- 5 real-world highway noise measurement locations
- All locations behind short barriers or berms
- Measured noise and traffic conditions
- TNM ‘Average’ pavement
- Pavement normalization made for Site 5

Case Study Site Descriptions – Sites 1, 2, 3

Site 1: Residence

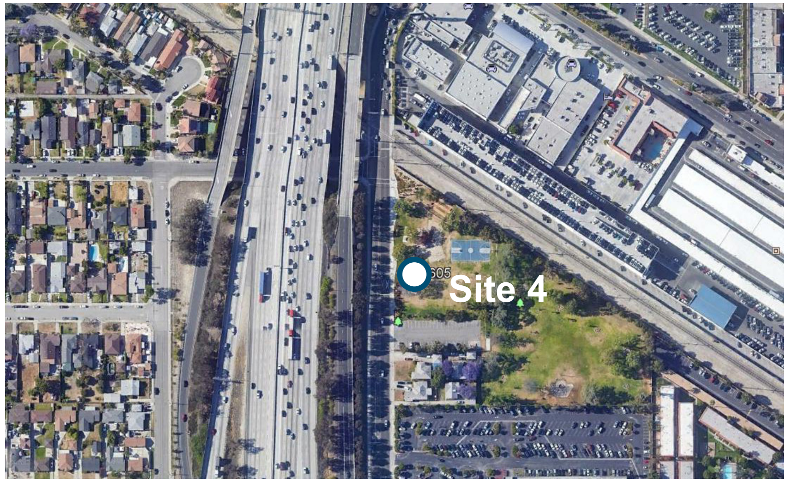


Site 2: Childcare Center

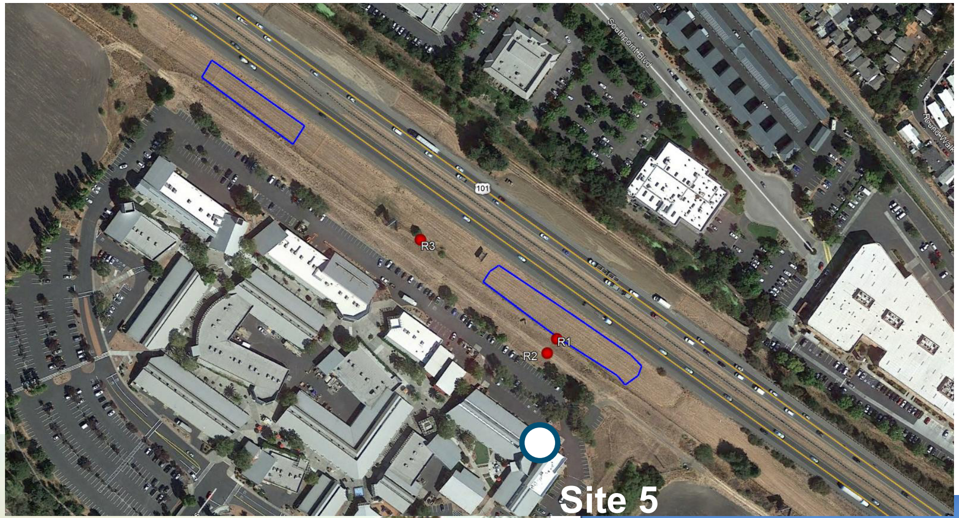


Site 3: Trail on Campus

Case Study Site Descriptions – Sites 4, 5



Site 4: Recreational Use



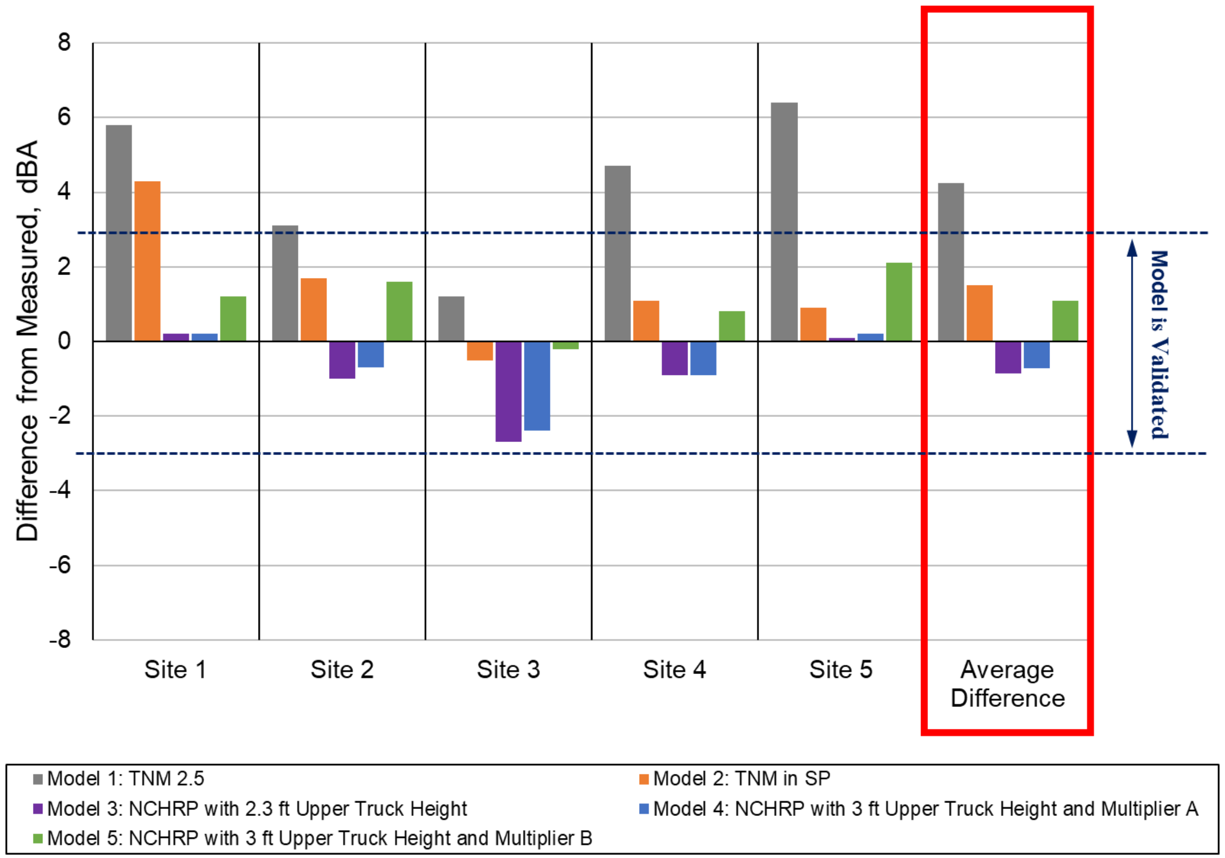
Site 5: Research Site Behind Berm

Case Study Validation Results

Model	Average Difference	Sites Validated
1	4.2 dB	3
2	1.5 dB	2, 3, 4, and 5
3	0.9 dB	All
4	0.7 dB	All
5	1.1 dB	All

Model 1 vs. Model 2: Effect of SP implementation (Model 2 approximates TNM 3.0)

Model 2 vs. Models 3/4/5: Direct effect of sub-source height alteration



Theoretical Testing

A testing matrix with 132 scenarios was used to assess the sensitivity of the modeling methods to common highway design variables.

STANDARD DESIGN ELEMENTS

- 10-foot-wide roadway shoulders
- 22-foot-wide median
- Receiver distances: 25 to 500 feet
- TNM ‘Average’ pavement
- Soft ground type (lawn)

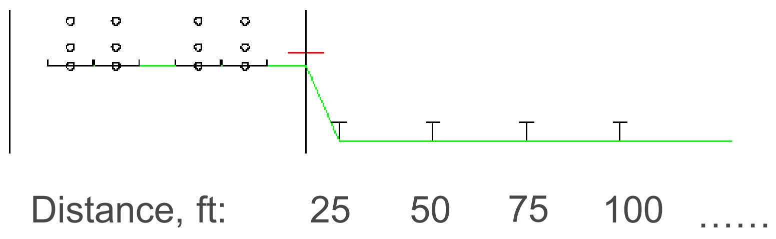
VARIABLE DESIGN ELEMENTS

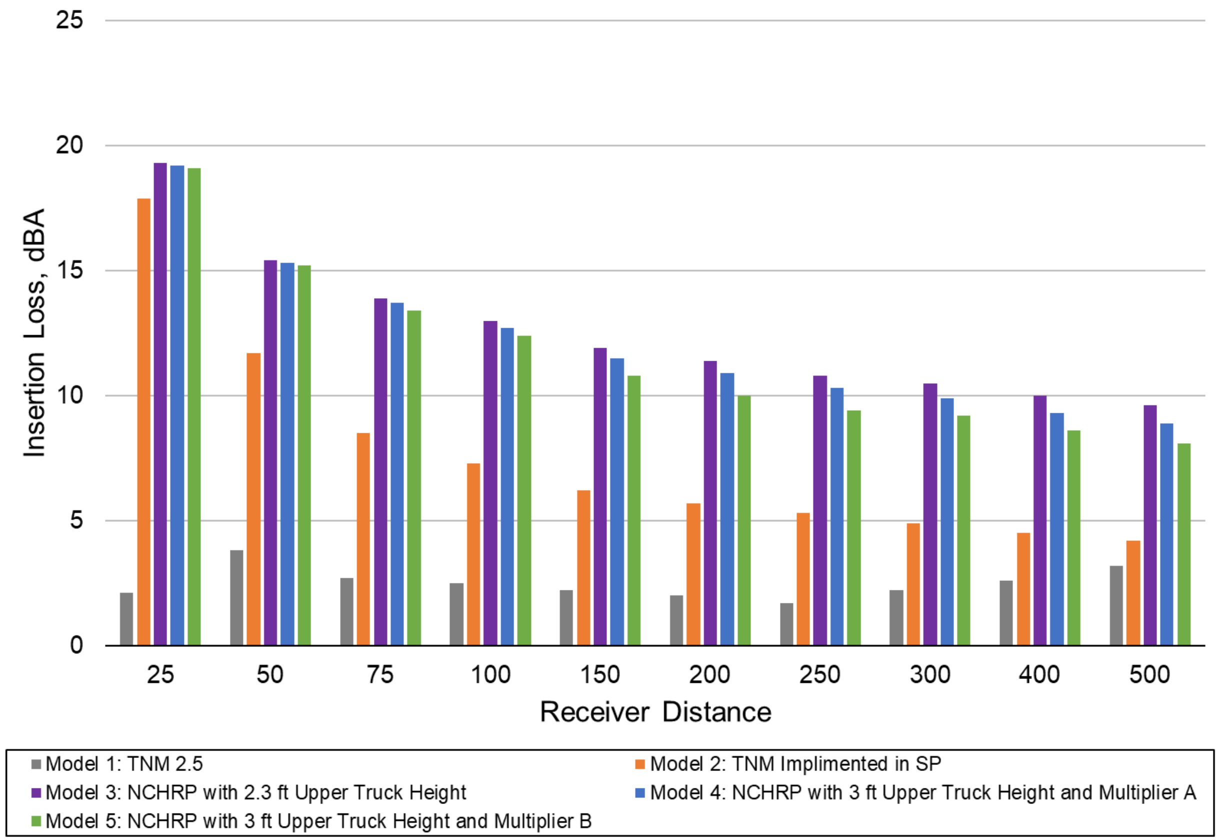
- At-grade roadway and 20-foot-high elevated bridge
- 4 and 6-lane highway alignments
- Barrier height alternatives: 0 to 16 feet
- Traffic Mix: 5, 10, and 100% trucks

Presentation focuses on 42-inch-high barrier, 10% trucks → most representative

Theoretical Example – Elevated Roadway

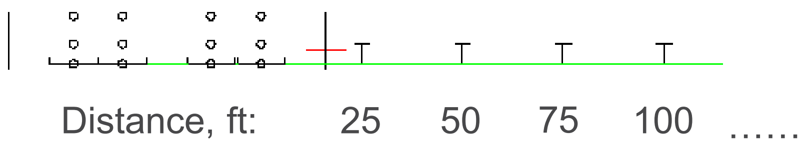
- Elevated 4-lane highway
- 42-in high barrier
- 10% trucks

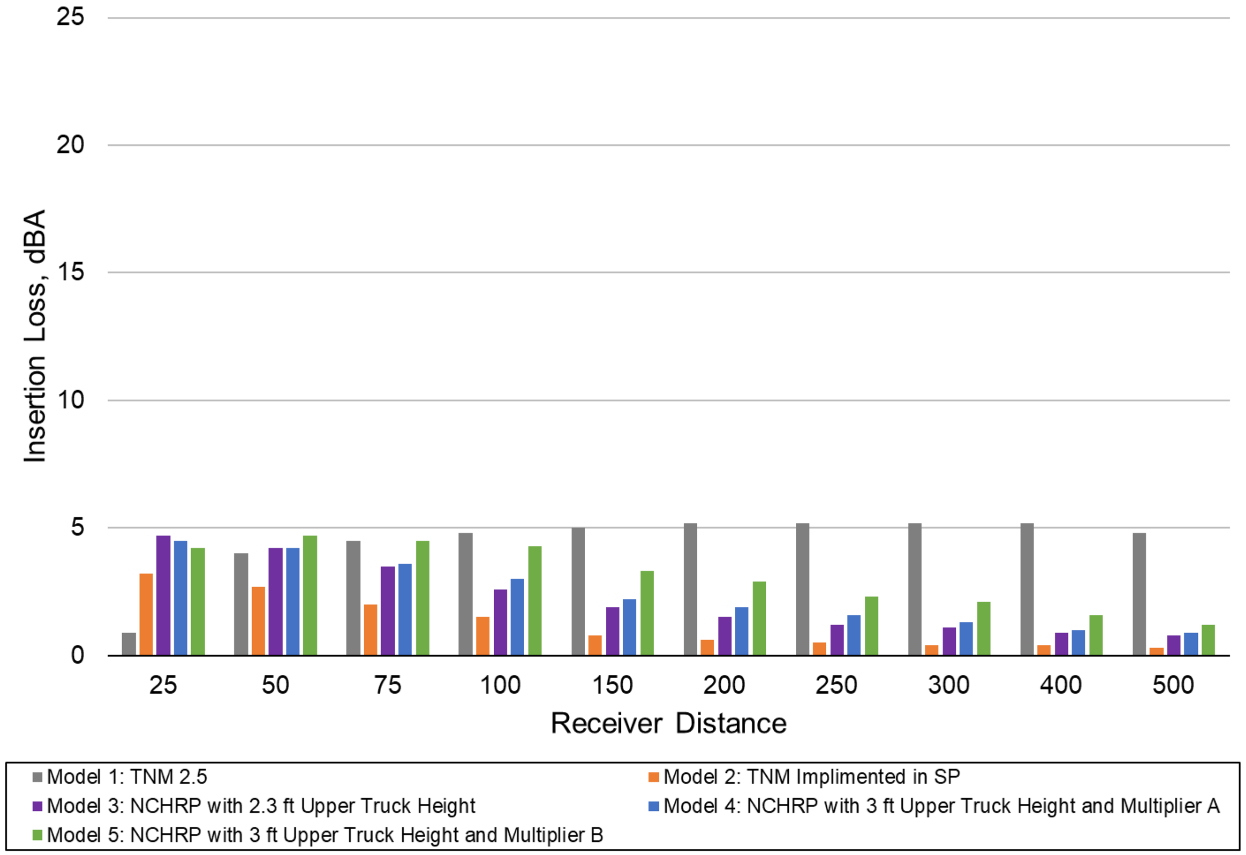




Theoretical Example – At-Grade Roadway

- At-grade 4-lane highway
- 42-in high barrier
- 10% trucks





Conclusions

- TNM 2.5 underpredicted noise reduction of elevated short barriers; may overpredict noise reduction for at-grade short barriers.
- Use of SoundPLAN implementation of TNM resulted in improvement of model validation with real-world highway noise scenarios → may represent TNM 3.0.
- Use of noise sub-source heights closer to the pavement surface further improved validation of the model with real-world highway noise scenarios. Overall improvement of 3.1 to 3.5 dB; 0.4 to 0.8 dB improvement due to sub-source height.
- Short solid barriers may provide 3 to 5 dB of noise reduction to the community for at-grade highway alignments.
- Short solid barriers may provide 10 to 15 dB of noise reduction to the community for elevated highway alignments.

Next step: *Run case studies using TNM 3.0*

Implications

- Short barriers are relatively inexpensive and easily constructed compared to tall barriers and can serve the dual purpose of improving driving safety and providing noise reduction to the adjacent community.
- If shorter barriers are found to meet Federal/State criteria, more barriers would be considered cost reasonable; therefore, more areas would potentially qualify for noise abatement.
- More tools for noise reduction would be available for State DOTs. Short barriers that provide 3 to 5 dB of reduction may be considered due to their low cost, even if Federal funding is not provided.

Acknowledgements

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Dana M. Lodico, PE, INCE Bd. Cert.

DIRECTOR

Dana.Lodico@rsginc.com

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