

# **A Very Difficult TNM Quiz**

**Get correct TNM results**

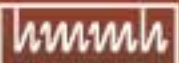
**Speed up your input and barrier design**

**Avoid TNM confusions**

**Avoid FHWA surprises**

**Grant Anderson**

**Harris Miller Miller & Hanson Inc.**



- **In acoustics:**

- $2 + 2 = 4$

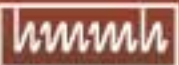
- $2 + 2 = 5$

- $2 + 2 \cong 5$

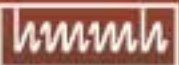
- **$2 + 2 \cong 5$**



- **On the average, TNM 2.5 over-predicts sound levels by:**
  - Zero dB at all distances
  - 2-to-3 dB at all distances
  - 2-to-3 dB at large distances
- **Zero dB at all distances**



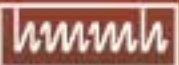
# Get correct TNM results



# Get correct results

<http://www.hmmh.com/>

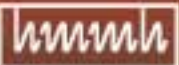
- Your receivers near up-grades have lower sound levels than those near down-grades.
- What is wrong with your input?
- You entered TNM roadways against the traffic.



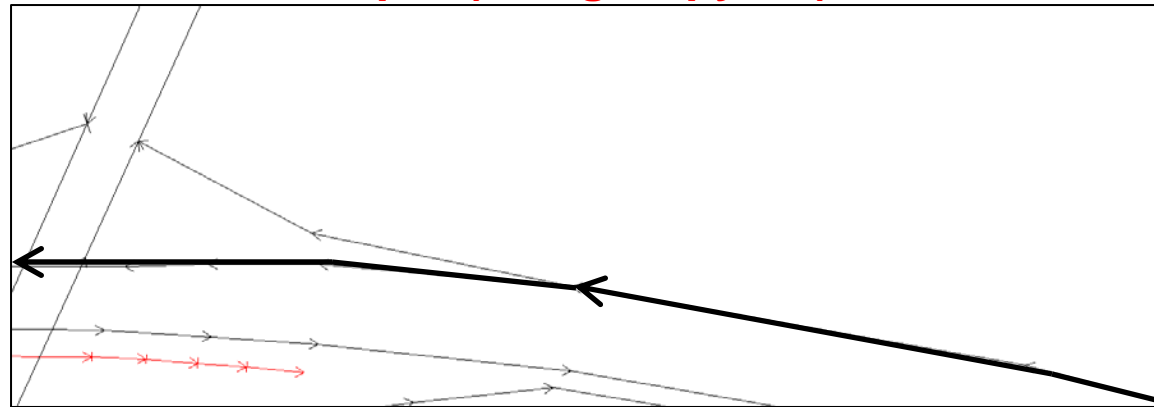
# Get correct results

<http://www.hmmh.com/>

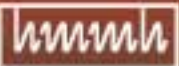
- To simplify traffic input, you divided all mainlines into separate TNM roadways.
- Why might TNM significantly under-compute?
- **TNM cannot continue the upgrade adjustment from one TNM roadway to the next.**



## Easiest traffic input (using Copy All)



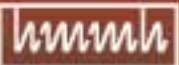
## Required for proper TNM upgrade adjustment



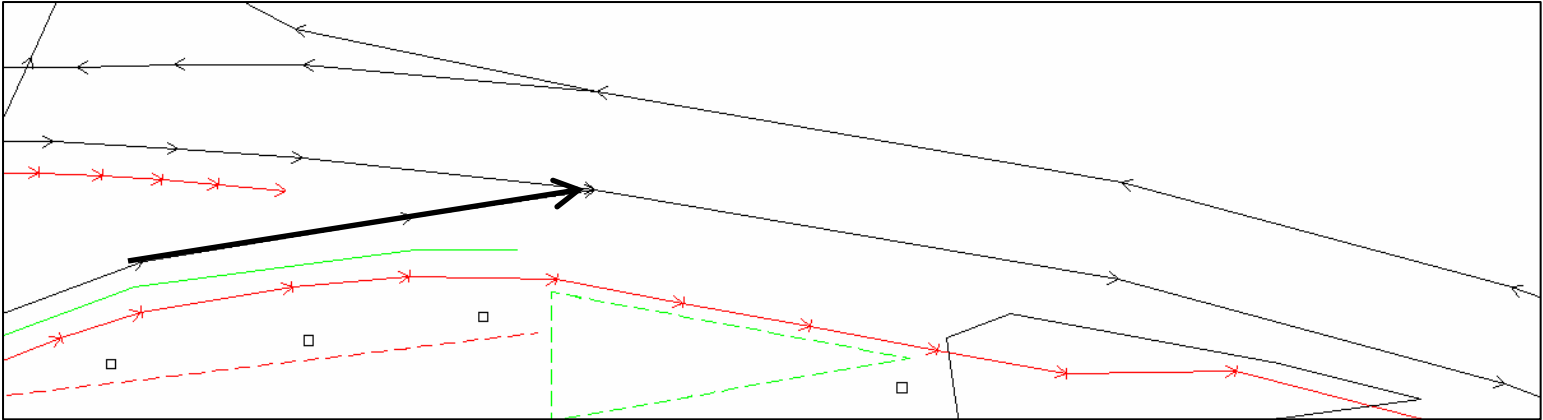
# Get correct results

<http://www.hmmh.com/>

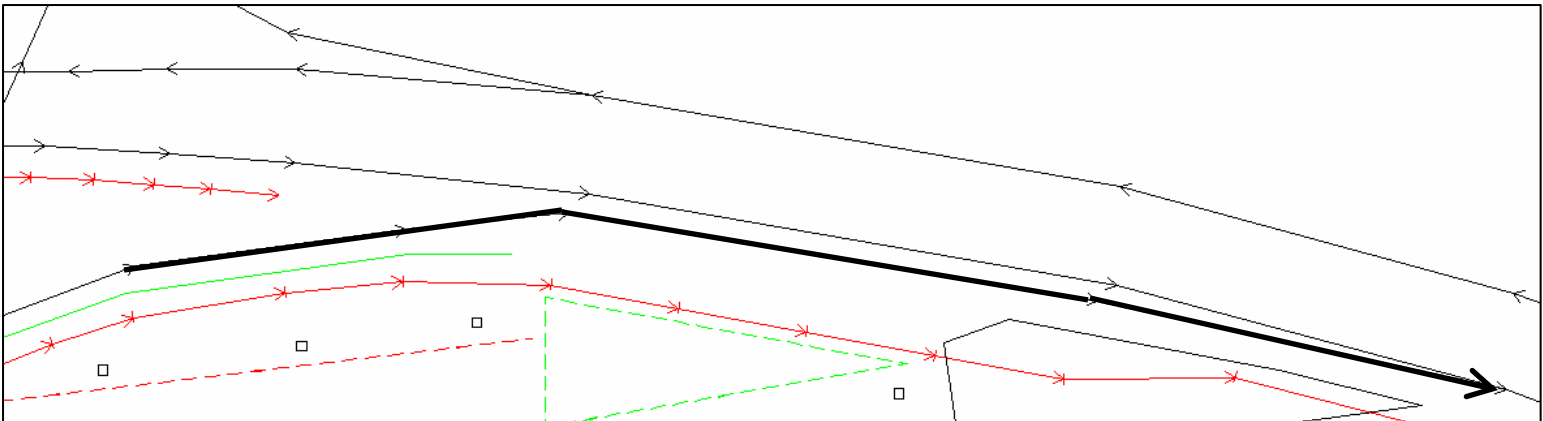
- After entrance ramps, TNM changed heavy trucks to “cruise throttle” at the physical merge point.
- Why might TNM under-compute?
- You did not extend the entrance ramp beyond the physical merge point.



**Ramp ends at physical merge point (TNM under-computes)**



**Ramp extends beyond physical merge**

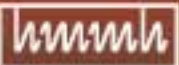




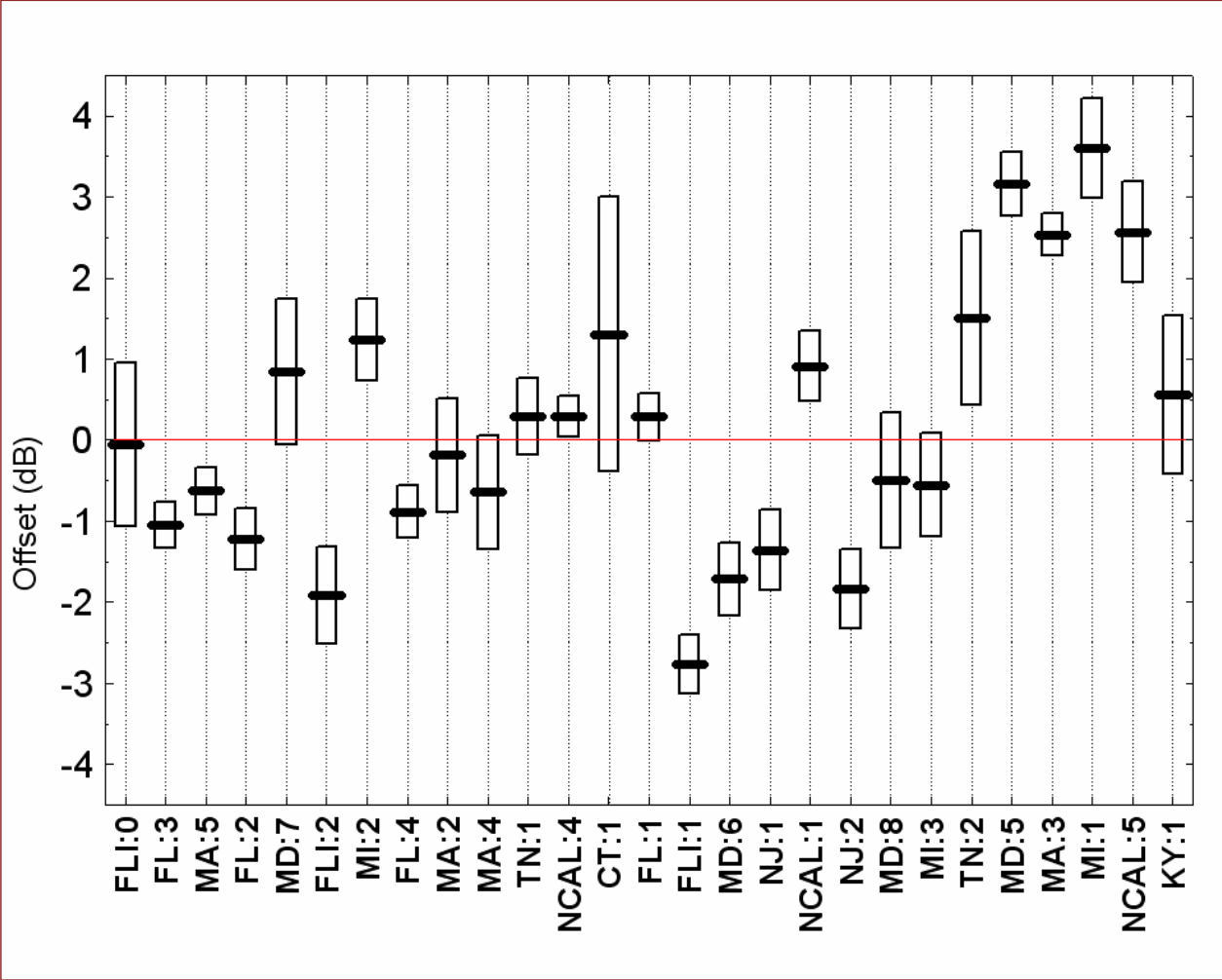
## Get correct results

<http://www.hmmh.com/>

- **You have a 4-dB difference between measured and computed noise.**
  - Are your measurements suspect? **Yes**
  - Is TNM suspect? **Probably not**
  - Could there be a “site bias”? **Yes**



### Site bias: TNM heavy-truck emissions

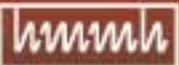


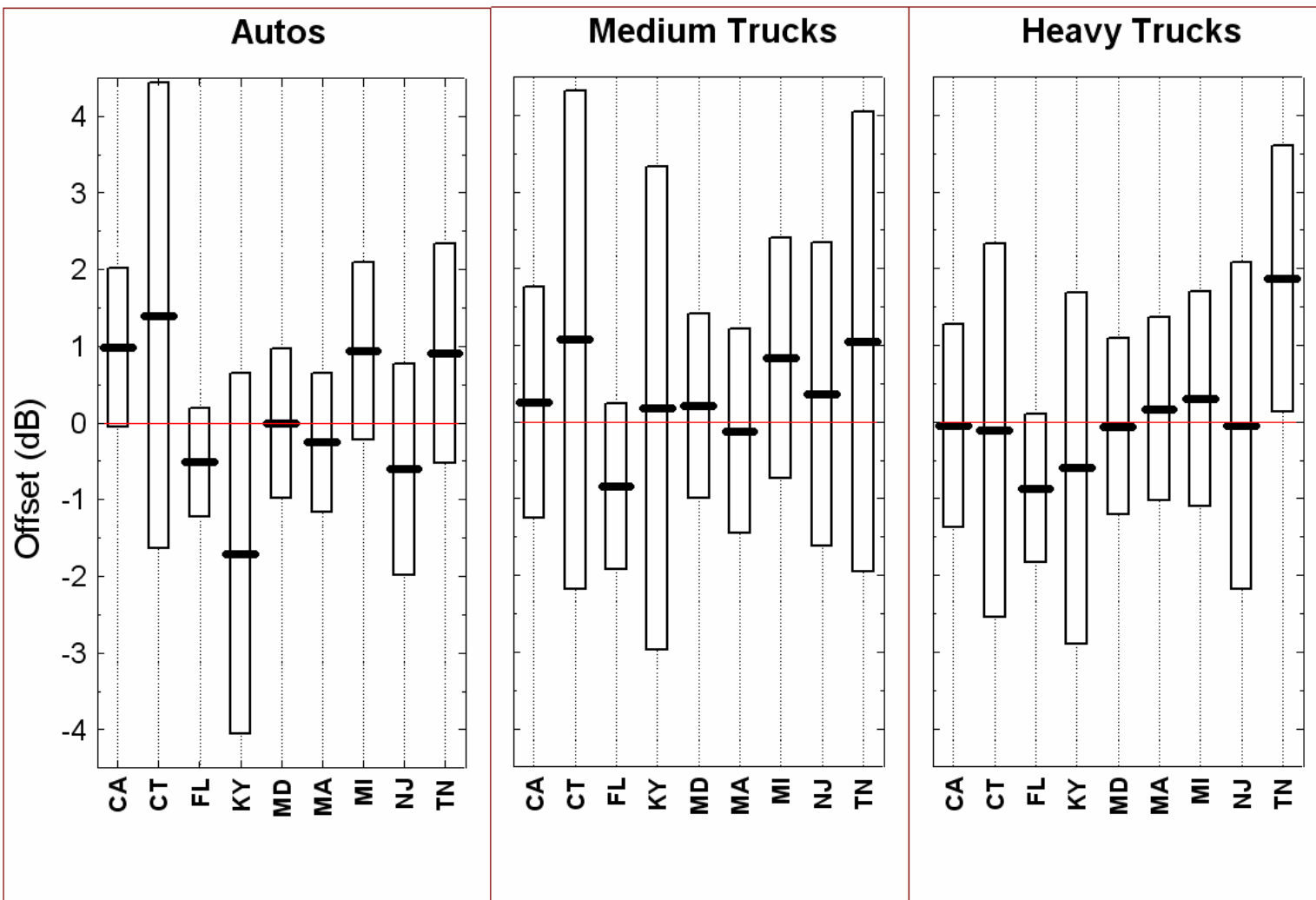


## Get correct results

<http://www.hmmh.com/>

- **Your state wants to show state-to-state differences in vehicle emissions—probably quieter heavy trucks.**
- **What differences exist among the nine states measured during TNM development?**
- **The emission data show no certain differences.**





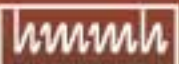


## Get correct results

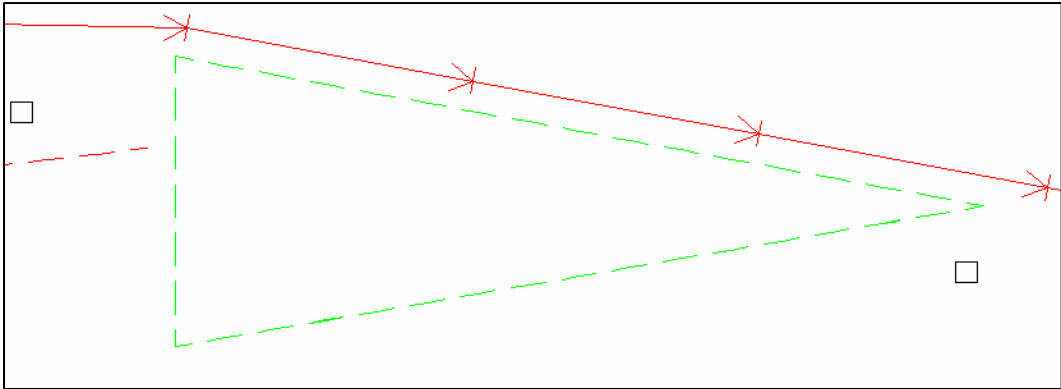
<http://www.hmmh.com/>

- Your trees completely block sight of the roadway and keep their leaves in the winter.
- So you input a Tree Zone.
- Why might computed sound levels be incorrect?
- **You must also input a “loose-soil” Ground Zone, contiguous with the Tree Zone.**

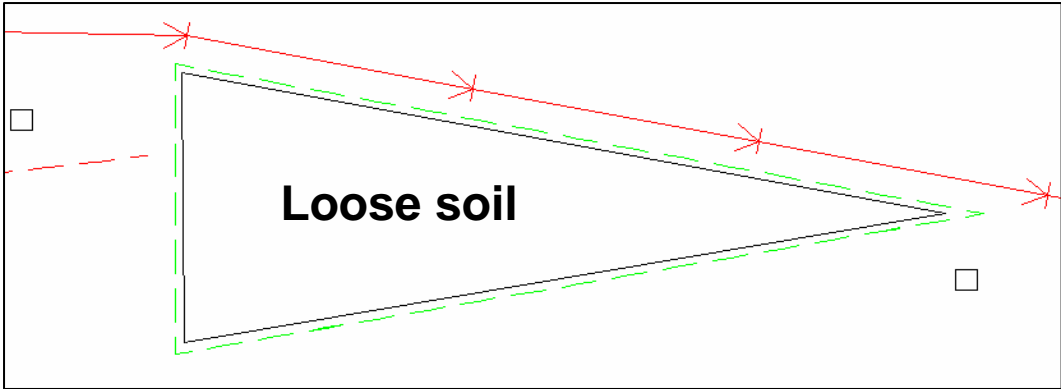
**Please request that TNM do this automatically.**



### Tree Zone, alone



### Tree Zone with contiguous Ground Zone

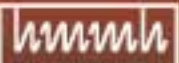




## Get correct results

<http://www.hmmh.com/>

- You entered mainline traffic as “vehicle volumes” and local streets as “total volume and vehicle percentages.”
- Why might TNM greatly under-compute?
- **TNM will ignore one complete set of traffic.**  
Please request this be fixed.



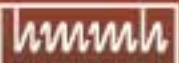


## Get correct results

<http://www.hmmh.com/>

- You have thoroughly proofread all input tables.
- What two types of input still might be wrong?
- Receiver adjustment factors
- Structure barriers

**Please request these both be fixed.**

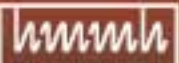


# Get correct results

<http://www.hmmh.com/>

- You have finished recommending noise barriers, providing XY coordinates and barrier-top elevations.
- Then the design engineers raise the roadway's vertical profile by 8 inches.
- Is this a problem?
- **We don't really know.**

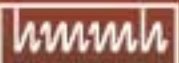
**Please request thorough “sensitivity tests.”**



# Get correct results

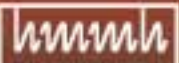
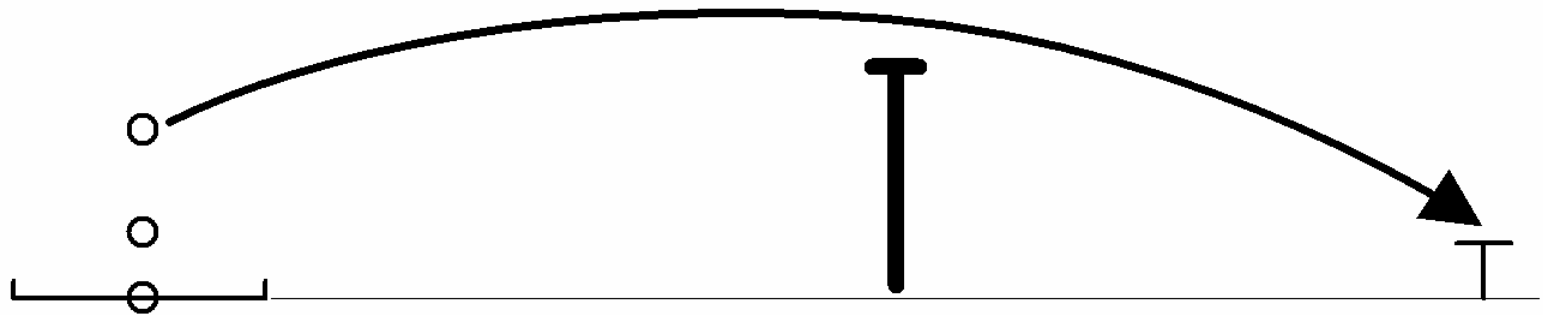
<http://www.hmmh.com/>

- **Wind can affect noise-barrier performance, but:**
  - Only for receivers down-wind from the roadway
  - TNM doesn't compute the effect
  - TNM computes the effect, but FHWA does not allow use of this TNM capability.
- **TNM doesn't compute the effect.**



**Wind direction**  
----->  
**Downwind propagation causes  
downward refraction.**

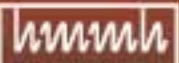
**Downward refraction can  
reduce or eliminate barrier attenuation,  
especially for mid-path barriers.**



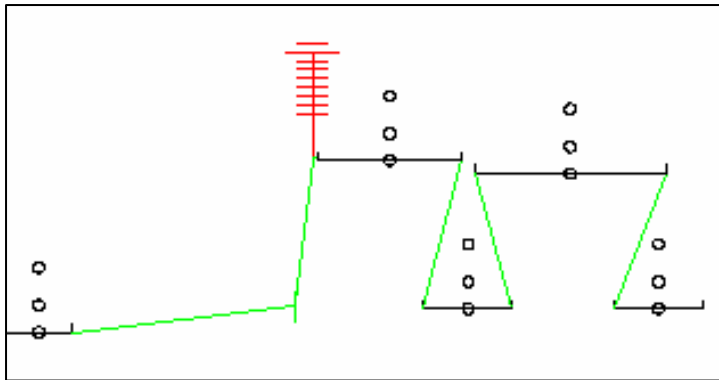
# Get correct results

<http://www.hmmh.com/>

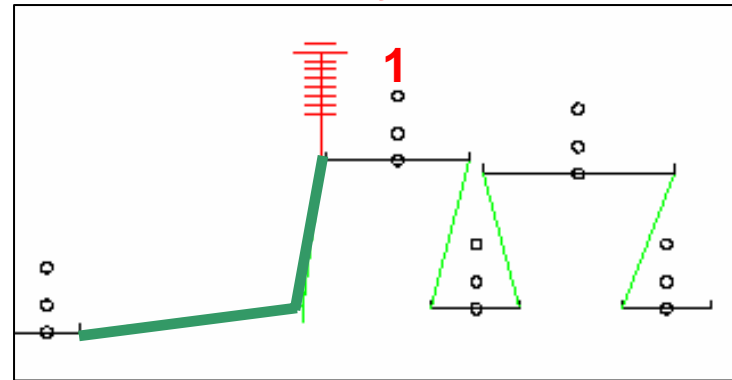
- A TNM skew section has a ground line that is obviously very wrong.
- How can you fix this so TNM's computations are correct?
- **No need to correct.**



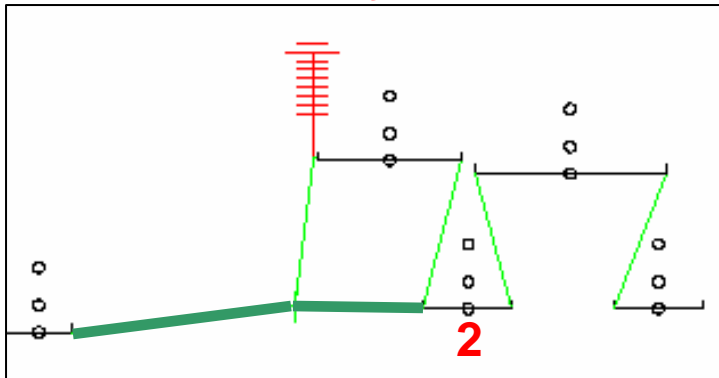
**Drawn by TNM**



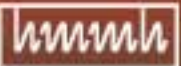
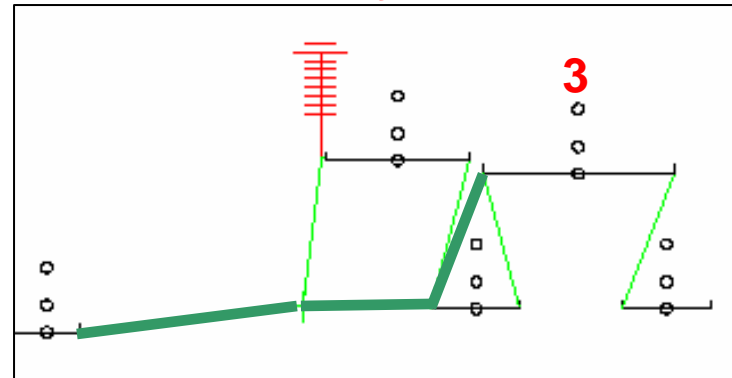
**Proper: Roadway 1**



**Proper: Roadway 2**



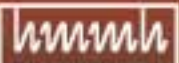
**Proper: Roadway 3**



# Get correct results

<http://www.hmmh.com/>

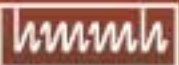
- After you are all done, you notice that TNM has modified the Temperature and Relative Humidity—away from the values FHWA mandates.
- Do you need to re-compute with the proper values?
- **Technically not needed.**
- **But... FHWA requires proper values.**

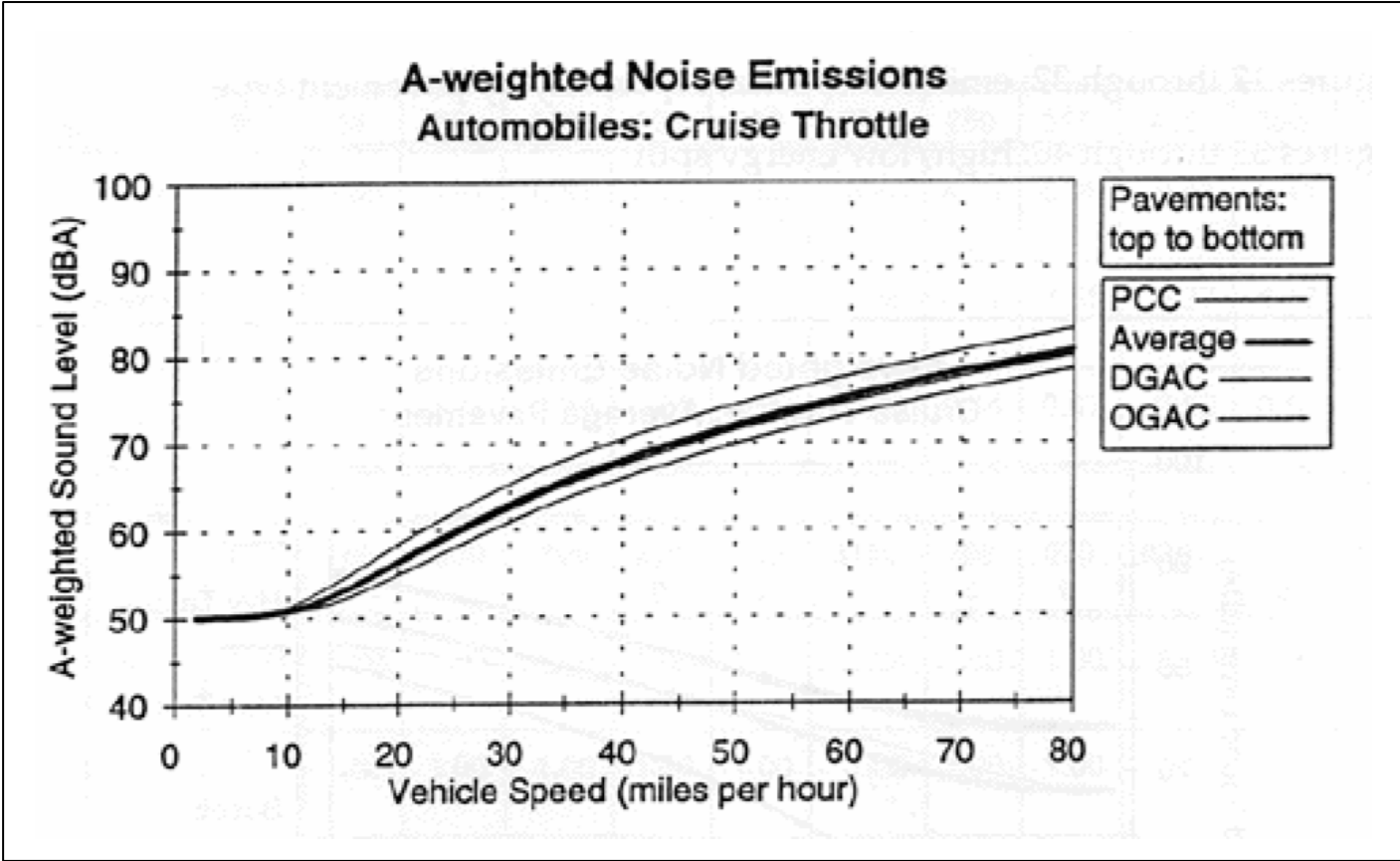


# Get correct results

<http://www.hmmh.com/>

- Using its built-in emissions for Open Graded Asphaltic Concrete, does TNM accurately compute the effect of Rubberized Asphalt Friction Course?
- **No.**



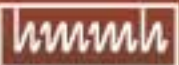


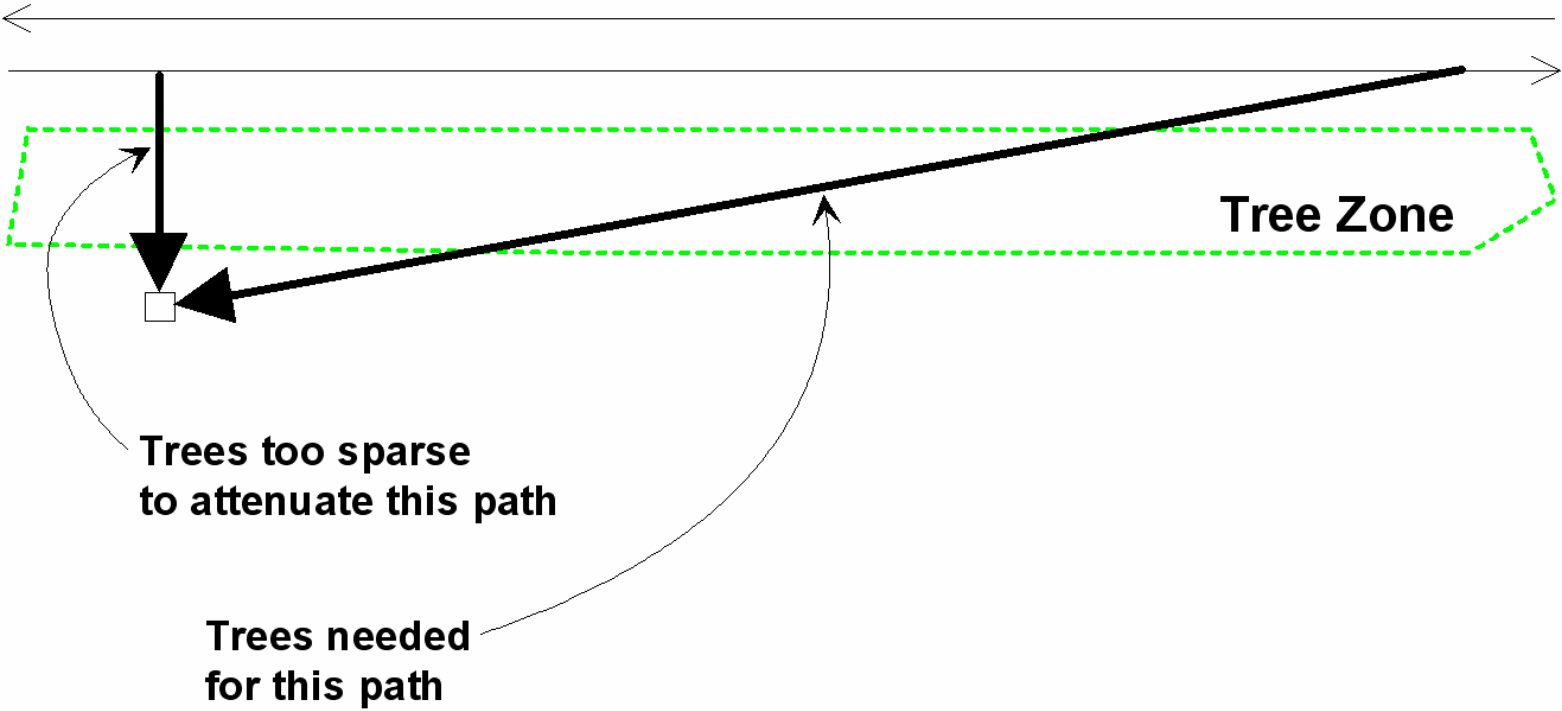


## Get correct results

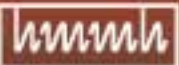
<http://www.hmmh.com/>

- Receivers can easily see the roadway through a 200-foot band of trees/undergrowth.
- So you leave out Tree Zones, per FHWA policy.
- Why might your noise barriers cost much more than truly necessary?
- **The trees do block sound from way up and down the roadway. So you made the barrier longer than necessary.**





# Speed up your work



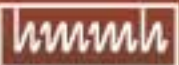


# Speed up your work

<http://www.hmmh.com/>

- You have 100 receivers, 30 project roadways and 15 non-project roadways.
- To account for quieter project pavement, how many mouse clicks are needed to enter Receiver Adjustment Factors?
- **27,000 with TNM 2.5**  
**37 with TNM 2.0**

**Please request that the 2.0 method be restored.**



**Adjustment List for R2-3** [X]

Adjustment factors are applied to individual roadway segments in TNM. To assign a single adjustment factor to a receiver, assign the adjustment factor to all roadways, all segments. Use the shift key to select multiple segments of each roadway.

Assigned Adjustment Factors  
(Roadway::Seg# - Adj. Fctor)

Turtle Road SB::15 - Factor=-0.0
Turtle Road NB::11 - Factor=-0.0

Roadways

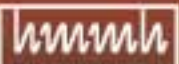
I95EB

Segments

- 3
- 4
- 28
- 17
- 23
- 30
- 29
- 6
- 7
- 8

Remove [→]      Add [←]

OK [✓]      Cancel [X]      Help [?]



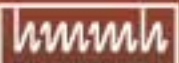


# Speed up your work

<http://www.hmmh.com/>

- You have a barrier across the roadway from your receivers.
- How can you include reflections from it?
- Use “image roadway segments.”

Please request that TNM’s single-reflection code be debugged and turned on.





# Speed up your work

<http://www.hmmh.com/>

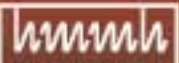
- With the Barrier Design Table, you want to watch barrier noise reduction change as you shift-up and shift-down the barrier segments.
- Under what two circumstances won't this yield proper noise reductions?
- **Quiet Pavement:** If you non-project roadways separately, then combine in spreadsheet.
- **Non-roadway ambient:** You must compute project noise, then combine with non-roadway ambient in spreadsheet.

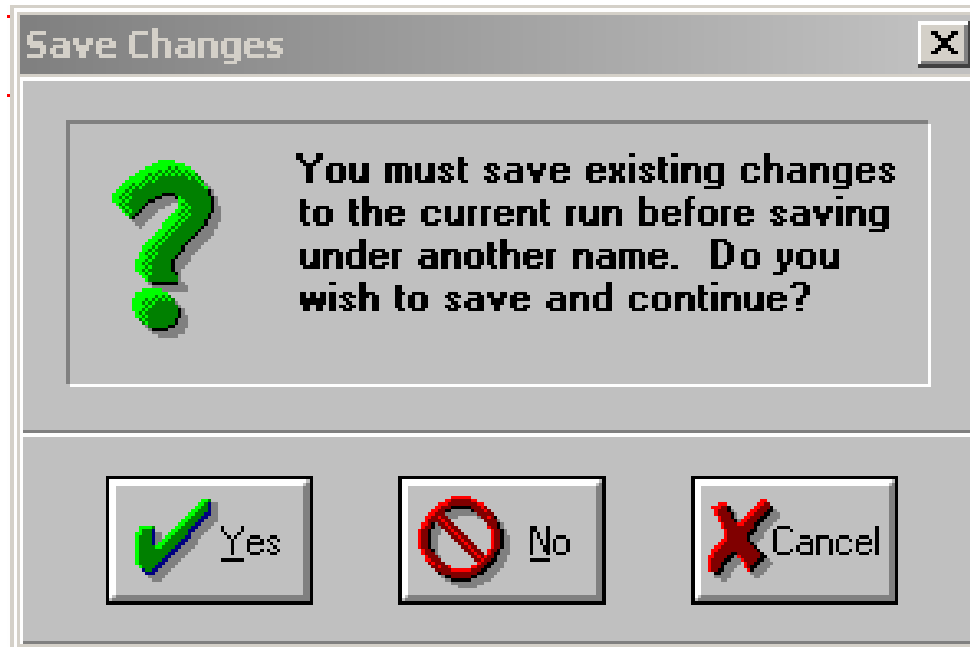
# Speed up your work

<http://www.hmmh.com/>

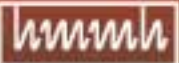
- You computed “existing conditions,” and now want to change all traffic to “future, no action.”
- What should you do first before changing traffic?
- **File, Save As to a different name.**

**Please request requirement be eliminated.**





# Avoid TNM confusions

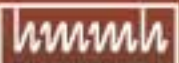


# Avoid TNM confusions

<http://www.hmmh.com/>

- Your barrier input header says the barrier's height is 16 feet.
- But the table below the header disagrees.
- Which is correct?
  
- The table is correct.
- Some parts of the header are only for input "defaults."

**Please request that headers be clarified.**



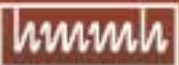
Name:	Main barrier	Pert. Increment (m):	0.50	# Pert. Up:	8	# Pert Dn:	4
Barrier Type:	Wall	Height (m):	4.00	Min. Height (m):	0.00	Max. Height (m):	8.00



# Avoid TNM confusions

<http://www.hmmh.com/>

- You imported your receiver points from MicroStation, but they never showed up in TNM.
- Why not?
- **TNM cannot import “points.”**



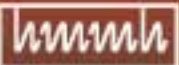
## Connect receivers with a line, then import into TNM



# Avoid TNM confusions

<http://www.hmmh.com/>

- Your 16-foot barrier properly intervenes—horizontally and vertically—between roadway and receiver.
- But it provides zero noise reduction.
- What is wrong with your input?
- You entered “zero” for all three barrier perturbation parameters.

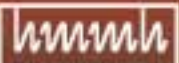


### Fixed-height barrier: Zero noise reduction

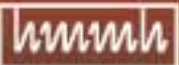
X [m]	Y [m]	Z(bottom) [m]	Height [m]	Increment [m]	#Up	#Dn
16.9	47.2	61.20	6.00	0.00	0	0
24.4	47.2	61.50	6.00	0.00	0	0
31.6	46.9	61.75	6.00	0.00	0	0
39.7	46.9	61.75	6.00	0.00	0	0
48.9	46.9	62.50	6.00	0.00	0	0
70.2	46.7	63.44	6.00	0.00	0	0
78.3	46.4	62.60	6.00	0.00	0	0
86.0	45.8	62.00	6.00	0.00	0	0
93.2	45.2	61.00	6.00	0.00	0	0
101.9	44.4	60.30	6.00	0.00	0	0

### Single-height barrier (will have noise reduction)

X [m]	Y [m]	Z(bottom) [m]	Height [m]	Increment [m]	#Up	#Dn
16.9	47.2	61.20	6.00	1.00	0	0
24.4	47.2	61.50	6.00	1.00	0	0
31.6	46.9	61.75	6.00	1.00	0	0
39.7	46.9	61.75	6.00	1.00	0	0
48.9	46.9	62.50	6.00	1.00	0	0
70.2	46.7	63.44	6.00	1.00	0	0
78.3	46.4	62.60	6.00	1.00	0	0
86.0	45.8	62.00	6.00	1.00	0	0
93.2	45.2	61.00	6.00	1.00	0	0
101.9	44.4	60.30	6.00	1.00	0	0



# Avoid FHWA surprises

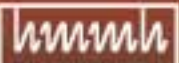




# Avoid FHWA surprises

<http://www.hmmh.com/>

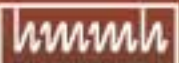
- You have entered all proper TNM input: Land use, roadway plans/profiles/sections, pavement types, traffic.
- Why might FHWA require revised computations?
- You entered PCC pavement instead of Average Pavement.



# Avoid FHWA surprises

<http://www.hmmh.com/>

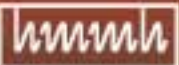
- Tree attenuation with Stamina was greater than with TNM.
- So you entered these larger values as Adjustment Factors?
- Why might FHWA require revised computations?
- **FHWA requires TNM's built-in values, using Tree Zones.**



# Avoid FHWA surprises

<http://www.hmmh.com/>

- You input a Tree Zone, because it completely blocks view of the roadway during months when homeowners use their outdoor spaces.
- Why might FHWA require revised computations?
- For Tree Zones, FHWA requires that trees retain their leaves during the winter.

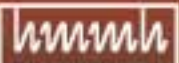




# Avoid FHWA surprises

<http://www.hmmh.com/>

- Almost all the heavy trucks in your state have low exhausts.
- So you decrease TNM's heavy-truck Subsource Height (in Setup/General).
- Might FHWA require revised computation?
- **No. That input does not affect noise-level computations.**



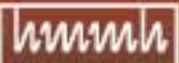
## Subsource heights: Acoustical computations

12 ft	<input type="radio"/>
5 ft	<input type="radio"/>
0 ft	<input checked="" type="radio"/>

## Subsource height: Line-of-sight check

Line-of-Sight Check

Subsource Height (ft):	<input type="text" value="11.5"/>	Distance Limit (ft):	<input type="text" value="500.00"/>
------------------------	-----------------------------------	----------------------	-------------------------------------



**Self-serving link to hidden quiz answers:  
[www.hmmh.com/tnm\\_refsheets.html](http://www.hmmh.com/tnm_refsheets.html)**

