TNM 3.0

• March 1, 2017 Limited Beta Evaluation; closed comments Sept 15, 2017
• Improved GUI
• Works w/ ACAD, Esri ArcGIS, Micro Station “Esri runtime built into beta test TNM 3.0 software, have to have active license key to activate this map feature.”
• Requires fast PCs and generates huge files; easily overwhelmed w too many receptors
• A few adjustments to TNM acoustic calculations and algorithms
Four Online Webinars Available at:
Greatly Improved GUI
3D View
Cross Section View
• Goal: Release late 2017 or Early 2018 (FHWQA has promised for 10 Yrs)
• Experienced trouble with 3rd party software issues in past iterations of TNM.
• Numerous GUI and Acoustic Algorithm bugs reported
• USDOT Volpe Acoustic Center develops TNM & subcontracts technical support to FHWA - $$
• Personnel turnover at DC – FHWA
• FHWA will develop training (or select 3rd Party)
TNM 2.5 Sub
Source Heights
Sound Energy
Distribution

Examples of Percentage Split Between Upper and Lower Source Heights (Cruise)

<table>
<thead>
<tr>
<th></th>
<th>Low Frequencies (500 Hz and below)</th>
<th>High Frequencies (2000 Hz and above)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 ft</td>
<td>27%</td>
<td>2%</td>
</tr>
<tr>
<td>0 ft</td>
<td>73%</td>
<td>98%</td>
</tr>
<tr>
<td>HEAVY TRUCK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 ft</td>
<td>43%</td>
<td>54%</td>
</tr>
<tr>
<td>12 ft</td>
<td>57%</td>
<td>46%</td>
</tr>
</tbody>
</table>

Caltrans LOS 10.5 ft.?
Acoustic Beam Forming Applied to Trucks
Measurements

- Acoustic “snap-shots” of vehicle passbys on actual highway
  - B&K 90 mic array & processing
  - Internal Matlab based processing

- Test Matrix
  - 3 sites with 3 AC pavements – 55 mph posted speed
  - Over 200 heavy truck passby events
  - Some medium trucks & light vehicles

- Objective
  - Assess vertical distribution truck noise sources for traffic noise modeling purposes
  - Improve understanding of in-service truck noise sources
Typical Images for Heavy Trucks
Atypical Exhaust Case

Overall A-Weighted Level, dB
Applications of Heavy Truck Noise Profiles Determined in NCHRP 25-45

Paul Donavan
Carrie Janello
Acoustic Beam Forming System

- Type WL9x6D2509 Foldable wheel Array
- Equal length arms
- 8.2ft in diameter
- 54 microphones
- Acquisition by B&K PULSE system
- Data processed by delay & sum method
- 315 to 4,000 Hz
Measurement Program

- 20 measurement sites – 4 in California & 16 in North Carolina
  - 6 Level
  - 6 Uphill
  - 5 Downhill
  - 3 Lower speed sites
- 1,289 truck pass-bys
- 29 to 66 mph average speed range
- Pavement types
  - Asphalt – 11, dense graded (9), open graded (2)
  - Concrete – 7, ground (3), transverse tined (4)
# 2-Point Source Distribution Approximation

<table>
<thead>
<tr>
<th>1/3 Octave Band Frequency Band</th>
<th>Lower Source</th>
<th></th>
<th></th>
<th>Upper Source</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Height</td>
<td>Level</td>
<td>Source Strength</td>
<td>Height</td>
<td>Level</td>
<td>Source Strength</td>
</tr>
<tr>
<td>315 Hz</td>
<td>0ft (0m)</td>
<td>80.5 dBA</td>
<td>44%</td>
<td>3.3ft (1m)</td>
<td>81.5 dBA</td>
<td>56%</td>
</tr>
<tr>
<td>400 Hz</td>
<td>0ft (0m)</td>
<td>82.5 dBA</td>
<td>56%</td>
<td>3.3ft (1m)</td>
<td>81.6 dBA</td>
<td>44%</td>
</tr>
<tr>
<td>500 Hz</td>
<td>0ft (0m)</td>
<td>86.6 dBA</td>
<td>65%</td>
<td>3.3ft (1m)</td>
<td>84.0 dBA</td>
<td>35%</td>
</tr>
<tr>
<td>630 Hz</td>
<td>0ft (0m)</td>
<td>87.0 dBA</td>
<td>59%</td>
<td>2.3ft (0.7m)</td>
<td>85.5 dBA</td>
<td>41%</td>
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<tr>
<td>800 Hz</td>
<td>0ft (0m)</td>
<td>88.5 dBA</td>
<td>67%</td>
<td>2.3ft (0.7m)</td>
<td>85.5 dBA</td>
<td>33%</td>
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<tr>
<td>1,000 Hz</td>
<td>0ft (0m)</td>
<td>88.0 dBA</td>
<td>67%</td>
<td>2.3ft (0.7m)</td>
<td>85.0 dBA</td>
<td>33%</td>
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<td>1,250 Hz</td>
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<td>85.5 dBA</td>
<td>74%</td>
<td>2.3ft (0.7m)</td>
<td>81.0 dBA</td>
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<td>1,600 Hz</td>
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<td>82.5 dBA</td>
<td>69%</td>
<td>1.6ft (0.5m)</td>
<td>79.0 dBA</td>
<td>31%</td>
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<td>2,000 Hz</td>
<td>0ft (0m)</td>
<td>80.0 dBA</td>
<td>78%</td>
<td>1.6ft (0.5m)</td>
<td>74.5 dBA</td>
<td>22%</td>
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<tr>
<td>2,500 Hz</td>
<td>0ft (0m)</td>
<td>77.3 dBA</td>
<td>77%</td>
<td>1.6ft (0.5m)</td>
<td>72.0 dBA</td>
<td>23%</td>
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<td>3,150 Hz</td>
<td>0ft (0m)</td>
<td>73.8 dBA</td>
<td>62%</td>
<td>1ft (0.3m)</td>
<td>71.7 dBA</td>
<td>38%</td>
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<td>4,000 Hz</td>
<td>0ft (0m)</td>
<td>71.2 dBA</td>
<td>65%</td>
<td>1ft (0.3m)</td>
<td>68.5 dBA</td>
<td>35%</td>
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</table>
Point Source Summary

- A source at 12ft is unrealistic for matching average truck profile any split
- Upper source height must vary with frequency to match average truck profiles from 3.3 to 1.3 ft
- Splits between upper & ground level sources must vary independently
- Future modeling should use 25-45 profile or equivalent two point source model
Barrier/Distribution Observations

- Height distributions are substantially modified by barriers.
- Distributions used in TNM do not reflect actual trucks measured in open conditions.
- TNM distributions show higher sensitivity to increasing barrier height.
  - Could result in higher walls.
  - Could result in more walls being not feasible or reasonable.
TNM Analysis

Making Sausage
Questions?

Early Caltrans Beamforming Measurements
April 2007 in D-4 Petaluma, CA
Time Saving Workflows with FHWA TNM 2.5 and 3.0
What is the role of Noise staff at DOT?

Noise Abatement Policy – for approval
Noise Wall Inventory

Scope of works - review
Instructions and guidance
Review of Traffic Noise Analysis Report

FHWA
ENVIRONMENTAL & PROJECT MANAGERS
Local Public Agencies (LPA)

CONSULTANTS
ADOT RESEARCH
ADOT COMMUNICATIONS

Scope of works - review
Traffic Noise Analysis
• Screening
• Reports, re-evaluations
• Construction Noise Analysis

Public meetings

Ad hoc impact studies (fog seal, chip seal)
Continuous improvement
Facts about noise & FAQ
Noise inquiries response & measurements
Public meetings

ADOT Continuous Improvement: Everyone, everywhere, solving problems, every day!
What is STREAMLINING?
Land Use Determination—Distance from project area
Land Use Determination—Distance from project area

Noise levels at 50-800 ft distances

Hourly volume

<table>
<thead>
<tr>
<th></th>
<th>7500</th>
<th>%</th>
<th>mph</th>
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<td>Auto</td>
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<td>70</td>
</tr>
<tr>
<td>MedTruck</td>
<td>5</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>HevTruck</td>
<td>5</td>
<td></td>
<td>70</td>
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ADOT distance for undeveloped land
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<tr>
<th>HOURS</th>
<th>rate</th>
<th>Total</th>
<th>Equipment</th>
<th>Material</th>
<th>Outsourcing</th>
<th>Other expenses</th>
<th>TOTAL DIRECT</th>
<th>OVERHEAD</th>
<th>SUM OF DIRECT AND INDIRECT EXPENSES</th>
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<td>115.00</td>
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<tr>
<td>3.00</td>
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<td>4,360.00</td>
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</tbody>
</table>
ADOT Continuous Improvement: Everyone, everywhere, solving problems, every day!
From planning to EIS Tier 1 analysis
- TNM 3.0 screening

- Preliminary
  - Long-term studies
  - Stakeholders inputs

- Alternatives
  - Selection
  - Determination

- List of Alternatives with Segments Evaluation

- Alternative 1 (Segments 1, 2, 3)
- Alternative 2 (Segments 4, 5, 6)

- Qualitative Evaluation of Selected Alternatives

- EIS Tier 1
  - Selection of Alternatives

- EIS Tier 2
  - Quantitative Evaluation of Selected Alternative and Segments

ADOT Continuous Improvement: Everyone, everywhere, solving problems, every day!
EIS Tier 1 analysis
- TNM 3.0 screening and contours

- land development planning
- visual presentation of zone beyond impacts
- historic properties
- wildlife and protected species
Pavement treatment

Site equivalency by TNM 3.0

- Modeling median barrier
- Modeling reflections off median barrier
- Single vs multilane modeling
- Atmospheric conditions temperature and humidity
Pavement treatment
Site equivalency by TNM 3.0

- Modeling median barrier
- Modeling reflections off median barrier
- Single vs multilane modeling
- Atmospheric conditions temperature and humidity
Noise Impact Determination

Methodology meeting

FHWA TNM Inventory Features

- DCR, Traffic Study,
- Terrain data
- Engineering documents
- Highway Infrastructure
- Land use inventory

Noise measurements

- Sites
- Procedure

FHWA TNM modeling approach
Methodology meeting

Preparation for Methodology meeting,
A phase where consultant acquires relevant information for the noise analysis

Methodology meeting
A phase where both consultant and ADOT EP Noise discuss noise analysis requirements in detail

Field Measurement, Existing conditions TNM modeling and model calibration
A phase where consultant prepares TNM model for ADOT EP Noise preliminary review

Acceptance of TNM model for Existing conditions by ADOT EP Noise
Future prediction TNM modeling, with impact determination and abatement measures consideration, internal review by consultant, following Pre-screening module

Acceptance of TNM model for Future conditions, with impact determination and abatement measures consideration, by ADOT EP Noise

Submittal draft report, and acceptance
Acceptance of the Final Report
Conclusion

• “a modernized and streamlined State government is one that moves at the speed of business… State government thinks and does business as one enterprise.”

https://ams.az.gov/

LEAN, removing Muda (waste), Muri (overburden) and Mura (unevenness)

In Noise, by removing
• Squirrels
• Bells, and
• Whistles
QUALITY POLICY
The Quality Policy for the Arizona Department of Transportation as shown below is hereby adopted and will be used in conjunction with all activities within the department:
We will consistently provide our customers products and services that meet mutually agreed-upon requirements.
Witness my hand this 1st day of March 1993.

GUIDING VISION
ADOT - 97
ADOT is recognized and respected as:
- The model of efficient, effective, responsive government.
- The preferred partner of business and industry.
- The employer of choice, attracting and retaining the best and brightest.
Continuous improvement is our way of life!

AdotAirNoise@azdot.gov

Beverly Chenausky
Joonwon Joo

Tremaine Wilson
Angie Newton
Joe D’Onofrio

Fred Garcia