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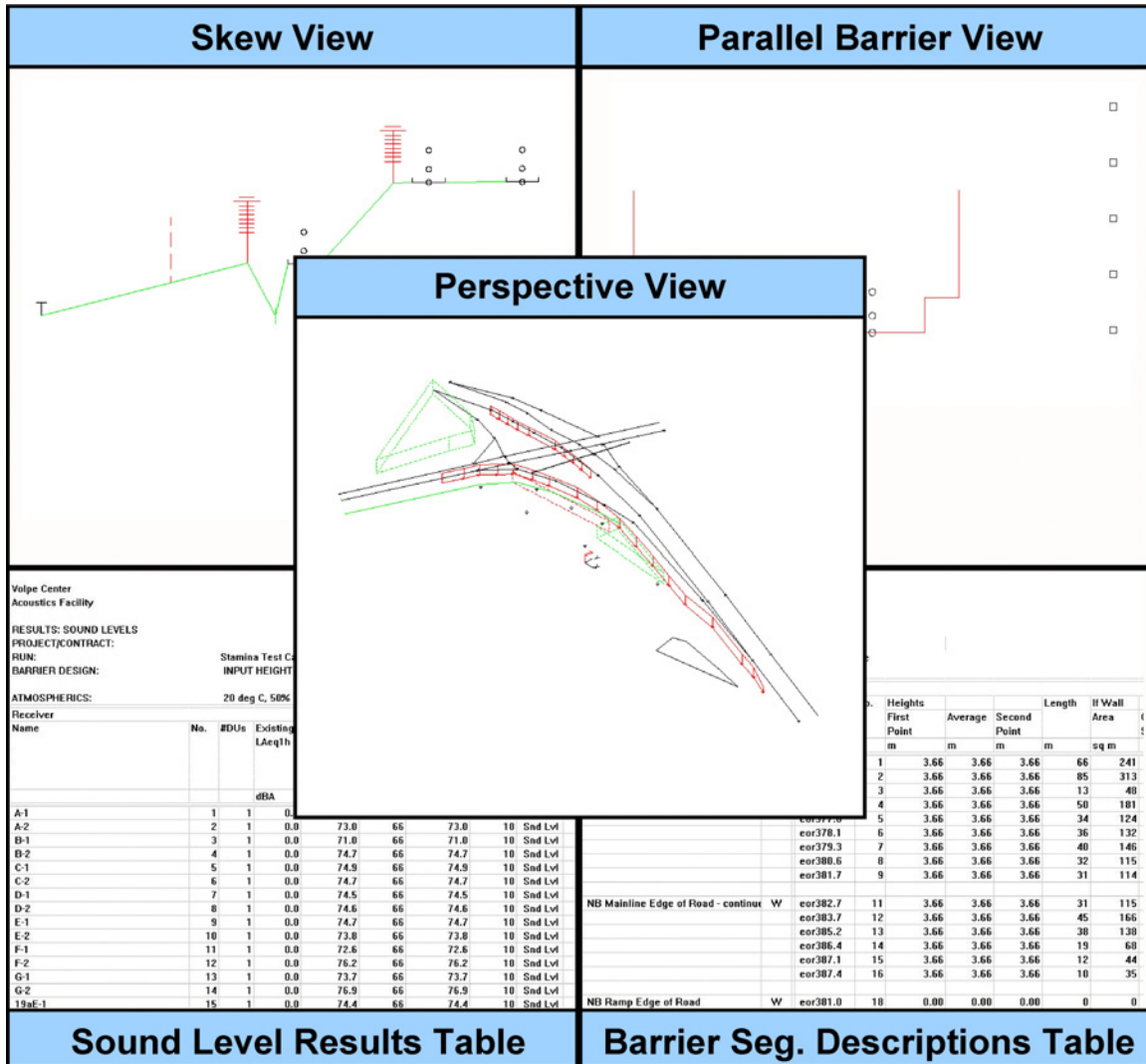of Transportation**

**Federal Highway
Administration**

FHWA TRAFFIC NOISE MODEL®
USER'S GUIDE
(VERSION 2.5 ADDENDUM)

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13. ABSTRACT (Maximum 200 words)

In March 1998, the Federal Highway Administration (FHWA), Office of Natural and Human Environment, released the FHWA Traffic Noise Model (TNM), Version 1.0, a state-of-the-art computer model for highway traffic noise prediction and analysis. Since then, the FHWA, with assistance from the Volpe Center Acoustics Facility (Volpe Center) and Foliage Software Systems (FSS), have released updates of TNM (Versions 1.0a and 1.0b) in March 1999 and August 1999, respectively. In support of the FHWA and the California Department of Transportation, the Volpe Center and FSS released Version 1.1 in September 2000. Two additional updates were released: TNM 2.0 in May 2002 and TNM 2.1 in March 2003. TNM 2.5 is the latest version of TNM. Two companion reports were released with TNM Version 1.0, a Technical Manual that describes the acoustics within TNM and a User's Guide. In addition, prior to TNM release, a data report was published that describes the vehicle noise-emissions database within TNM. This document is an addendum to the FHWA TNM Version 1.0 User's Guide. It details the enhancements in the program up to and including Version 2.5.

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PREFACE

In March 1998, the Federal Highway Administration (FHWA), Office of Natural and Human Environment, released the FHWA Traffic Noise Model (TNM), Version 1.0, a state-of-the-art computer model for highway traffic noise prediction and analysis. Since then, the FHWA, with assistance from the Volpe Center Acoustics Facility (Volpe Center) and Foliage Software Systems (FSS), have released updates of TNM (Versions 1.0a and 1.0b) in March 1999 and August 1999, respectively. In support of the FHWA and the California Department of Transportation, the Volpe Center and FSS released Version 1.1 in September 2000. Two additional updates were released: TNM 2.0 in May 2002 and TNM 2.1 in March 2003. TNM 2.5 is the latest version of TNM.

Two companion reports were released with TNM Version 1.0: a Technical Manual that describes the acoustics within TNM and a User's Guide (References 1, 2). In addition, prior to TNM release, a data report was published that describes the vehicle noise-emissions database within TNM (Reference 3). This document is an addendum to the FHWA TNM Version 1.0 User's Guide. It details the enhancements in the program up to and including Version 2.5.

ACKNOWLEDGMENTS

Special thanks go to the TNM 2.5 beta test team. The staff at Bowlby and Associates, Inc., Harris Miller Miller and Hanson, Inc., and Environmental Acoustics, Inc. provided invaluable assistance during development of TNM 2.5.

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1. GETTING STARTED

This section lists TNM's hardware and software requirements and provides instructions on how to install TNM.

1.1 How to Use This User's Guide Addendum

This User's Guide Addendum is essential to both the experienced and inexperienced TNM user. It details the enhancements in the program up to and including Version 2.5. This addendum should be used to supplement the TNM 1.0 User's Guide, which should be utilized as the primary TNM information source. New users should also use the "TNM Trainer" CD-ROM, the interactive tutorial that is included with the initial purchase of the TNM package (Reference 4). For quick-reference help, users can select the <u>H</u>elp menu while using TNM, or peruse the ***Frequently Asked Questions*** on the TNM website (http://www.thewalljournal.com/a1f04/tnm). In addition, TNM sometimes "pops up" brief help information during various operations (see Section 7.1 in the TNM 1.0 User's Guide).

The different typeface and icon conventions used in this User's Guide Addendum are as follows:

Bold   Bold is used for emphasis and to introduce new terms, which are defined in Section 2, Terminology, of the TNM 1.0 User's Guide.

<u>Underline</u> Underline is used to denote an available shortcut key to invoke a menu or submenu item. For example, to invoke the <u>H</u>elp menu while using TNM, press the Alt+H keys.

A light bulb icon points out helpful tips, suggestions, engineering hints, and shortcuts that may save you time.

A stop sign icon represents warnings and when to pay special attention in order to avoid unexpected results.

A Department of Transportation icon directs the user to refer to Appendix A of the TNM 1.0 User's Guide for FHWA policies relating to a topic.

1.2 Contents of the TNM Version 2.5 CD-ROM

The TNM Version 2.5 CD-ROM contains the following:

- FHWA TNM Version 2.5
- FHWA Memorandum
- TNM 2.5 Release Notes
- TNM 2.5 User's Guide Addendum
- TNM 2.5 Technical Manual Update Sheets
- TNM 2.5 Validation Phase 1 Preview
- Updated TNM FAQs with Guidelines

Note: TNM Version 2.5 is the latest upgrade to the TNM Version 1.0 release package. It is a free upgrade to users of TNM 2.0 and 2.1. Users who purchased any version of TNM on or after March 1, 2002, may also obtain the 2.5 upgrade at no charge. Registered users of TNM Versions 1.0, 1.0b, and 1.1 can upgrade to TNM 2.5 for $495.

Information on how to purchase TNM can be found on the McTrans website (http://mctrans.ce.ufl.edu) or by contacting McTrans directly at:

> McTrans Center
> University of Florida
> 2088 Northeast Waldo Road
> Gainesville, FL 32609
> (352) 392-0378
> Fax: (352) 392-3224

Additional information on TNM 2.5 can be found on the official TNM website (http://www.thewalljournal.com/a1f04/tnm). The website contains this TNM Version 2.5 User's Guide Addendum in Adobe Acrobat PDF file format, as well as contact information for technical support.

1.3 System Requirements

Beginning with the release of Version 1.1, TNM has been upgraded from a 16-bit Microsoft® Windows application to a 32-bit Windows application. This change effectively removes any platform dependence, allowing TNM to run more efficiently, regardless of the Windows operating system (Windows 98/NT/2000/XP). It should be noted that this change has also obviated TNM use on previous Windows operating systems (e.g., Windows 3.1, since 3.1 is a 16-bit platform).

Substantial improvements to computational run-time have been shown during testing, with most cases computing in approximately half the time. A run-time comparison of the official TNM test case (see Section 3) is shown below for several combinations of hardware and operating systems. The test case consists of the following: 9 roadways, 1 barrier (with 3 perturbations up and down), 2 terrain lines, and 32 receivers.
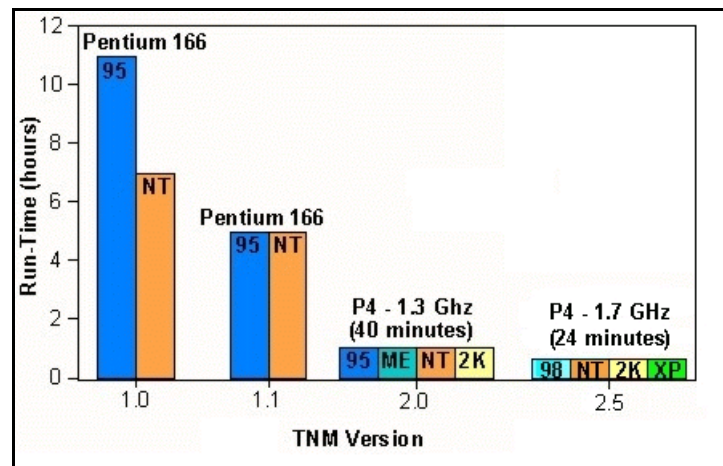
Figure 1. TNM run-time comparison

System requirements for TNM Version 2.5 are:

- Microsoft® Windows 98/NT/2000/XP
- 500 MHz Intel® Pentium or equivalent, Pentium III recommended
- 32 MB of RAM or above recommended
- 10 MB of available hard-disk space for installation
- Up to 1 MB of available hard-disk space for each TNM run
- Super VGA (1024 x 768), 16-bit colors, configured with "small" fonts
- CD-ROM compatible drive

Although TNM may run on a less efficient computer than recommended above, some capabilities may be affected, including the graphical user interface or noise calculation run times. For additional information, refer to Section 1.3 in the TNM 1.0 User's Guide.

1.4 Installation

To install TNM:

1. On the Windows taskbar, click [Start]. Select Run.
2. Click [Browse]. Navigate to your CD-ROM drive.
3. Double-click on Setup.exe and follow the onscreen instructions.*

*Note, when choosing a directory to install TNM Version 2.5, you must choose a directory on your local (or network) drive that meets DOS requirements (e.g. C:\TNM25). Do not use a directory that contains spaces and periods anywhere in the pathname. Calculating contours in TNM requires use of NMPlot, a DOS program. DOS programs cannot understand long file names (8 character max in TNM) or names with spaces, periods, or other DOS-illegal characters (e.g., ' / , ; ^ + [ ] " = * ? | < : >).

1.5 Source Code Licensing Agreement

FHWA TNM is a registered copyright and trademark, which encompasses the User's Guide, Technical Manual, and software source and executable codes. For developers interested in obtaining the software source code, acceptance of the TNM Source Code Licensing Agreement is a prerequisite. Under the terms of the Licensing Agreement, any modifications, enhancements, or derivatives of TNM, as well as distribution of the modified source code, which makes reference to the FHWA's trademarks, are strictly prohibited without the express written permission of the FHWA.

See Appendix A in the TNM 1.0 User's Guide for FHWA policy related to TNM Copyright and Trademark.

1.6 Technical Support

Services are available to help you with your questions. Registered owners are entitled to receive technical support and information on upgrades and supplementary guides.

■ For installation and supplementary guide information, users may contact the Center for Microcomputers in Transportation (McTrans) at (352) 392-0378 or on the web at http://mctrans.ce.ufl.edu.

■ For technical support, users may visit the TNM website at http://faq.trafficnoisemodel.org where a comprehensive *Frequently Asked Questions* webpage is available. Users may also contact TNM technical support at the Volpe Center at (617) 494-2372 or via email at support@trafficnoisemodel.org.

2. WHAT'S NEW

This section discusses the enhancements that have occurred in TNM since Version 2.5. It includes changes implemented in versions 1.0a, 1.0b, 1.1, 2.0, 2.1, and 2.5. The structure of this entire section is organized by TNM menu and function items to facilitate referencing within the TNM graphical user interface and this User's Guide Addendum.:

- ■ File Menu: Section 2.1;
- ■ Edit Menu: Section 2.2;
- ■ View Menu: Section 2.3;
- ■ Setup Menu: Section 2.4;
- ■ Input Menu: Section 2.5;
- ■ Calculate Menu: Section 2.6;
- ■ Barrier Analysis Menu: Section 2.7;
- ■ Parallel Barriers Menu: Section 2.8;
- ■ Contours Menu: Section 2.9;
- ■ Tables Menu: Section 2.10; and
- ■ Non-menu Items: Section 2.11.

Below is a summary table of TNM modifications that have been made since version 1.0.

Table 1. TNM updates and improvements.

Menu	Menu Item	Modification	Implemented in TNM Version:
- All -	-	Implemented/improved 32-bit coding architecture, effectively removing any platform dependence and substantially improving computational run-time.	1.1 and 2.0
	-	Clicking on a background window will bring it to the foreground.	2.1
	-	Hard drives 2.1 GB and greater in size no longer generate an "out of space" error.	2.1
	-	Status bar redesigned and enlarged.	2.1
	-	Editing object names or notes no longer invalidate sound level results. Object names and notes are dynamically linked and appear as their current names in the tables.	2.1

Table 1. TNM updates and improvements.

Menu	Menu Item	Modification	Implemented in TNM Version:
	-	Improvement to the implementation of the vehicle emission level database - a more comprehensive methodology applied in correcting the measured emission levels back to the source.	2.5
	-	Bug in the acoustics code was identified and corrected, where related diffraction algorithm parameters were improved.	2.5
File	New	Eliminated eight-character run-name restriction.	1.1
	Open	Added "Convert Run" dialog. Runs created in previous versions can be backed-up, then converted for use in TNM 1.1/2.0/2.1/2.5	1.1
	Import Stamina-2.0 Input File	Corrected import of Stamina shielding factors.	2.1
	Import DXF File	Updated functionality to support compatibility with AutoCAD® 2000.	1.1 and 2.0
		Added "cancel" option to cancel deletion of unconverted DXF objects when prior to closing a run.	1.1
		Corrected scaling of metric DXF files.	2.0
	Cleanup Run	Added new menu item used to correct database errors, as necessary.	1.0b
Edit	-	Added ability to use the Snap tool in conjunction with Move.	1.1
Setup	General	Implemented invalidation of results with applied default ground type changes.	1.1
Input	-	For all input dialogs, changes to data in a dialog's spreadsheet area are reflected in RED until the user selects the Apply button to apply the changes.	1.1
		Corrected "paste" functionality in all dialogs.	2.0
	Roadway	Changed the weighting factor for Lden computation for consistency with state law in California.	1.0b
	Receiver	Implemented change to receiver input dialog such that all receivers are displayed on a single spreadsheet page.	1.1

Table 1. TNM updates and improvements.

Menu	Menu Item	Modification	Implemented in TNM Version:
		Added ability for users to "activate" or "deactivate" specific receivers to be calculated.	1.1
		Corrected scroll buffer which caused problems in runs with many receivers.	2.0
		Corrected allowance of negative adjustment factors.	1.1
		Function added to better handle non-intersecting objects in close proximity, which reduces the occurrence of "invalidated" receivers.	2.1
		Input method for adjustment factors redesigned.	2.1
		Adjustment Factors dialog box dynamically linked to the Receiver Adjustment Factors table.	2.1
	Barriers	Noise reduction coefficient (NRC) values restricted to 0.00-0.95.	2.1
		Changing NRC values invalidates sound level results.	2.1
		A pop-up warning box is generated each time a user enters a non-zero value for berm width and prohibits the user from adding width to a berm.	2.5
	Contour Zone	Modified functionality such that changes to a contour zone input no longer invalidates results.	1.1
	Adjustment Factors	Corrected allowance of negative adjustment factors.	1.1
	Input Check	Added several new input checks.	1.1
Calculate	-	Implemented an error-catching mechanism to eliminate fatal crashes during computations.	1.0b
	-	Calculations for Ldn and Lden have been modified to incorporate accurate numbers of hours.	2.1
	Multiple Runs	Added ability to calculate sound levels in batch-mode for multiple runs.	1.1
Barrier Analysis	-	Directional arrow keys now fully active for panning views in Barrier Design.	2.1
Parallel Barriers	Cross Section	Noise reduction coefficient (NRC) values are restricted to 0.00-0.95.	2.1
Contours	-	Updated NMPlot to Version 3.06.	1.1
		Corrected linkage to NMPlot module.	2.0
Tables	-	Added display of the version of TNM used to compute the sound level results.	1.1

Table 1. TNM updates and improvements.

Menu	Menu Item	Modification	Implemented in TNM Version:
	-	A "calculated with" current version number stamp appears in all results tables.	2.1
	Sound-level Input	In barrier input table, column widths have been resized to allow all fields to be displayed without horizontal scrolling.	2.1
	Barrier Design	Added new output table.	1.1
		Dollar amounts rounded to the nearest whole dollar.	2.1
		Includes additional cost values when calculating "Total Cost, All Barriers".	2.1
		When barrier height is perturbed, related values are dynamically calculated.	2.1
		Total Cost, All Barriers field is dynamically updated if the Cost in the barrier input dialog box is changed.	2.1
		Design of barrier design table updated and simplified.	2.1
	Barrier Descriptions	Values over $500,000 are displayed properly.	2.1
	Hide Rows	Hide Rows function fully operational.	2.1
	Print Tables	Added menu item which allows printing of multiple input/output tables at once.	1.1
		Corrected problems printing tables.	2.0

2.1 F̲ile Menu

2.1.1 N̲ew. When creating a new run in TNM Version 1.1, 2.0 , 2.1 or 2.5, it is important to note that because TNM has been upgraded from a 16-bit Windows application to a 32-bit Windows application, the eight-character run-name restriction no longer exists.

It is also important to note that any run created using TNM Version 2.0 and above will not open in 16-bit versions of TNM (i.e., versions 1.0, 1.0a, and 1.0b). However, runs created in previous versions of TNM (1.0, 1.0a, 1.0b, and 1.1) can be opened in TNM 2.0, 2.1 and 2.5.

2.1.2 O̲pen. Opening a Version 1.0, 1.0a, or 1.0b TNM run will display the **Convert Run** dialog (see Figure 2). Once the user selects OK, TNM will automatically convert and open the selected run into a Plan View. Note to use the original unconverted run, save a backup of the run before selecting the OK button in the Convert Run dialog. The "Save Backup of Run" checkbox in the dialog allows the user to automatically save a copy of a run as "Backup of Run_Name" prior to conversion.
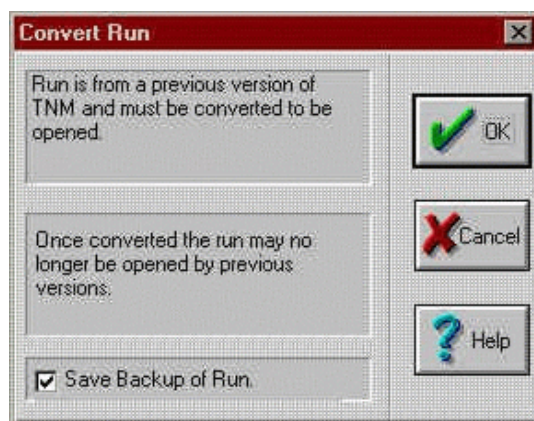
Figure 2. Convert Run dialog.

Save a backup of your runs: Always save a backup copy of an original TNM run prior to opening it in TNM. If a backup copy of the run is not saved, then once that run has been converted by TNM 2.5, it cannot be opened in previous versions of TNM (except Version 1.1).

2.1.3 I̲mport a STAMINA 2.0/OPTIMA File. TNM allows the user to import a STAMINA 2.0/OPTIMA file. Prior to Version 2.1, TNM did not correctly import STAMINA shielding factors. This has since been corrected. To import shielding factors into TNM, be sure to select the **Import Shielding Factors** check box in the **Import STAMINA 2.0 Input File** dialog window (see Section 4.7.1 in the TNM 1.0 User's Guide for more details).

💡 **Shielding factors and adjustment factors:** TNM imports shielding factors from STAMINA files as adjustment factors (see Section 8.4.4 in the TNM 1.0 User's Guide). Typically, shielding factors in STAMINA files were used to account for things such as building row and tree zone effects. However, in most cases, do not import them, but rather model building rows and tree zones explicitly in TNM. An exception would be where STAMINA factors were developed from measured data. The user may wish to input/edit TNM adjustment factors to account for parallel barrier degradations between receiver-roadway pairs and propagation effects not calculated by TNM – for example, wind effects.

2.1.4 Import a DXF File. Since TNM Version 2.0 the DXF import functionality was substantially updated to support compatibility with AutoCAD® 2000 objects. The following table shows all the DXF objects available in AutoCAD® 2000 and indicates which items TNM can and cannot import.

Table 2. DXF Import Items.

DXF Item	Import Object for Conversion	Import as Background
3DFace	No	Yes
3DSolid	No	No
ACAD_Proxy_Entity	No	No
Arc[1]	Yes	Yes
Arcaligned text[2]	No	Yes
Attdef	No	No
Attrib	No	No
Body	No	No
Circle[1]	Yes	Yes
Dimension[2]	Yes	Yes
Ellipse	Yes	Yes
Hatch	No	No
Image	No	No
Insert[2]	Yes	Yes
Leader	No	No
Line	Yes	Yes

Table 2. DXF Import Items.

DXF Item	Import Object for Conversion	Import as Background
LWPolyline	Yes	Yes
Mline	No	Yes
Mtext[2]	No	Yes
Oleframe	No	No
Ole2frame	No	No
Point	No	No
Polyline[3]	Yes	Yes
Ray	No	No
Region	No	No
Rtext	No	No
Seqend	Yes	Yes
Shape	No	No
Solid	No	Yes
Spline	Yes	Yes
Text	No	No
Tolerance	No	No
Trace	No	Yes
Vertex	No	No
Viewport	No	No
Wipeout	No	No
Xline	No	No

1   Arcs and circles are converted into a series of straight segments.
2   When you import a DXF file for conversion into TNM, DXF labels and other text are placed in the DXF Background, which is not normally displayed by default. To view labels/text, you must select Show/Hide in the View menu, then check the "DXF Background" check box in the "Show Objects" column (see also Section 6.2 in the TNM 1.0 User's Guide).
3   Polylines are imported if the polyline or any of its vertices are complex, i.e., curve-fit, spline-fit, mesh, or polyface mesh.

Importing DXF Point Objects: TNM does not import DXF points. As a work-around, the user may connect points with polylines in the CAD program prior to import, then after import, snap-digitize TNM receivers to the DXF points in the polylines.

Unconverted DXF Objects: A Cancel option is available so that the user may cancel closing the run before unconverted DXF objects are deleted.

2.2 <u>E</u>dit Menu

2.2.1 Move. As mentioned in the TNM 1.0 User's Guide, the Move capability is not a menu option; it is only available in the Plan View using the Ctrl key and a mouse. This selection is used to graphically relocate a selected object, or portions of an object, to a new location, i.e., change the XY coordinates. TNM has the added ability for the user to also use the Snap tool in conjunction with Move. This aids the user in moving objects or points of objects and "snapping" them to other objects, e.g., placing a barrier on structure or a wall on top of a berm for a combination barrier.

2.3 <u>V</u>iew Menu

2.3.1 <u>S</u>how/Hide. For all graphical views, any of TNM's input objects, as well as the aspects of those objects (e.g., point name and number), may be selected to be shown or hidden. This option is helpful in keeping complex cases from appearing cluttered and difficult to read. If point name/number text is not displayed after Show/Hide check boxes have been "checked," the TNM 1.0 User's Guide advises the user to first check their computer "TGLINK" settings. This was usually sufficient for most users - however, for some Windows NT Version 4.0 users, the following may also need to be checked:

1. On the Windows taskbar, click [Start]. In Settings click on **Control Panel**.
2. Open the **System** icon.
3. When the **System Properties** dialog is displayed, select the **Environment** tab.
4. In the **Variable** field, type **TGLINK**.
5. In the **Value** field, type in the TNM program directory (e.g., **C:\TNM\PROGRAM**).
6. Click on the **Set** button and confirm that the settings that were just typed have been added to the **System Variables** and the **User Variables** window lists, respectively.
7. In the **System Variables** window, select **Path** in the **Variable** column. The path statement will then be highlighted and appear in the **Variable** and **Value** fields.
8. Click anywhere within the **Value** field. At the end of the text line, add your TNM directory (e.g., **C:\TNM**.).
9. Click on the **Set** button. Click on the **OK** button to exit **System Properties**. Exit the **Control Panel**.

2.4 Setup Menu

2.4.1 General. General Input includes user preferences that affect TNM calculations. Most changes to TNM input will invalidate computed sound level results. TNM has been updated such that changes to the default ground type will invalidate results. **Use File, Save As to rename a run prior to making any changes. This preserves the original run with its already computed sound level results.**

💡 **Invalidating TNM results:**   After inadvertently changing the default ground type, thus invalidating previously computed results, the user may close the run without saving changes. The original run may then be reopened with previously computed results restored.

2.5 Input Menu

💡 **Input data changes:**   For all input dialogs, changes to data in a dialog's spreadsheet area are reflected in **RED** until the user selects the Apply button to apply the changes.

2.5.1 Roadway Input. In the computation of the community noise equivalent level (L_{den}), a 5-dB penalty is added to evening operations, which equates to a 3.16 weighting factor. For consistency with state law in California, the primary user of the L_{den} metric, the weighting factor has been changed to 3.00.

Calculations for Ldn and Lden have been modified starting in TNM 2.1 to incorporate accurate numbers of hours. The calculations for L_{dn} and L_{den} in TNM Version 2.0 and all previous versions assumed the entered ADT value was split evenly between day and night for L_{dn} and day, evening, and night for L_{den}. Because the calculations were not accounting for the different number of hours included in day, evening, and night, erroneously high sound levels were being calculated for L_{dn} and L_{den}.

L$_{dn}$ (DNL) and L$_{den}$ (CNEL) functions: The ADT distribution is set at 9/24ths night and 15/24ths day for L$_{dn}$ (DNL) [9/24ths night, 3/24ths evening, and 12/24ths day for L$_{den}$ (CNEL)], which assumes the hourly volumes are equal for each of the 24 hours. If this assumption does not apply, compute hourly Leqs for typical hours of the day, then average them together properly in a spreadsheet to calculate L$_{dn}$ (DNL) and L$_{den}$ (CNEL). Specific guidance on how to perform these calculations is found in the FAQs with Guidelines on the TNM website (http://faq.trafficnoisemodel.org) under input-roadways.

Roadway Widths: As with previous versions of TNM, overlapping roadways is still recommended. The overlap can be as little as 0.03 m (0.1 ft). Avoid exactly matching the edges of the roadways. The acoustics processes in TNM 2.5 do behave differently than previous versions, but this recommendation remains.

Roadway Medians: Unlike previous versions of TNM, overlapping roadways and median ground zones is *not* recommended in TNM 2.5. In addition, avoid exactly matching the edges of the ground zones and adjacent roadways. When modeling roadway medians in TNM 2.5, it is important to note, that the minimum recommended median width is still 3.05 m (10 ft). However, if the median is a ground type *other than the default, use a ground zone* to model the median.

2.5.2   Receiver Input. The receiver input dialog has been changed such that information for all receivers are displayed on a single spreadsheet page (see Figures 3 through 5) rather than displaying information for a single receiver (i.e., one receiver at a time). This change allows for more efficient editing of receiver input information.

Figure 3. Changes to Receiver Input dialog: General tab.

Figure 4. Changes to Receiver Input dialog: Levels/Criteria tab.

Figure 5. Changes to Receiver Input dialog: Notes tab.

In the Notes tab shown in Figure 5, users are able to **"activate"** or **"deactivate"** specific receivers for calculations by checking/unchecking boxes in the Active column. Two buttons are also available in the header area to activate and deactivate receivers. All receivers are active by default. Users can use this feature to:

- Compute a newly added receiver(s);
- Compute a specific receiver(s) to see how a small input change affects that receiver(s); and
- Compute a subset of receivers representing a portion of the study to save run-time.

Receiver active/inactive status is displayed in the receiver input table (see Figure 6) and is reflected in the sound level results tables, as well (see Figure 7).[*]

Receiver Input Table : Testcase:2											
Volpe Center						8 April 2004					
Acoustics Facility						TNM 2.5					
INPUT: RECEIVERS											
PROJECT/CONTRACT:		FHWA TNM									
RUN:		Test Case									
Receiver											
Name	No.	#DUs	Coordinates (ground)			Height above Ground	Input Sound Levels and Criteria				Active in Calc.
			X	Y	Z		Existing LAeq1h	Impact Criteria LAeq1h	Sub'l	NR Goal	
			m	m	m	m	dBA	dBA	dB	dB	
A-1	1	1	14,127.8	3,718.0	180.75	1.52	0.00	66	10.0	8.0	Y
A-2	2	1	14,127.8	3,718.0	180.75	4.57	0.00	66	10.0	8.0	Y
B-1	3	1	14,129.0	3,730.1	180.75	1.52	0.00	66	10.0	8.0	
B-2	4	1	14,129.0	3,730.1	180.75	4.57	0.00	66	10.0	8.0	
C-1	5	1	14,146.7	3,743.6	180.75	1.52	0.00	66	10.0	8.0	Y
C-2	6	1	14,146.7	3,743.6	180.75	4.57	0.00	66	10.0	8.0	Y
D-1	7	1	14,159.5	3,745.1	180.75	1.52	0.00	66	10.0	8.0	Y
D-2	8	1	14,159.5	3,745.1	180.75	4.57	0.00	66	10.0	8.0	Y

Figure 6. Changes to Receiver Input table.

---

[*] Note: Results for a "deactivated" receiver will not be available in the sound level results table when a run is calculated with only the active receivers (see Section 2.6.2).

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduct Calculated
			dBA	dBA	dBA	dB	dB		dBA	dB
A-1	1	1	0.0	66.2	66	66.2	10	Snd Lvl	57.5	8.7
A-2	2	1	0.0	67.2	66	67.2	10	Snd Lvl	57.4	9.8
B-1	3	1	0.0	0.0	66	0.0	10	inactive	0.0	0.0
B-2	4	1	0.0	0.0	66	0.0	10	inactive	0.0	0.0
C-1	5	1	0.0	68.5	66	68.5	10	Snd Lvl	59.1	9.4
C-2	6	1	0.0	74.6	66	74.6	10	Snd Lvl	63.3	11.3
D-1	7	1	0.0	68.2	66	68.2	10	Snd Lvl	58.9	9.3
D-2	8	1	0.0	74.4	66	74.4	10	Snd Lvl	63.1	11.3

Figure 7. Changes to Sound Level Results table.

2.5.3 B̲arriers Input. In all versions of TNM, it is recommended that TNM users only use wedge berms (a default berm top-width of 0.0) because TNM had shown some apparent anomalies in the diffraction algorithms for berms with a top width (flat top berms). These anomalies may also surface for other TNM geometries that produce terrain shapes similar to flat top berms (i.e rising slope, leveling off, and then recessing slope). This problem does not manifest itself for geometries that come to a peak, and in many instances, flat top berm geometries can be effectively modeled with wedge berms. In TNM 2.5, a new pop-up warning box is generated each time a user enters a non-zero value for berm width. The message box warns against using flattop berms in TNM and prohibits the user from modeling a flattop berm with the barrier/berm function.
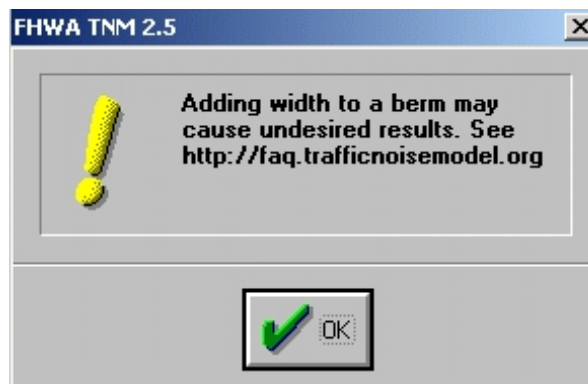

Figure 8. Berm top-width warning message.

When a user enters a noise reduction coefficient (NRC) greater than 0.95 or less than 0 in TNM 2.5, a pop up error message is displayed (see Figure 10).

Figure 9. Invalid NRC value in Barrier Input dialog: Reflections tab.
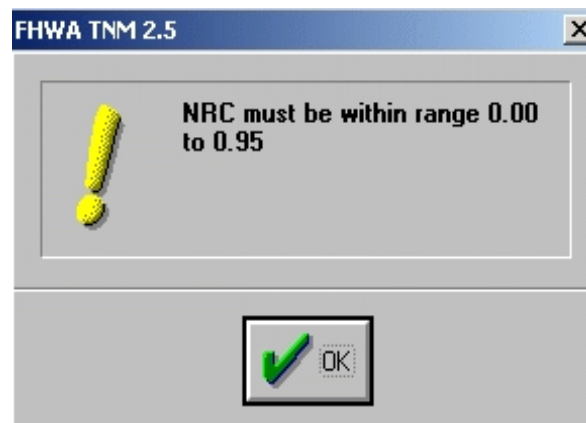

Figure 10. NRC out of range error message.

> 💡 **Changing NRC values will invalidate results:** Starting with TNM 2.1, changing NRC values will invalidate sound level results.

2.5.4 Terrain Lines. In TNM Version 2.5, the user is prohibited from modeling a flat top berm with the barrier/berm function. If modeling flat-top-berm-like geometries with terrain lines, it has been found that by rounding-off any sharp corner geometries in TNM with 2 terrain lines per corner instead of just 1, the anomalies in the diffraction algorithms associated with flattop-berm-like geometries can be minimized and even eliminated. This has been shown to improve results as long as the slope of the "rounded" corner is not too shallow (similar to the flat top; 5:1 run to rise, or greater) or steep (steeper than the slope of the berm).

💡 **Terrain undulations:**   Insert terrain lines in order to provide TNM the general height of the terrain between source and receiver. However, please note that small changes in terrain elevations have little effect on the final sound levels. In general, model terrain lines when there are ground undulations of 1.52 m (5 ft.) or greater. If a more detailed terrain analysis is desired, smaller ground undulations can be included; although TNM automatically "smooths" away minor elevation changes, TNM Version 2.5 does so less aggressively, allowing for greater detail in terrain changes. Remember to take line-of-sight into account when choosing to model a terrain line.

2.5.5 Contour Zones. TNM has been updated such that changes to contour zone inputs do not invalidate computed sound level results.

2.5.6 Adjustment Factors.   Receiver adjustment factors are sound level adjustments in dB that are algebraically added to, not subtracted from, the sound levels calculated by TNM. TNM has been updated such that negative adjustment factors are allowed for input. See Section 8.4.4 in the TNM 1.0 User's Guide for more information.

☯ See Appendix A in the TNM 1.0 User's Guide for FHWA policy related to adjustment factors.

💡 **Shielding factors:**   Prior to Version 2.1, TNM did not correctly convert STAMINA shielding factors into adjustment factors. This has since been corrected. To import shielding factors into TNM, be sure to select the **Import Shielding Factors** check box in the **Import STAMINA 2.0 Input File** dialog window (see Section 4.7.1 in the TNM 1.0 User's Guide for more details).

Input for the Adjustment Factors in the Receivers Input Dialog Box has been redesigned. This was done to clarify some confusion with the previous version of the input, remove unnecessary portions, and make the overall use of adjustment factors easier. The redesign includes:

■   <Select> function removed. All adjustment factor assignments must be done using the <edit> function.

■   Two fields have been removed from the top: "Default Receiver Settings" and "Assigned Adj. Factor (dB)."

■   The "Assigned Factor" column has been removed. Values in this column were used only as defaults when entering the <edit> function, not as assigned adjustment factors.

■   In conformance with standard Windows operations, the Shift key has been enabled for selecting a group of inputs, and the Control key is enabled for selecting multiple inputs.

■   The "Clear All" button has been removed to avoid confusion and miscomprehension about which assignment factors are being removed. Keep in mind that assigned adjustment factor values must be removed before re-assigning a value.

■   In the Adjustment Factors input box, text has been added to the top to give guidance on adjustment factor functionality: "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 roadway."

■   The "Roadway Name" column has been widened.

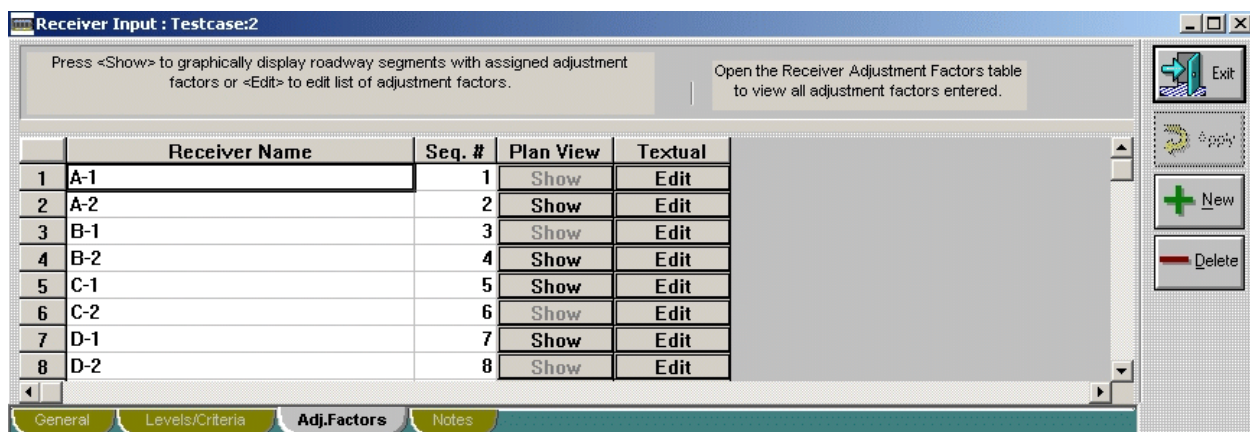■   The Adjustment Factors dialog box is now dynamically linked to the Receiver Adjustment Factors Table.

Figure 11. Changes to Receiver Input dialog: Adjustment Factors tab.

Figure 12. Changes to Adjustment Factors Input dialog box.

Figure 13. Changes to Adjustment Factors Input table.

2.5.7 Input Check. The following input checks have been implemented:

- Single point objects - TNM will display an input check error for objects that consist of only one point with the exception of receivers, and for zones that consist of only two points;
- Objects overlapping roadways - TNM will display an input check error for objects (with the exception of ground zones), which overlap a roadway including the roadway's width; and
- Receivers with zero coordinates - TNM will display an input check error for receivers with all zero (x, y, and z) coordinates.

2.5.8 User-Defined Vehicles. Users who would like to use the User-Defined Vehicles feature can find information on the TNM FAQ page at http://faq.trafficnoisemodel.org under input-Roadways. Users may also contact TNM Technical Support at support@trafficnoisemodel.org for additional guidance.

2.6 Calculate Menu

2.6.1 Error-Catching Mechanism.

Error-catching mechanisms have been implemented in TNM to eliminate any fatal crashes. As such, when TNM encounters a receiver error during computations, the program skips the problematic receiver and continues computations with the next receiver. Any skipped receiver will be identified in TNM output tables as "invalid" (see Figure 14).

Figure 14. Invalidated receiver in Sound Level Results table.

Starting in TNM 2.1, a function was added to better handle non-intersecting objects in close proximity, which reduces the occurrence of "invalidated" receivers.

STOP | **Runs with errors:** Any runs with receivers invalidated should be sent to TNM Technical Support for further testing and diagnosis. A run consists of an OBJECTS.DAT and an OBJECTS.IDX file. Also provide an indication of which receiver the error occurred on and a detailed description of the error message.

TNM Technical Support   Telephone: (617) 494-2372
55 Broadway, DTS-34   Email: support@trafficnoisemodel.org
Cambridge, MA 02142

2.6.2 Multiple Runs. When the user selects Calculate, two menu options are available (see Figure 15): calculate the sound levels for the Current Run; or calculate the sound levels in batch-mode for Multiple Runs.
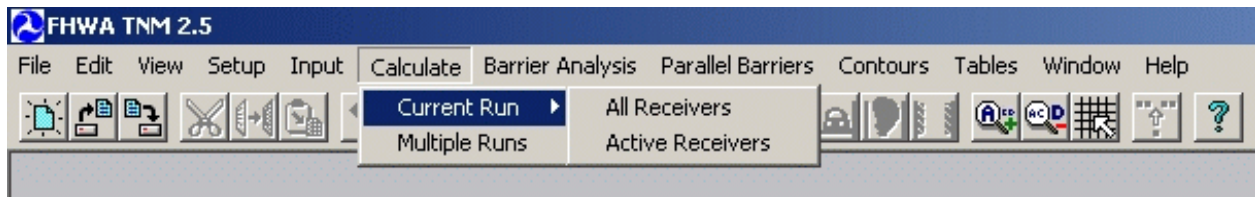
Figure 15. Calculate menu.

STOP | When calculating multiple runs, first close all open runs or else TNM will display a warning.

■ When the user selects Current Run, two options are available: All Receivers and Active Receivers. Selecting All Receivers begins TNM computations immediately on the currently open run. Selecting Active Receivers begins TNM computations on the currently open run for only the receivers marked active in the Receiver Input dialog (see Section 2.5.2).
■ When the user selects Multiple Runs, the **Calculation Manager** dialog is displayed.

In the **Calculation Manager** dialog (see Figure 16), the *Run Name* area displays the list of selected runs. Runs are displayed with their full path name. The list will be automatically scrolled during the batch-mode calculations to ensure that the current run is visible in the list.

Buttons are provided on the right side of the **Calculation Manager** dialog for the following functions:

Figure 16. Calculation Manager dialog.

- *Add Run* - Displays the **Browse for Folder** dialog (see Figure 17) for adding runs to the list of runs to calculate;
- *Remove Run* - Removes a run selected in the **Run Name** list;
- *Remove All* - Clears the entire Run Name list;
- *Start/Continue* - Begins calculating runs. The button is greyed and un-selectable once calculations have started. If a calculation is cancelled, then this button will be changed to a *Continue* button, which when selected, will allow the interrupted calculation to continue (see Figure 18). If any changes are made to the **Calculation Manager** dialog, then this button will revert to a *Start* button to re-initiate calculations from the first run. Runs will be calculated in the order in which they were selected. As each run is calculated, a "gauge" dialog will be displayed to track the progress of that run (exactly as it does for a <u>C</u>urrent Run calculation);
- *Cancel* - Exits the **Calculation Manager** dialog without calculating further runs but will retain the results of any runs already calculated; and
- *Help* - Displays help information regarding the **Calculation Manager** dialog.

Figure 17. Browse for Folder dialog.
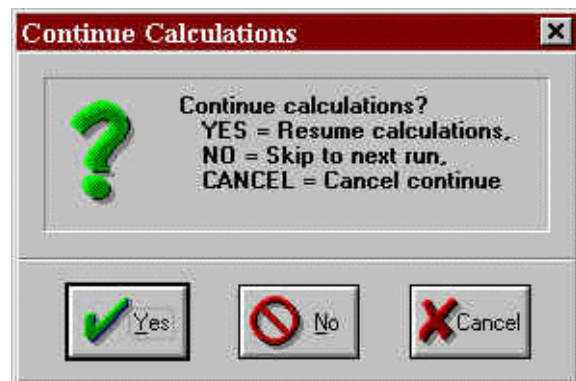
Figure 18. Continuing calculations after cancelling.

A column of icons will be displayed to the left of the list of runs to indicate the status of each run as follows:

☐   Run not yet calculated;

➡   Computations in progress;

☑   Computations finished;

☑   Computations finished, but some receivers were invalidated (see Section 2.6.1);

☒   Computations cancelled; and

☒   Computations failed, errors were detected during input check that need fixing (see Appendix C of the TNM 1.0 User's Guide).

The status is also reported in an **Output Report** window which is generated during multiple-run calculations (see Figure 19). The window displays information from each run as the batch progresses, including the status of the run currently being calculated, the status of runs completed, and each run's total run-time. This report will also indicate if TNM encountered an error during computations, and, if so, how many receivers were invalidated for a particular run (see Section 2.6.1). TNM saves a copy of this report in a file called, batchCalc.out, and places it in the TNM Program subdirectory. This file is over-written each time batch-mode calculations are performed.
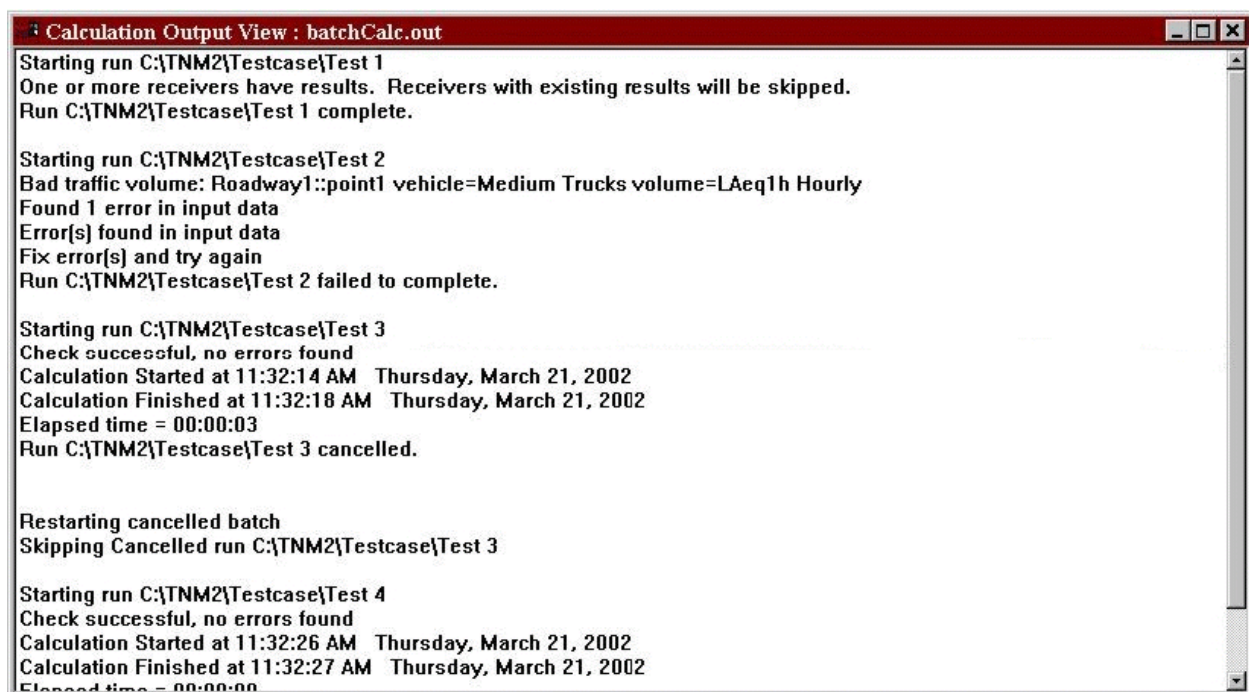
Figure 19. Multiple run (batch-mode) capability: output report.

2.7 Barrier Analysis Menu

2.7.1 Barrier Design View. In TNM 2.1 and above, directional arrow keys are fully active for panning views in Barrier Design.
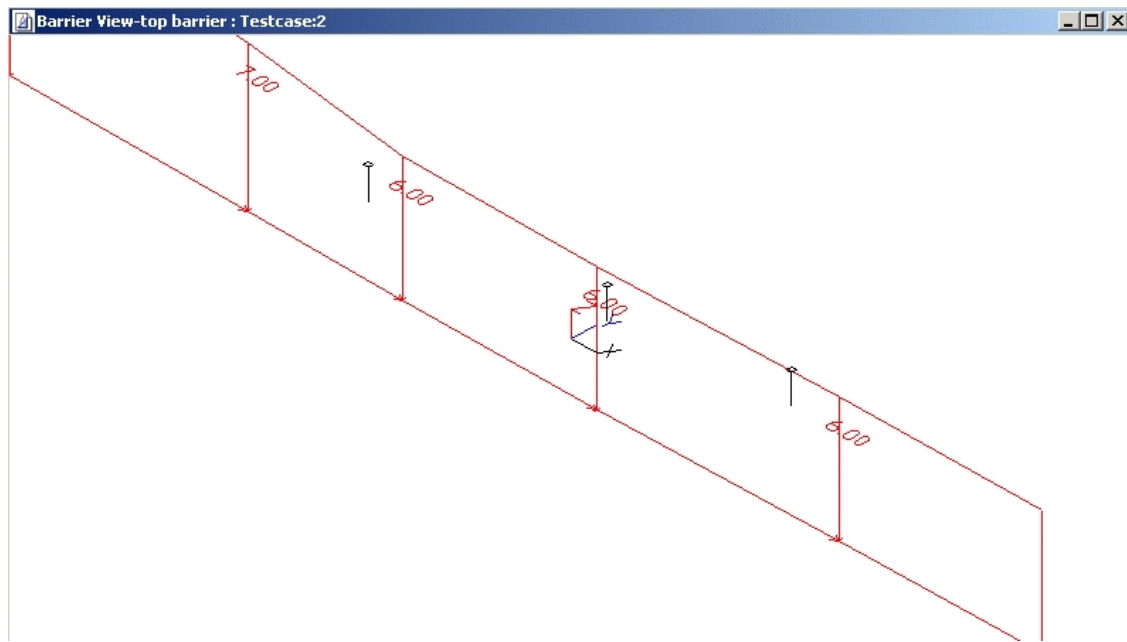
Figure 20. Barrier Design View.

2.8 Parallel Barriers Menu

2.8.1 Cross Section. When a user enters a noise reduction coefficient (NRC) greater than 0.95 or less than 0 for the default value for barrier surfaces in TNM 2.5, a dialog box pops up "NRC must be within range 0.00 to 0.95" (see Figure 22). When entering an NRC value directly in a cell for a specific barrier segment, the value will be limited to the range of 0.00 to 0.95.
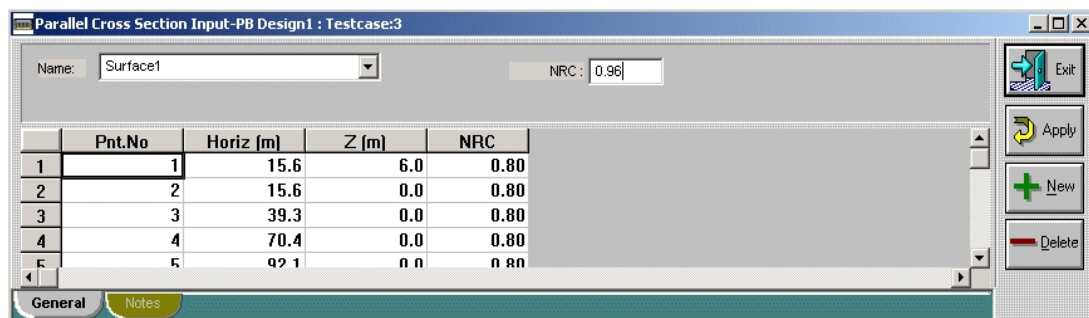
Figure 21. Invalid NRC value in Parallel Barriers: Cross Section dialog box.
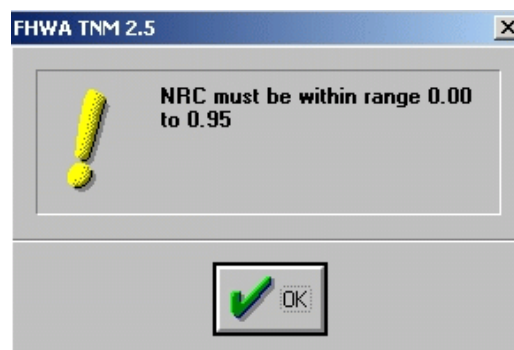
**Figure 22. NRC out of range pop-up
error message.**

💡 **Changing NRC values will invalidate results:** In TNM 2.1 and above, changing
NRC values will invalidate sound level results.

2.9 Contours Menu

2.9.1 Calculating Contours. NMPlot Version 3.06 has been incorporated into TNM. The
previous version of NMPlot was having difficulties running on computers with CPUs faster than
200 MHz giving some users a runtime error message.

Development is underway to incorporate the Windows version of NMPlot (Version 4.7) into
TNM. In the interim, for users who would like to use some of the additional features that can be
found in the Windows Version of NMPlot, it is available on the NMPlot website,
http://www.wasmerconsulting.com/nmplot.htm. To use Version 4.7, download and run
install_nmplot.exe. Once TNM has computed the grid file (*.grd), it may be read by Version 4.7
and used to compute contours external to TNM.

🛑 **"NMPlot Out of Memory" Error:** If a Windows 98 installed computer displays an
"Out of Memory" error while running NMPlot, modify the computer's memory
allocation for MS-DOS applications as follows: open an MS-DOS window; select the
MS-DOS window's upper-left icon; select Properties in the resultant pull-down menu;
select the Memory tab; then increase the values shown. Users may need to consult with
their system administrator for additional assistance.

🛑 **"Run-time 216" Error:** If a TNM run uses very large coordinates (e.g., greater than 1,000,000.00, NMPlot may display this error. By scaling all the coordinates down a few decimal places, TNM should be able to compute the contours.

🛑 **"Noisemap Grid File Could Not Be Opened" Error:** NMPlot is a DOS application with an 8-character filename/directory limit. If the TNM run is greater than 8-characters or is embedded within many subdirectories or has long subdirectory names, then NMPlot may display this error. Reduce the number of characters in the run name or move the run to the root directory (C:\) to run contours.

2.10 Tables Menu

2.10.1 Version Identification. In the right header area, TNM displays the current date and the version of TNM that is being used. An additional line of text has been added to let the user know which version of TNM was used to calculate the results being displayed (see Figure 23).

Volpe Center						2 April 2004		
Acoustics Facility						TNM 2.5		
						Calculated with TNM 2.5		
RESULTS: SOUND LEVELS								
PROJECT/CONTRACT:		FHWA TNM						
RUN:		Test Case						
BARRIER DESIGN:		INPUT HEIGHTS				Average pavement type shall be us		
						a State highway agency substantia		
ATMOSPHERICS:		20 deg C, 50% RH				of a different type with approval of		

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Redu Calculated
			dBA	dBA	dBA	dB	dB		dBA	dB
A-1	1	1	0.0	66.2	66	66.2	10	Snd Lvl	57.5	8.7
A-2	2	1	0.0	67.2	66	67.2	10	Snd Lvl	57.4	9.8
B-1	3	1	0.0	68.5	66	68.5	10	Snd Lvl	59.1	9.4
B-2	4	1	0.0	70.1	66	70.1	10	Snd Lvl	59.4	10.7
C-1	5	1	0.0	68.5	66	68.5	10	Snd Lvl	59.1	9.4
C-2	6	1	0.0	74.6	66	74.6	10	Snd Lvl	63.3	11.3
D-1	7	1	0.0	68.2	66	68.2	10	Snd Lvl	58.9	9.3
D-2	8	1	0.0	74.4	66	74.4	10	Snd Lvl	63.1	11.3

Figure 23. Version identification in all results tables.

2.10.2 Hide Rows. The Hide Rows function is fully operational in TNM 2.1 and above. Please refer to section 13.4 in the TNM 1.0 User's Guide for information on how to use the Hide Rows function.
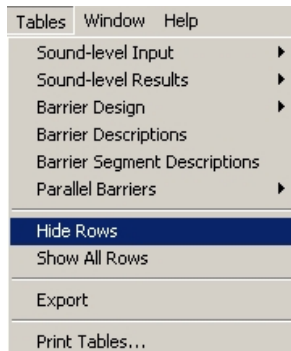
Figure 24. Tables Hide Rows menu item.

Figure 25.   Sound Level Results table with Hide Rows function enabled.

2.10.3 Print Tables. A new menu item in the Tables menu, Print Tables, has been implemented to allow the user to print all TNM tables at once (see Figures 26 and 27). When the user selects this menu item, TNM displays a **Print Tables** dialog that lists all TNM tables (labeling each as an Input or Results table). The user can individually select tables by highlighting/clicking on the them in the list.
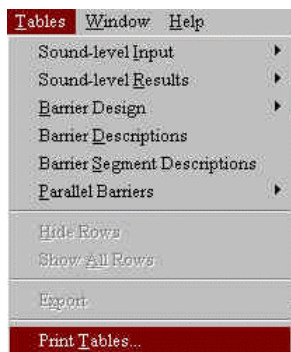
Figure 26. Print Tables menu item.
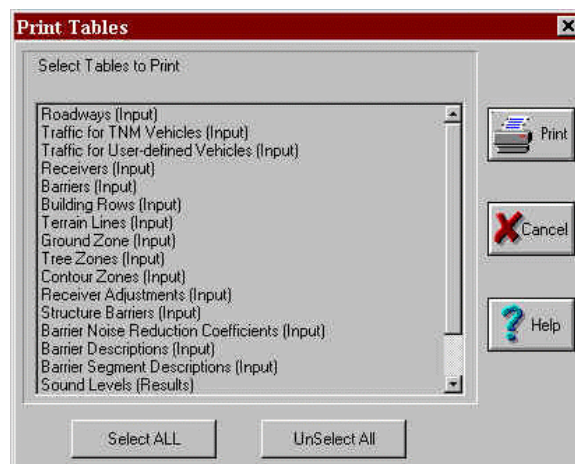
Figure 27. Print Tables dialog.

2.10.4 <u>B</u>arrier Design Table. A new table has been designed and incorporated into TNM. The Barrier Design Table was developed to aid the user during the barrier analysis and design process by placing the most frequently referred to information from various tables into one comprehensive table. The Barrier Design Table combines select information from the following tables:

- Sound Level Results;
- Barrier Descriptions;
- Barrier Segment Descriptions; and
- Diagnosis by Barrier Segment.

The table is available in two forms and can be selected using the <u>T</u>ables menu (see Figure 28).

Two submenu options are listed: <u>B</u>arrier Design Table and <u>S</u>how Important Segments. Note that the <u>S</u>how Important Segments option is greyed-out until the user first opens a barrier design table. When the user opens a barrier design table, the table is displayed with the selected barrier analysis receivers and their associated data on sound levels, noise reduction, important barriers and barrier segments, and partial sound levels (see Figure 29). The user may then select the <u>S</u>how Important Segments option, which "unchecks" the option in the menu and toggles the table to a more condensed form, hiding the important barrier segment rows and their associated partial sound levels (see Figure 30).

Figure 28. <u>B</u>arrier Design Table menu item.

💡   **Barrier costs rounded to the nearest whole dollar:**   Starting with TNM 2.1, all dollar amounts in the barrier design table are rounded to the nearest whole dollar. Also, the Total Cost, All Barriers field is dynamically updated if the Cost in the barrier input dialog box is changed.

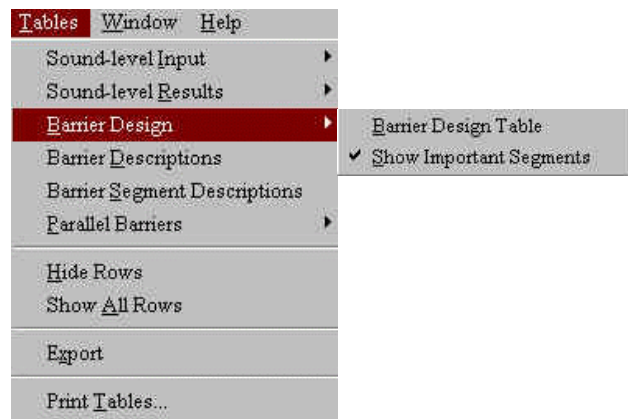| Volpe Center							2 April 2004			
Acoustics Facility							TNM 2.5			
							Calculated with TNM 2.5			
RESULTS: BARRIER DESIGN										
PROJECT/CONTRACT:		FHWA TNM Test Case								
RUN:										
BARRIER DESIGN:		INPUT HEIGHTS								
ATMOSPHERICS:		20 deg C, 50% RH								
Selected Receivers										
Name	No.									
		Calc	Noise Reduction			Barrier Reviewed	Important Segments			Partial
		LAeq1h	Calc	Goal	Calc-Goal		Name	No.	Height	LAeq1h
		dBA	dB	dB	dB				m	dBA
A-1	1	57.5	8.7	8	0.7	N Mainline Edge of Road	eor380.6	8	3.7	52.9
A-2	2	57.4	9.8	8	1.8	N Mainline Edge of Road	eor380.6	8	3.7	52.8
B-1	3	59.1	9.4	8	1.4	N Mainline Edge of Road	eor380.6	8	3.7	54.8
B-2	4	59.4	10.7	8	2.7	N Mainline Edge of Road	eor380.6	8	3.7	55.4
Total Cost, All Barriers (including additional cost(s))							$1415174			

Figure 29. Barrier design table: expanded display.

Volpe Center							2 April 2004			
Acoustics Facility							TNM 2.5			
							Calculated with TNM 2.5			
RESULTS: BARRIER DESIGN										
PROJECT/CONTRACT:		FHWA TNM Test Case								
RUN:										
BARRIER DESIGN:		INPUT HEIGHTS								
ATMOSPHERICS:		20 deg C, 50% RH								
Selected Receivers										
Name	No.									
		Calc	Noise Reduction			Barrier Reviewed	Important Segments			Partial
		LAeq1h	Calc	Goal	Calc-Goal		Name	No.	Height	LAeq1h
		dBA	dB	dB	dB				m	dBA
A-1	1	57.5	8.7	8	0.7	N Mainline Edge of Road	eor380.6	8	3.7	52.9
						N Mainline Edge of Road	eor381.7	9	3.7	51.1
						N Mainline Edge of Road	eor379.3	7	3.7	50.4
						NB Mainline Edge of Road - continued	eor382.7	11	3.7	48.3
Total Cost, All Barriers (including additional cost(s))							$1415174			

Figure 30. Barrier design table: condensed display.

2.11 Non-menu Items

2.11.1 Acoustical Changes.

■ In TNM 2.5, an improvement was made to the implementation of the vehicle emission level database. A more comprehensive methodology was applied in correcting the measured emission levels back to the source.

■ Also in TNM 2.5, a bug in the acoustics code was identified and corrected in order to improve related diffraction algorithm parameters.

2.11.2 Input Changes.

■ Since TNM 2.1, editing object names or notes no longer invalidate sound level results. Object names and notes are dynamically linked and appear as their current names in the tables.

2.11.3 Graphical User Interface (GUI) Changes.

■ In TNM 2.1 and above, the status bar was redesigned and enlarged.
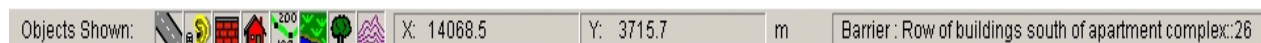
Figure 31. Redesigned status bar.

2.11.4 Error Messages Updated.

■ Starting with TNM 2.1, hard drives 2.1 GB and larger no longer generate an "out of space" error message.

3. CERTIFIED OUTPUT FOR THE OFFICIAL TNM TEST CASE

This section contains the certified output computed for the official TNM test case using Version 2.5. TNM 2.5 is the first version of the software, since the original release, with major improvements to the acoustics. Users should expect to see predicted sound levels that are different than sound levels predicted with previous versions of TNM. Appendix E in the TNM 1.0 User's Guide displays the sound level results computed using TNM Version 1.0 for the official TNM test case. The sound level results computed using the current version are shown in Figure 32 on the next page.

Volpe Center
Acoustics Facility

2 April 2004
TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: FHWA TNM
RUN: Test Case
BARRIER DESIGN: INPUT HEIGHTS   Average pavement type shall be used unless
     a State highway agency substantiates the use
ATMOSPHERICS: 20 deg C, 50% RH   of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
A-1	1	1	0.0	66.2	66	66.2	10	Snd Lvl	57.5	8.7	8	0.7
A-2	2	1	0.0	67.2	66	67.2	10	Snd Lvl	57.4	9.8	8	1.8
B-1	3	1	0.0	68.5	66	68.5	10	Snd Lvl	59.1	9.4	8	1.4
B-2	4	1	0.0	70.1	66	70.1	10	Snd Lvl	59.4	10.7	8	2.7
C-1	5	1	0.0	68.5	66	68.5	10	Snd Lvl	59.1	9.4	8	1.4
C-2	6	1	0.0	74.6	66	74.6	10	Snd Lvl	63.3	11.3	8	3.3
D-1	7	1	0.0	68.2	66	68.2	10	Snd Lvl	58.9	9.3	8	1.3
D-2	8	1	0.0	74.4	66	74.4	10	Snd Lvl	63.1	11.3	8	3.3
E-1	9	1	0.0	67.8	66	67.8	10	Snd Lvl	58.7	9.1	8	1.1
E-2	10	1	0.0	73.4	66	73.4	10	Snd Lvl	62.9	10.5	8	2.5
F-1	11	1	0.0	69.5	66	69.5	10	Snd Lvl	60.2	9.3	8	1.3
F-2	12	1	0.0	71.5	66	71.5	10	Snd Lvl	61.6	9.9	8	1.9
G-1	13	1	0.0	70.3	66	70.3	10	Snd Lvl	60.7	9.6	8	1.6
G-2	14	1	0.0	72.1	66	72.1	10	Snd Lvl	62.7	9.4	8	1.4
19aE-1	15	1	0.0	70.5	66	70.5	10	Snd Lvl	61.0	9.5	8	1.5
H-1	16	1	0.0	69.8	66	69.8	10	Snd Lvl	60.6	9.2	8	1.2
H-2	17	1	0.0	73.6	66	73.6	10	Snd Lvl	63.9	9.7	8	1.7
I-1	18	1	0.0	69.4	66	69.4	10	Snd Lvl	60.5	8.9	8	0.9
I-2	19	1	0.0	73.3	66	73.3	10	Snd Lvl	63.7	9.6	8	1.6
J-1	20	1	0.0	68.2	66	68.2	10	Snd Lvl	59.8	8.4	8	0.4
J-2	21	1	0.0	72.0	66	72.0	10	Snd Lvl	62.6	9.4	8	1.4
K-1	22	1	0.0	67.4	66	67.4	10	Snd Lvl	59.4	8.0	8	0.0
K-2	23	1	0.0	71.3	66	71.3	10	Snd Lvl	62.2	9.1	8	1.1
L-1	24	1	0.0	67.0	66	67.0	10	Snd Lvl	59.3	7.7	8	-0.3
L-2	25	1	0.0	71.2	66	71.2	10	Snd Lvl	62.1	9.1	8	1.1
M-1	26	1	0.0	66.2	66	66.2	10	Snd Lvl	59.0	7.2	8	-0.8
M-2	27	1	0.0	70.7	66	70.7	10	Snd Lvl	61.8	8.9	8	0.9
19aE-2	28	1	0.0	70.0	66	70.0	10	Snd Lvl	60.6	9.4	8	1.4
N-1	29	1	0.0	65.2	66	65.2	10	—	58.5	6.7	8	-1.3
N-2	30	1	0.0	66.5	66	66.5	10	Snd Lvl	58.1	8.4	8	0.4
O-1	31	1	0.0	67.8	66	67.8	10	Snd Lvl	59.9	7.9	8	-0.1
O-2	32	1	0.0	72.8	66	72.8	10	Snd Lvl	63.6	9.2	8	1.2

Dwelling Units	# DUs	Noise Reduction Min	Avg	Max
		dB	dB	dB
All Selected	32	6.7	9.2	11.3
All Impacted	31	7.2	9.3	11.3
All that meet NR Goal	28	8.0	9.4	11.3

Figure 32. Updated Sound Level R̲esults table for the official TNM test case.

4. REFERENCES

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