

PC-WARRANTS

Traffic Signal Warrant Analysis Software Reference Manual



Copyright © 2008 by Ridge Engineering Technologies, Inc. All rights reserved. No part of this publication may be reproduced, transmitted, transcribed, or translated into any language without the prior written permission of the publisher, Ridge Engineering Technologies, Inc.

Ridge Engineering Technologies, Inc. Software License Agreement

This software license agreement including any warranties and special provisions, is a legal agreement between you (as an entity or an individual) and Ridge Engineering Technologies, Inc. By installing or otherwise using this software you are agreeing to be bound by the terms of this agreement. If you do not agree to the terms of this agreement, return the unused software, along with all accompanying documentation, to Ridge Engineering Technologies, Inc.

The Software which accompanies this agreement is, and will remain the property of Ridge Engineering Technologies, Inc., and is protected by copyright law. Ridge Engineering Technologies, Inc. is providing you with certain rights to use the Software upon your acceptance of this agreement.

YOU MAY:

- 1) Use the Software on one computer;
- 2) Use the Software on several computers with the following provisions:
 - a) All computers that use this Software are located in the same building;
 - b) All persons using the Software are employed by the individual or entity who originally purchased the Software;
- 3) Use the software on a home computer with the following provisions:
 - a) The individual using the Software on a home computer is employed by the individual or entity who originally purchased the Software;
 - b) The individual is doing work for the individual or entity who originally purchased the Software;
- 4) Transfer this license to another individual or entity with the following conditions:
 - a) All copies of the Software must be transferred;
 - b) No copy of the Software may remain with the original licensee;
 - c) All documentation must accompany the Software;

YOU MAY NOT:

- 1) copy the documentation which accompanies the Software;
- 2) sublicense, lease, transfer, or rent any portion of the Software;
- 3) continue to use a previous version of the Software in addition to any updates that may be received. All copies of previous versions must be destroyed except that one copy may be kept for archival purposes;
- 4) reverse engineer, decompile, disassemble, modify, translate, make any attempts to reconstruct or find the source code for the Software;

U.S. GOVERNMENT RESTRICTED RIGHTS

The Software and documentation are provided with RESTRICTED RIGHTS. Use, duplication, or disclosure by the United States Government is subject to the restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.227-7013 or subparagraphs (c)(1) and (2) of the Commercial Computer Software-Restricted Rights at 48 CFR 52.227-19, as applicable. Manufacturer is Ridge Engineering Technologies, Inc./151 Keith Valley Road, Horsham, PA 19044.

WARRANTY

Ridge Engineering Technologies, Inc. warrants that the media on which the Software is distributed will be free from defects for a period of ninety (90) days from the date of delivery of the Software to you. Your sole remedy for a breach of this warranty will be that Ridge Engineering Technologies, Inc. will, at its option, replace any defective media returned to Ridge Engineering Technologies, Inc. within the warranty period or refund the purchase price of the Software.

The Software is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose with respect to the Software and accompanying documentation. Ridge Engineering Technologies, Inc. does not warrant, or make any claims that the Software will meet your requirements, or that the Software will provide uninterrupted service, or that the Software is free from errors.

THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS. YOU MAY HAVE OTHER RIGHTS, WHICH VARY FROM STATE TO STATE.

NO LIABILITY FOR CONSEQUENTIAL DAMAGES

In no event shall Ridge Engineering Technologies, Inc. be liable for any damages whatsoever (including without limitation, direct or indirect damages for personal injury, loss of information, loss of data, loss of business profits, business interruption, or any other loss) arising out of the use of or inability to use the Software, even if Ridge Engineering Technologies, Inc. has been advised of the possibility of such damages or loss. In any case the entire liability of Ridge Engineering Technologies, Inc. under any part of this agreement shall be limited to the amount actually paid by you for the Software.

Windows is a registered trademarks of Microsoft Corporation. Ridge Engineering Technologies, Inc. recognizes the trademarks of all other companies and products mentioned in this manual.

This manual was produced using Adobe InDesign 2.0.

If you have any questions about the use of PC-Warrants, please call the following number:

877-603-5844

Monday – Friday 8:00 AM to 5:00 PM Eastern time

You may also contact us by fax at:

1-813-980-0187

or via e-mail at:

support@pc-warrants.com

For more information on our products, the latest news in product development, and to download software updates, visit our web site at:

www.pc-warrants.com

Address any correspondence to:

**Ridge Engineering, Inc.
710 Druid Hills Road
Temple Terrace, FL 33617**

Table of Contents

Technical Support	iii
Chapter 1 — Introduction and Installation.....	1.1
Computer Requirements	1.2
Software Updates	1.2
Software Support.....	1.2
How to Install PC-Warrants.....	1.3
How to Run PC-Warrants.....	1.5
Chapter 2 — Learning the Basics of PC-Warrants	2.1
Tutorial 1 - Learning the Basics of PC-Warrants	2.2
Setting Preferences	2.2
Startup Options	2.5
Select Study	2.5
Study Summary.....	2.6
Volume Data.....	2.7
Site Data.....	2.8
On-Line Mapping	2.10
Warrant Data	2.12
Producing Reports.....	2.16
Chapter 3 Advanced Lessons	3.1
Tutorial 2 - How to Import Volume Data from ATRs.....	3.2
Volume Data Wizard	3.3
Transferring Data	3.5
Tutorial 3 - How to Import Volume Data from PETRAPro\PETRA Files.....	3.8
Volume Data Wizard.....	3.9
Transferring Data	3.12
Tutorial 4 - How to Create Volume Data from Estimated ADTs.....	3.14
Volume Data Wizard	3.15
ADT to Volume Converter	3.16
How to Retrieve a Volume Profile	3.19
Tutorial 5 - Introduction to Multi-Way Stop Sign Warrants.....	3.20
Setting Preferences	3.20
Select Study	3.22
Study Summary.....	3.23
Volume Data.....	3.23
Site Data.....	3.23
Warrant Criteria	3.24
Producing Reports.....	3.25
Appendix.....	A.1
Differences between MUTCD 1988 & 2000/2003 Editions	A.2
Differences in PC-Warrants from 1988 to 2000/2003 mode.....	A.3
2003 MUTCD Traffic Signal Warrants	A.5
2003 MUTCD Multi-Way Stop Sign Criteria	A.15
Gap and Delay Worksheets	A.16
Volume Data Options in Multiway Stop Warrants	A.18
Averaging Mode Option in Multiway Stop Warrants.....	A.24

Chapter 1



Introduction and Installation

Introduction

Welcome to PC-Warrants, a software program designed to perform traffic signal and multi-way stop sign warrant studies. This program allows you to perform some of the standard calculations required when determining whether a traffic signal (and multi-way stop signs) should be considered for installation at an intersection.

Important Note: The Manual on Uniform Traffic Control Devices (MUTCD) states, *The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.*

PC-Warrants does not report when a traffic signal should be installed, but rather when it should (or should not) be considered. If one (or more) of the warrant conditions is satisfied, then installation of a traffic signal can be considered further. **The final determination of whether to install a traffic signal should be based on the judgment of a traffic engineer.**

The MUTCD does provide guidance on when a traffic signal should **not** be installed.

1. A traffic control signal should not be installed unless one or more of the warrants are met.
2. A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.
3. A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.

This Reference Manual refers to using either the 2000 or 2003 Manual on Uniform Traffic Control Devices warrants. The 2003 MUTCD clarified a few of the details on how warrants should be evaluated, as covered in the 2000 MUTCD, but otherwise made no changes from the 2000 version. The latest versions of PC-Warrants are fully compliant with the MUTCD 2003 guidelines. In general, the software and this manual makes no distinction between the 2000 and 2003 MUTCD versions. PC-Warrants also has support for the older 1988 MUTCD standards.

Minimum Computer Requirements

- Windows 98 or higher operating system, including NT, 2000, ME, XP and XP SP2.
- 64 Megabytes of RAM (although it probably will run in less).
- 10 Megabytes of free space on your hard disk.
- CD-ROM (to install the software only)
- Screen resolution of 800 x 600 or better.

Software Updates

Updated versions of the software are released periodically and are posted on the support web site. Licensed owners of PC-Warrants can download updates to the program to make sure they always have the latest version of the software on their computer. To download the latest version of PC-Warrants, go to **www.pc-warrants.com** and then select **Downloads** from the list of options.

Software Support

If you encounter any problems while using the program, or have any questions on specific operations, refer first to this manual and the program's built-in Help system. For up to the minute information on all known issues with the program, refer to the PC-Warrants support web page at: **www.pc-warrants.com**

How to Install PC-Warrants

PC-Warrants (PCW) has the standard install procedure that most Windows programs use. The following pages outline the procedure to follow to install the software.

Begin the installation by placing the PCW CD into your CD-ROM drive. If your CD drive is configured for Auto-play, the Installation Options program will start after a few seconds. Otherwise, click on the 'Start' button on your Windows desktop. Select Run from the list of options and type the command line 'X:\setup' where X is the letter of your CD-ROM drive. Press OK and you will see the Installation Options for the program.

The Installation Options allow you to do a number of things in addition to installing the program. You can view a copy of this manual, register your copy of the software and check out some other Ridge Engineering products. To begin installing the program, click on **Install PC-Warrants**.



Figure 1.1 – Welcome Screen

The Welcome screen reminds you to be sure all other programs are closed before proceeding with the installation. During the installation, files used by the program will be copied to your computer, including some Windows system files. If other programs are open and using some of the files that need to be installed, an error can occur. So make sure you close any programs that obviously are running (especially virus checkers) before you install this or any Windows based software.

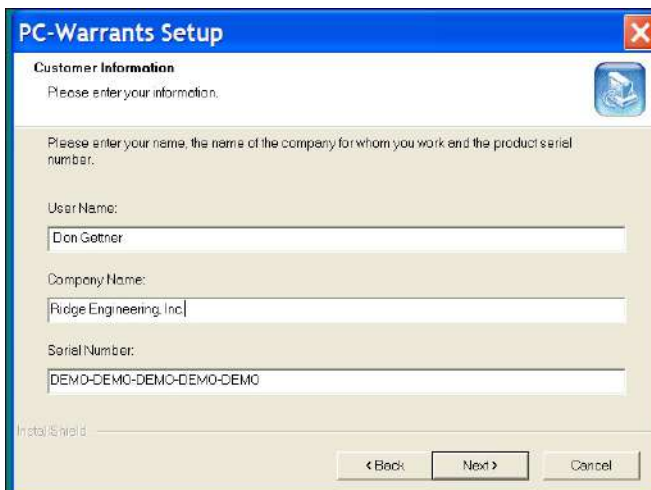


Figure 1.2 – Customer Information Screen

After a screen that shows the license agreement (not shown here) you'll see the screen shown here. This screen asks for your Name, Company and Serial Number. This should be the name and company of the primary person using the program. The Serial Number defaults to DEMO mode. You don't need to enter the serial number here; you can do it later in the software. Once the information has been entered, click the Next button to continue.

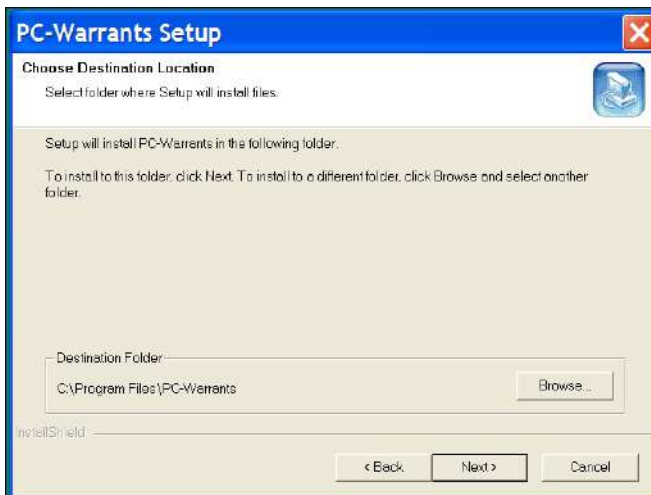


Figure 1.3 – Choose Destination Location Screen

The Choose Destination Location screen is used to select the folder where PC-Warrants will be installed. The default folder is C:\Program Files\PC-Warrants, but you can change this if you like. Click the Browse button and navigate to the folder you want. Once the directory listed is correct, click Next to continue.

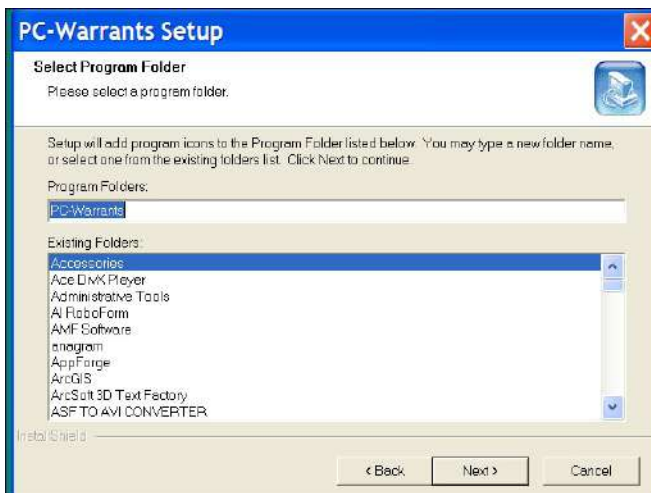


Figure 1.4 – Select Program Folder Screen

The next screen, shown in Figure 1.4, lets you enter or pick the name of the folder where the icons for the program will be stored. Unless you have a specific reason, just click Next to select the default shown.

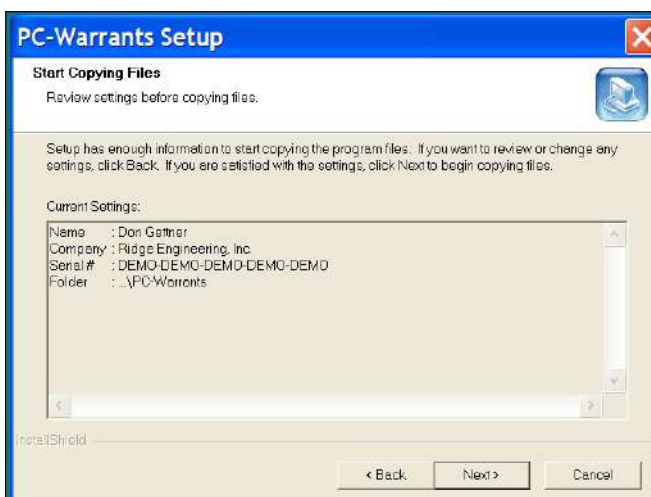


Figure 1.5 – Start Copying Files Screen

You will then see the screen shown in Figure 1.5, which is a summary of the information you have entered. Make sure everything looks ok, then click on Next.

Once the installation program has enough information, the files will be copied from the CD to your computer. You'll then see a screen that tells you the installation has completed. You may be asked if you want to re-start your computer now. If you get this message, you should re-start your computer before you try to run the program. This will allow any of the System files that were copied during the installation to be loaded properly.

You are now ready to run the program.

How to Run PC-Warrants

Like most Windows programs, there are several ways you can run the software. Here are two:

1. Open an Explorer window (right click on My Computer and select Explore) and find the PC-Warrants.exe file, which probably is in the *C:\Program Files\PC-Warrants* folder. You will see a screen that looks something like the figure shown here. Double click on the file **PC-Warrants.exe** and the program will run.

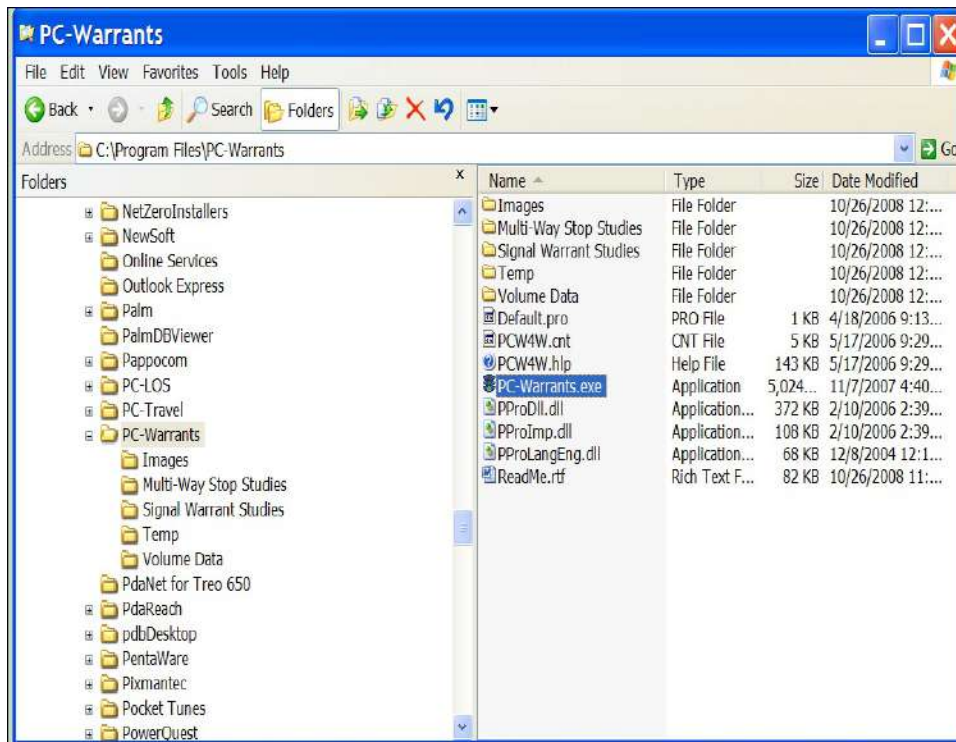


Figure 1.6 – Starting From Windows Explorer

2. Select **Start**, **Programs**, and then **PC-Warrants** from the list. There could be a long list, and they may not be in alphabetical order. Choose **PC-Warrants** again to run the program.

Chapter 2



Learning the Basics of PC-Warrants

Tutorial 1 - Learning the Basics of PC-Warrants

This tutorial will guide you through the basics of the software. To simplify things we will retrieve an existing study that was installed when the rest of the program was installed.

Note: The first time anyone runs PC-Warrants after installing it, the software loads the Preferences screens so that the various settings can be checked and edited. From then on, the program starts with the Startup Options screen. This tutorial will start with the Preferences screen, assuming you just installed it. Go to Page 2.5 to skip this section if it doesn't apply to you.

Run the program (refer to the previous chapter for information on how to do this). The first screen you will see is a little message box that tells you that since this is the first time you have run PC-Warrants, you need to check the settings. Just click **Ok**.

Setting Preferences

The Preferences screen has six tabs: **Signal War Options**, **Signal War Defaults**, **Stop Sign Options**, **Paths**, **Reports**, and **Misc Options**. The Signal War Options tab is shown first, since these options are the ones you will most often change when you use the software.

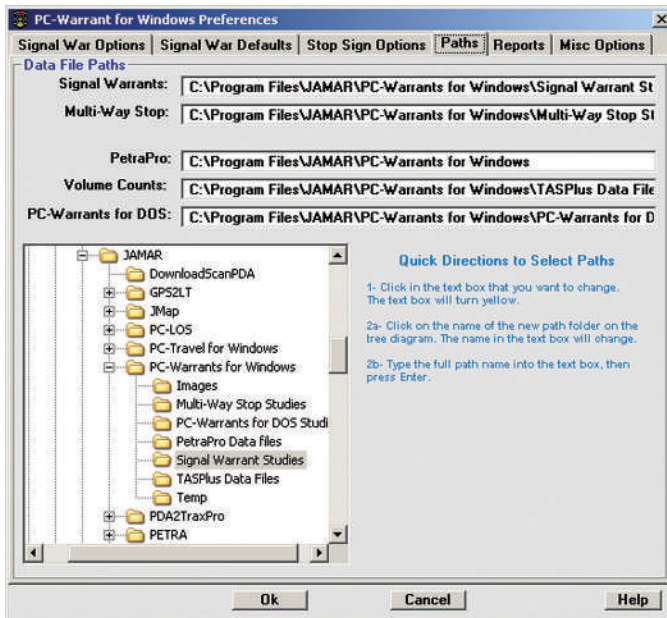


Figure 2.1 – Preferences: Path Tab

We want to check the Paths tab to see if the paths used in the software are set correctly. Click on the **Paths** tab at the top of the screen. You should see a screen similar to the one shown in Figure 2.1.

If you selected the default installation directory when you installed the software, then you will see the same paths shown in Figure 2.1.

PC-Warrants uses five basic directories:

1. Signal Warrant Data Path

This path points to the directory that stores the signal warrant files you create in PC-Warrants. When you Save or Open a warrant study, the software uses this directory.

2. Multi-Way Stop Data Path

This path points to the directory that stores the Multi-Way Stop warrant files you create in PC-Warrants. When you

Save or Open a stop sign warrant study, the software uses this directory.

3. PETRAPro Studies Data Path

This path points to the folder where your PETRAPro (or PETRA) studies are stored. Typically, these will be turning movement counts used for the volume data required by many of the warrants. The turning movement counts may also contain pedestrian volumes, which are also used for warrant evaluation.

4. Volume Count Data Path

This path points to the folder where your approach volume counts are stored. These may be TAS or TRAXPro files, or files from another manufacturer that is supported in PC-Warrants, such as Mitron, Numetrics, Streeter/Peek, ITC or TimeMark. Often there will be four separate count files, one for each approach. It will simplify things if you have all of your files in one directory, but it isn't strictly needed.

5. PC-Warrants for DOS Data Path

This path points to the directory where any PC-Warrants for DOS study files are stored. You can convert these studies to PCW4W studies easily in the software.

You should not have to edit the paths shown on the screen. The installation software created a folder called *Signal Warrant Studies* and stored a couple of signal warrant studies for you to use. It created a folder called *Multi-Way Stop Studies* and stored a study for you to use. It created folders named *PETRAPro Data Files* and *Volume Count Data Files* and stored a few typical studies in those folders for you to use with the Volume Import Wizard. It also created a folder called *PC-Warrants for DOS Studies* and stored a sample study so you can see how the Convert feature works. We will use one of the studies in the Signal Warrant Studies folder for this tutorial.

Even though we won't need to change any of the settings in the other Preferences tabs for this tutorial, you should look at each one to get an idea what options you have when you use the software.

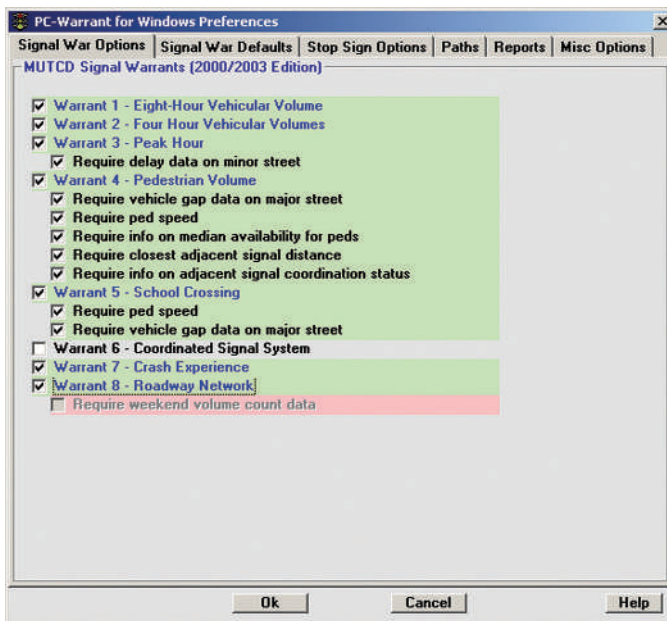


Figure 2.2 – Preferences: Signal War Options Tab

Signal War Options – This tab shows you each of the signal warrants and, for some of them, a list of sub-options you can select or de-select. You can have the software skip warrants that do not apply to the current intersection. You can also tell the software what data is required or not required before a specific warrant can be evaluated. In the screen shown in Figure 2.2, *Warrant 6 - Coordinated Signal System* is disabled, as is the requirement for weekend volume data in *Warrant 8 - Roadway Network*. If your settings aren't like these, then edit them to make them match.

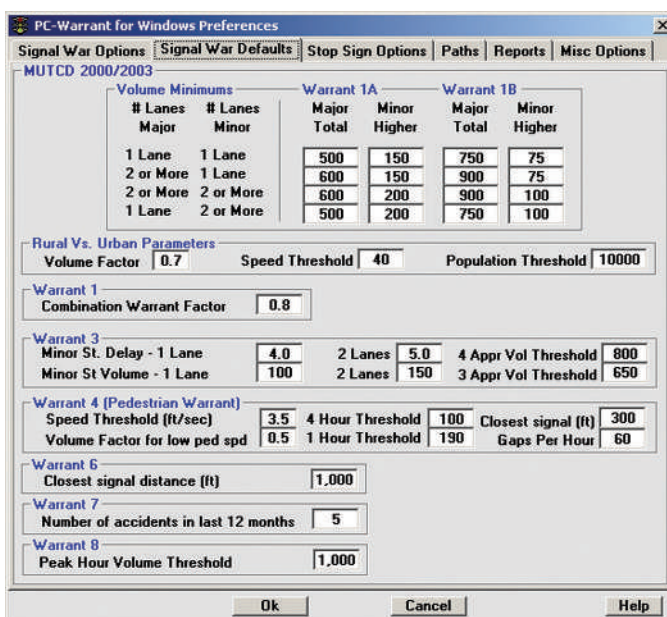


Figure 2.3 – Preferences: Signal War Defaults Tab

Signal War Defaults – This screen has almost all of the numeric values used to evaluate signal warrants, and you can edit any of them to meet your needs. The default values are the MUTCD values, and you probably won't ever want or need to change them. However, some states or local agencies have changed these values in the past to more efficiently meet the needs of their areas. The values shown here are the most likely to be edited.

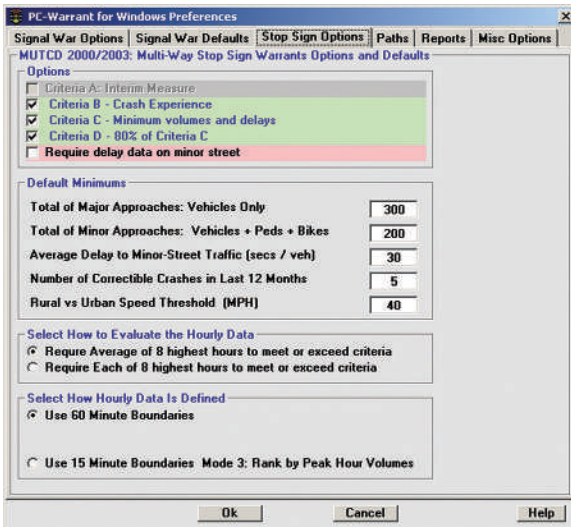


Figure 2.4 – Preferences: Stop Sign Options Tab

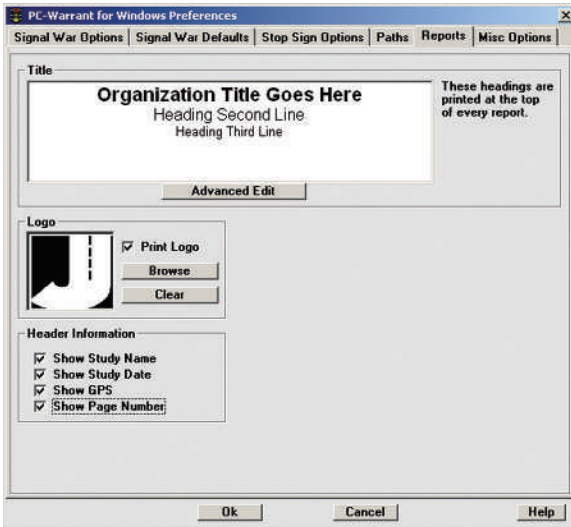


Figure 2.5 – Preferences: Report Options Tab

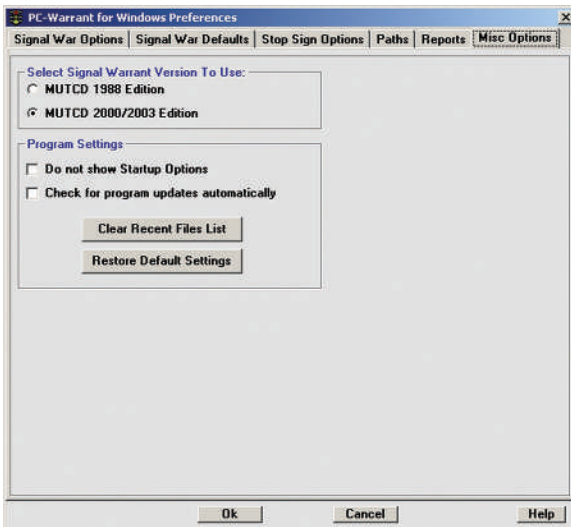


Figure 2.6 – Preferences: Misc Options Tab

Stop Sign Options – This screen shows the options available for Multi-Way Stop Sign warrants, including the warrant options and the numeric values used to evaluate stop sign warrants. You can edit any of them to meet your needs. The default values are the MUTCD values, and as with the Signal Warrant values, you probably won't ever want or need to change them.

These options are discussed in more detail in Chapter 3 in the section titled *Introduction to Multi-Way Stop Sign Warrants*.

Report Options – This screen shows the default titles that are printed at the top of every report. You can edit the titles now if you want; it will make any reports you print look a little better. You don't have to use all three lines. The *Advanced Edit* button can be used to modify the font type, size, style and a few other settings.

The *Logo* field can be used to add a graphical logo to the report headings. If you would like to include your logo, click the *Browse* button, then navigate to where your logo is stored. Note that the compatible graphic formats are .jpg, .jpeg, .bmp and .gif. Once the logo is selected, a preview of it will appear. Place a check in the *Print Logo* box to have it included with reports.

The *Header Information* field can be used to select some of the study information that you want to include with your reports.

Misc Options – This screen lets you select between MUTCD 1988 and MUTCD 2000/2003 modes for both the signal warrants and the stop sign warrants. For this tutorial we will be using the 2000/2003 MUTCD mode.

The *Program Settings* field also gives you the chance to turn off the *Startup Options* screen and set PC-Warrants to automatically check for software updates. Automatically checking for updates requires an Internet connection on the computer; the software will run a quick check on the pc-warrants support web site every time the program is started.

The *Clear Recent Files List* button removes the list of the recently accessed files from the *File* menu. The *Restore Default Settings* button will return all the settings used in the Preferences to their initial installation defaults.

When you are through looking and/or editing the Preferences, click on the **Ok** button at the bottom of the screen. The Preferences will be stored in a file on your computer (called PCW.bin), and the next time you run the program those preferences will automatically be loaded.

When you click on the Ok button in the Preferences screen, the **Startup Options** screen, shown in Figure 2.7, appears.

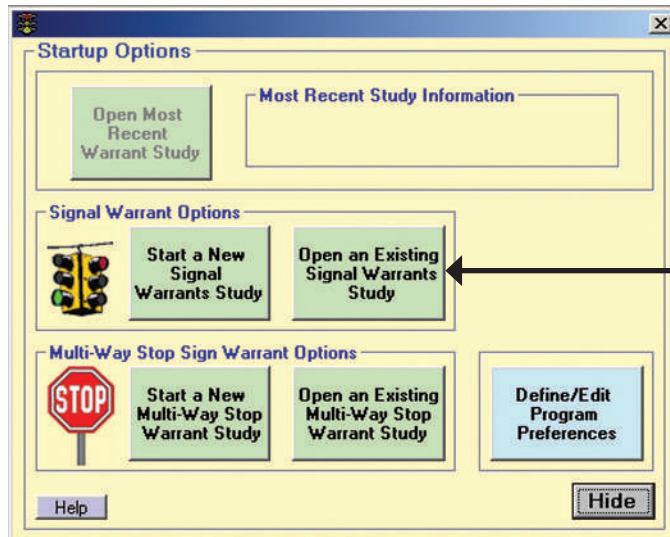


Figure 2.7 – Startup Options

Startup Options

This is the screen you normally see when you first run the program (after a splash screen that shows the licensing information). It shows the choices you have when you start the program. In this tutorial we are going to load a sample signal warrant study that was installed with the program. Click on the big button labeled **Open an Existing Signal Warrants Study**.

Select Study

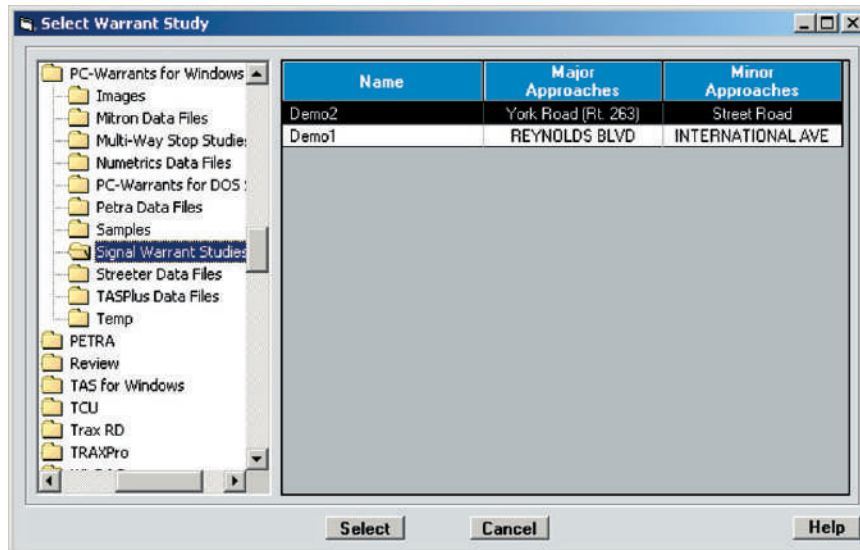


Figure 2.8 – Select Signal Warrant Study

On the left side of the screen is a list of folders in the familiar Windows tree structure, starting with the *PC-Warrants* folder. The *Signal Warrant Studies* folder should be highlighted. In the right hand window are the two sample signal warrant studies that are installed with the program. The name of each study is shown, along with the names of the major and minor approaches. For this tutorial, we'll use the **Demo2** study. If it isn't highlighted, then click on the Demo2 name so it is highlighted.

Click on the **Select** button to select the study.

Study Summary

This is the Summary Screen, the most important screen in the program. There are several parts to this screen:

Menus – At the top of the screen are the typical pull-down menus you find in most Windows programs. You should be familiar with how these work.

Toolbar – Below the menus are icons that make up the toolbar. These are the most common operations you can do in the program. They duplicate options in the menus, but are easier and quicker to use. We will usually use the toolbar to select options during this tutorial.

Summary of Study: Demo2 – The large box below the toolbar has two sections. The top section shows two lines: **Volume Data** and **Site Data**.

The color of the line is important: If the color is green, then that means that all of the data required by the program is available (volume data for the Volume Data line and site data, such as street names, speeds, etc, for the Site Data line). If the color is red, then some data is needed before the program can try to evaluate the warrants.

Warrant Summary – Below the Volume Data and Site Data section is a section that shows each of the warrants. The color of each warrant is important here as well. If the background is green, that means that there is sufficient data to evaluate that warrant. If the background is red, that means that there is *not* sufficient data to evaluate that warrant. If the background is gray, then that warrant has been disabled in the Preferences screen, and therefore is not evaluated.

In the screen shown in Figure 2.9, all of the required warrant data is available, so all of the backgrounds are green, with the exception of Warrant 6, which was disabled in the Preferences screen at the beginning of the tutorial.

Warrant Status – To the right of the list of warrants is a list that shows whether each warrant is met or not met. The warrant will only be evaluated if all of the required data for that warrant is known, which you'll recall is indicated by a green background in the warrant summary section.

In the screen shown in Figure 2.9, all of the required data is available, so all of the warrants are evaluated (with the exception of Warrant 6, which we had previously disabled). In this case, warrants 2, 3, 4, 5, 7, and 8 are met, the others are not.

Volume Data and Site Data Buttons – To the left of the Volume Data and Site Data summaries are buttons. If you click on these buttons you'll see a screen where you can enter or edit the data required by the warrants. We will go through these screens in a moment.

Warrant Detail Buttons – To the left of each warrant summary is a button. If you click this button, a separate screen is shown with all of the information about that warrant shown. We will go through each of these screens in a few moments.

You can see that the background colors of the various sections are very informative. In general, when you start a new warrant study all of the Volume Data, Site Data, and Warrant Summary backgrounds will be red, because there isn't any data yet. As you enter data into the program, such as vehicle volumes, pedestrian volumes, gaps, delays,

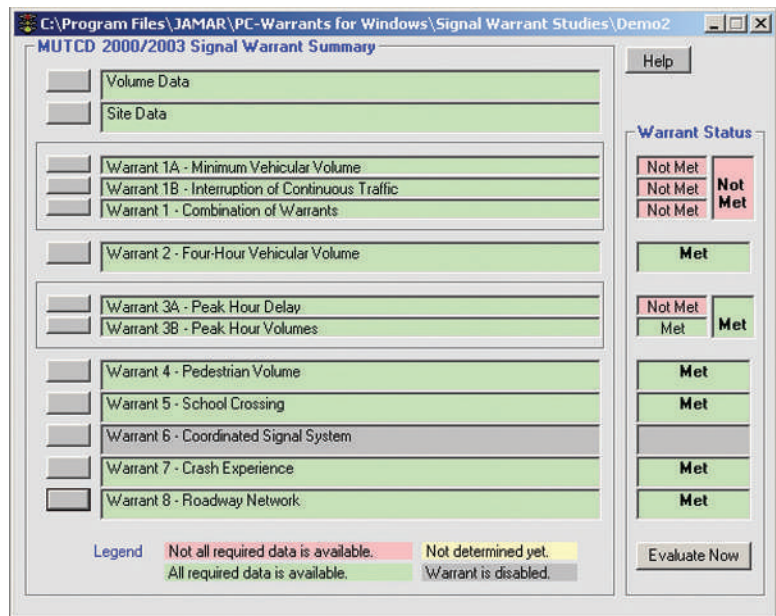


Figure 2.9 – Summary Screen

street names, approach speeds, etc. the software keeps track, and when you have entered enough information for a particular warrant, then the background color is changed to green, the warrant is evaluated, and the status shown.

Your job using this software normally follows these three steps:

1. Determine which warrants you want to evaluate and what data for those warrants you require. This is done in the **Preferences** screen, and often will use the default values.
2. Enter the data for the intersection until all of the required data is available. You will know this when the warrant summaries turn green. The software will automatically evaluate the warrants for you and show you the status. If you want, you can examine the details of any of the warrants to see exactly why the warrant was met or wasn't, but this isn't necessary.
3. Print the report you want.

The screen shown in Figure 2.9 has all of the background in green. This is because we retrieved a study where all of the data was entered before the study was saved. Now let's see how the data for the intersection is entered and/or edited.

Volume Data

Click on the **Volume Data** button on the Warrant Summary screen. Then click on the scroll bar on the far right side of the screen and scroll down until 7:00 AM is at the top of the screen. Your screen should look like the screen shown in Figure 2.10 above.

Pedestrian Volumes – These are shown at hourly intervals for each approach. You can edit the volumes directly on this screen, or run the Volume Wizard (explained below) to import the volumes from an external file (usually a PETRAPro turning movement file). Technically, you only need pedestrian data for one hour to be able to satisfy this warrant. However, a minimum of four hours is generally recommended.

Vehicle Volumes – These are shown in a few different ways, depending upon the method used to collect the vehicle counts. This is controlled by the Volume Wizard, which helps you import vehicle counts from external files like PETRAPro turning movement files or TRAXPro approach volumes. In this case, the data came from a PETRAPro file, and so is shown as 15 minute counts, by movement. The software calculates the approach totals and hourly totals.

Normally, the vehicle volume data is imported from an external file using the Volume Wizard (this is explained in detail in Chapter 3). However, you can enter the data manually if needed. You also can edit the data by typing over the existing counts.

You can make the data a little easier to read by selecting the checkboxes in the lower right part of the screen:

Show Hourly Totals Only hides the 15 minute count data and just shows the hourly totals.

Show Approach Totals Only hides the movement counts and just shows the total approach counts.

Figure 2.10 – Volume Data

You cannot edit the Hourly Totals and Approach Totals directly. You have to edit the 15 minute movement counts to affect these totals.

Click on Ok to return to the Warrant Summary screen.

You should be back at the Warrant Summary screen. Click on the Site Data button. This will bring up the Site Data screen, as shown in Figure 2.11 below.

Site Data

GIS Info

Degrees: Latitude: 40, Longitude: 75
Minutes: 12.40404, 5.9844
GPS: or 40.20673, 75.09974
Direction: North, West

Study Info

Study Date: 2/6/2002

Worksheets

Gap
Delay

Major Approach Data

Daily Volume = 3,524
York Road (Rt. 263)
of Lanes: 1 2+
85% Speed: 45
Closest Signal: 1,001

Minor Approach Data

Daily Volume = 509
Street Road
of Lanes: 1 2+

Major Approach Selection Checkboxes

Major Approach is N/S
 Major Approach is E/W

Warrant Specific Data

Check All That Apply

Built-up community < 10,000
 Adjacent coordinated signals

Pedestrian Warrant

Ped speed < 3.5 ft/sec
 Existing median?

School Crossing Warrant

07:00 AM Start time children begin using school crossing.
09:00 AM Stop time children stop using school crossing.

Accident Warrant

6 Number of correctable accidents in last 12 months

Systems Warrant

Major route? NB EB
 SB WB

Gap & Delay Worksheets

Approach Enable Buttons

Minor Approach Data

Major Approach Data

Edit Intersection Photos

Ok Cancel Help

Figure 2.11 – Site Data

The big window shows a representation of the intersection, showing many of the parameters needed to evaluate the warrants.

GIS Info – This field can be used to enter GPS coordinates of where the intersection is located. The coordinates can be entered in either the degrees & minutes format or just degrees format. The direction of the coordinates (North or South and East or West) must also be selected. Our sample file has this information already entered, and a little later in this tutorial we'll see how we can use this information with on-line mapping applications.

Study Info – This field allows you to enter the date the study was performed. This date will be included with the reports you produce.

Major Approach Selection Checkboxes – Use these checkboxes to pick which approaches are the major approaches. The software initially picks the approaches based on the approaches with the highest total approach volumes. Usually this is correct. However, you can override the selection simply by checking the other box.

Change the major approaches from NS to EW and then back again. Notice how the major approach and minor approach input boxes change based on your selection.

Major Approach Data – The major approaches show several pieces of information. First, the name of the approach

is shown along with the number of lanes. Also shown are the 85% Speed and the distance to the closest signal. These last two parameters are used in more than one warrant, but only for the major approach.

Minor Approach Data – Like the Major Approaches, the minor approaches show the approach name and the number of lanes. Since this is all that is really needed from the minor approaches, that is all you need to enter.

Edit the name of one of the *Street Road* approaches by clicking on the name and changing it to *Test*. Now double click on the opposite *Street Road* name text box. Notice that the name *Test* from the text box you edited is copied to the text box you just selected. Since both approaches will usually have the same name, this is a little trick to save you some typing. This trick also works with the 85% Speed and the Closest Signal settings. Change the name back to *Street Road* when you are done.

Now, change the number of lanes on a major or minor approach, then change it back. See how the image underneath changes? There are different images for one lane or two lane approaches.

Warrant Specific Data – Several warrants have site specific requirements that are only used in those warrants. The software shows a warrant specific field only if the warrant it applies to is enabled in the Preferences screen. There are up to four Warrant Specific Data fields: Pedestrian Warrant, School Crossing Warrant, Accident Warrant and Systems Warrant.

The **Pedestrian Warrant** field is used to determine how the requirements for the Pedestrian Warrant should be handled. If checked, the *Ped Speed < 3.5 ft/sec* checkbox allows the warrant to reduce the pedestrian volume requirements by 50%. Checking the *Existing Median?* checkbox requires gap data to be used on a directional basis.

The **School Crossing Warrant** field is used to tell the program what times, if any, school children are crossing the major approach. These times are used when evaluating the gap data in the School Crossing warrant.

The **Accident Warrant** field is used to tell the program the number of correctable accidents that occurred in the last 12 months. This data is then used in the Accident (or Crash) Experience warrant.

The **Systems Warrant** field is used to tell the program if an approach is part of a major route. This information is used when evaluating the System (Roadway Network) Warrant. The MUTCD provides guidelines for determining whether an approach is a major route. Refer to the System Warrant information on page 2.14 for more details.

In our sample file all of the warrants that apply to the Warrant Specific Data are enabled, so all of the warrant specific fields are shown. However, if we were to disable the School Crossing warrant in the Preferences, this field would not appear in the Site Data screen. The same principal hold true with the other Warrant Specific Data fields.

Gap and Delay Worksheets – Although most people don't bother, technically you need to collect gap and delay data to properly evaluate signal warrants. The Gap Worksheet and Delay Worksheet attempt to simplify the process of getting the gap and delay data into the software. You may want to take a quick look at the screens just to see how they look. For a detailed description of these worksheets, refer to the Appendix.

Approach Enable Buttons – In the center of the intersection are four buttons. You can enable or disable an approach by clicking these buttons. Normally you would disable the minor approach not used at a T intersection. The software recognizes that an approach has been disabled and uses that fact in various places in the software.

Edit Intersection Photos – Click the *Edit Photos* button and a new window will appear. This feature allows you

to add up to four digital photos to your file, which can then be included with your report. A sample photo was installed with the program, so click the *Browse* button and we'll add it to our file.

The name of the sample file is *York & Street.jpg*. It was installed in the program's Images folder, which is normally located at C:\Program Files\PC-Warrants\Images. Navigate to this location and select the file.

Once the photo is selected, a large preview will appear of the photo. The photo can be edited using Windows Paint by clicking the *Edit Image* button. A title for the photo can be assigned in the Image Title field.

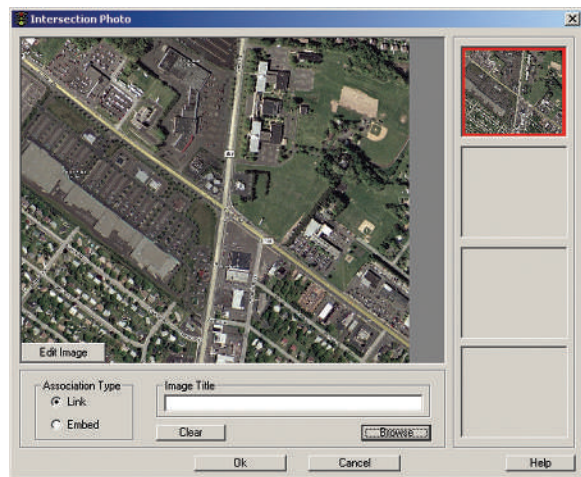


Figure 2.12 – Intersection Photo

Note that images can be in any of the following formats: Windows bitmap (.bmp), JPEG (.jpg), or GIF (.gif). Also note that there are two ways you can attach a photo, *Embed* or *Link*. These options can be set using the Association Type field at the lower left.

The Embed option adds a copy of the photo to your data file (making the file larger). The Link option only adds a link to where the file is currently stored on your computer. In general, the embed option should be used if you will be sending the data files to other people while the link option should be used if the files will always be on your computer (and the location of the digital photos won't change). We used the Link option when adding our file.

If we wanted to add another photo, we'd click a blank preview box on the right side of the screen, then repeat the previous process. To remove a photo, we'd click the photo's preview box on the right, then click the *Clear* button.

Now that our photo has been added, click the OK button to exit. We're now going to see where we can get photos like the one we just added, for free, using the Internet. Click on the **OK** button at the bottom of the Site Data screen to go back to the Warrant Summary screen.

On-Line Mapping

Earlier in this tutorial we saw where GPS coordinates could be added to a file and that our demo file already has them loaded. We'll now use these coordinates to view aerial maps of the study location by using the on-line mapping applications Google Earth and Windows Live Local.

Google Earth and Windows Live Local are competing programs that in essence do the same thing - allow you to see aerial views of the Earth. To use these applications, you must have an Internet connection on your computer, and GPS coordinates stored in your PC-Warrants file.

The first application we'll look at is Google Earth. This application requires that you download and install a portion of it from the Google web site. If you plan to use Google Earth with PC-Warrants, or want to follow along on your computer with this tutorial, download the free version of Google Earth now at: <http://earth.google.com/>.

Once Google Earth has been installed on your computer, you can start it by going to the View/Edit menu, sliding down to Online Map and selecting Google Earth. Note that you can also access this feature by clicking on the Google Earth icon in PC-Warrants' toolbar.

Google Earth begins with an aerial view of the Earth and begins to zoom in to the coordinates of your PC-Warrants file.

It's a pretty cool process to watch. As the zoom brings you closer and closer to your location you'll begin to see more details. Finally the zoom will stop, around 1500 ft. above the coordinates of your PC-Warrants data file.

Google Earth contains a number of different tools that you can use when viewing your map. The 'Layers' checklist lets you choose what information to include on the map you see. The 'Tilt' commands can be used to tilt your view for the map up or down while the 'Rotate' commands can be used to change your perspective. The 'Zoom' commands can be used to zoom farther out or closer in to your coordinates.

Once you have the map set to show what you want, you can save a copy of it for use in your PC-Warrants file by selecting 'Save Image' from the File menu. The picture you saved can then be added to the Intersection Photos in PC-Warrants, as we did earlier. Exit out of Google Earth once you are done playing with it.

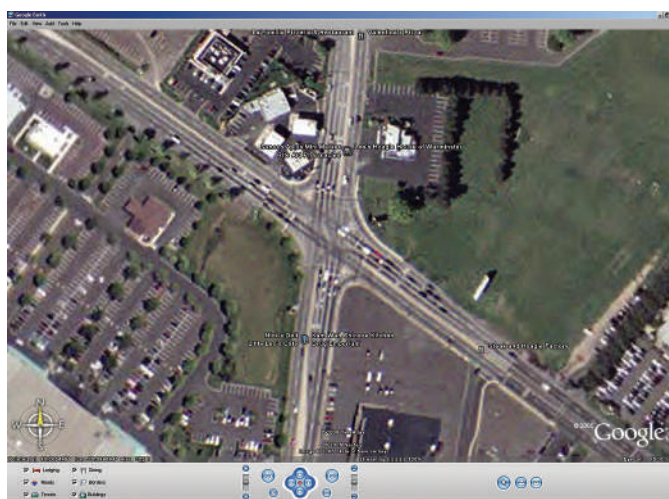


Figure 2.13 – Google Earth View

The Windows Live Local application is very similar to Google Earth in that it provides aerial views of the Earth. Unlike Google Earth, this application does not require any program to be downloaded and installed on your computer, so to start it, go to the Tools menu, slide down to Online Map and select Windows Live Local. Note that you can also access this feature by clicking on the Windows Live Local icon in PC-Warrants' toolbar.

Once you start Windows Live Local, it takes you directly to an aerial view of your coordinates. Like Google Earth, Windows Live Local has a few tools that can be used when looking at the map. A slider bar can be moved to zoom out from your location or zoom in.

For some locations, Google Earth has better images and for some Windows Live Local has the edge.

At the time this tutorial was written, Google Earth appears to have an advantage over Windows Live Local in that the maps you create with Google Earth can be directly saved as a graphic and used in PC-Warrants. However, these are both fairly new applications that are sure to evolve and improve as time goes by.

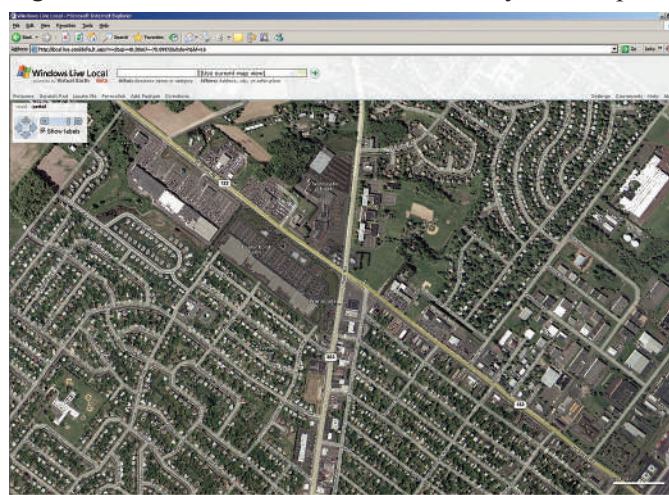


Figure 2.14 – Windows Live Local View

Once you are finished looking at the on-line maps, exit back to the main Summary Screen. We'll now let's take a look at each of the warrant detail screens and see the information that is available for each warrant.

Warrant Data

To the left of each Warrant Summary line is a button. If you click on a button, it brings up the detail screen for that warrant.

Major Road (Rt. 263)				Minor Road (Street Road)				Met?	
Hour	NB	SB	Total	Street Road	NB	SB	Total	Major Road	Minor Road
12M-1	0	0	0	0	0	0	0	WB	No
1-2	0	0	0	0	0	0	0	WB	No
2-3	0	0	0	0	0	0	0	WB	No
3-4	0	0	0	0	0	0	0	WB	No
4-5	0	0	0	0	0	0	0	WB	No
5-6	0	0	0	0	0	0	0	WB	No
6-7	0	0	0	0	0	0	0	WB	No
7-8	134	283	417	217	0	0	0	WB	No
8-9	102	261	363	267	0	0	0	WB	No
9-10	94	265	359	217	0	0	0	WB	No
10-11	96	271	367	250	0	0	0	WB	No
11-12	84	293	367	334	0	0	0	WB	No

Figure 2.15

Warrant 1A-Minimum Vehicular Volumes

Click on the button to the left of **Warrant 1A - Minimum Vehicular Volumes**. This brings up the screen shown to the left. Note that this warrant corresponds to Warrant 1 in the 1988 MUTCD mode.

There are five sections to this screen:

Description – A single sentence, usually taken from the MUTCD, that explains the purpose for this warrant.

Site Data Required by Warrant – This field contains information taken from the Site Data screen that is specifically used in this warrant. You can edit this data if you notice that a parameter is wrong. Any changes you make will be used throughout the program.

Summary – This field shows the result of evaluating this warrant based *solely* on the data on this screen. The summary is immediately updated after any changes are made to the site data.

Volume Requirements – This field contains the threshold volumes for the total of the major approaches and the higher minor approach, based on the information in the site data window and the values stored in the Preferences file. The requirements are immediately updated after any changes are made to the site data.

Current Volume Data – This field contains volumes taken from the Volume Data screen organized into hourly approach totals. The two major approaches are shown and their totals calculated and shown. The higher volume of the minor approaches is shown along with the direction. The volumes of the total major and higher minor volumes are compared to the volume requirements, and the results shown for each hour. If an hour meets the requirement then that hour is colored green. If the hour doesn't meet the minimum requirements then it is colored red. Finally, the warrant is evaluated for that hour and the status shown in the **Met?** column.

To see how this screen works, try the following:

First, notice that currently there are three hours that meet the Volume Requirements, which are 420 for the major approaches and 105 for the higher minor. There are 11 hours that meet the minor requirement but only three that meet the major. Since the minor is met for these three hours as well, the warrant is met for three hours. This is less than the 8 required for this warrant, so the warrant is not met.

1. Click the **85% Speed > 40 MPH** checkbox to remove the check mark. Notice that the Volume Requirements changed from rural values to urban values. Now no hours meet the minimum volumes. There still are 11 hours that meet the minor requirement, but now no hours meet the major requirement.

2. Change the **Number of Major Lanes** from 2 to 1. The Volume Requirements change, which changes the number of hours met to 2.

Click on the **Cancel** button to return to the Warrant Summary screen without making any changes to the data.

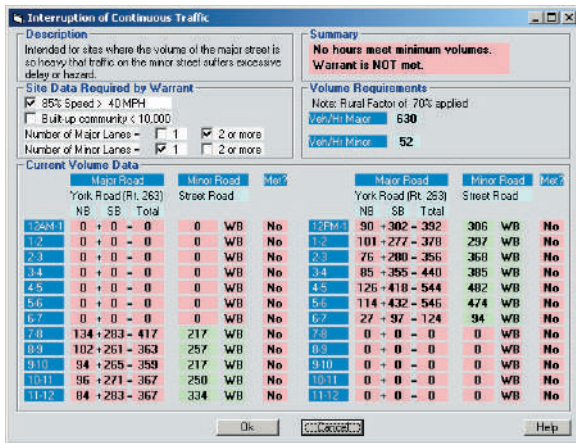


Figure 2.16

Warrant 1B-Interruption of Continuous Traffic

Click on the button to the left of **Warrant 1B - Interruption of Continuous Traffic**. This brings up the screen shown to the left. Note that this warrant corresponds to Warrant 2 in the 1988 MUTCD mode.

This screen is almost identical to the Warrant 1A screen; the only difference is in the Volume Requirements. You can play with the options on this screen like you did before to see how the summary changes. Click on Cancel to return to the Warrant Summary screen when finished.

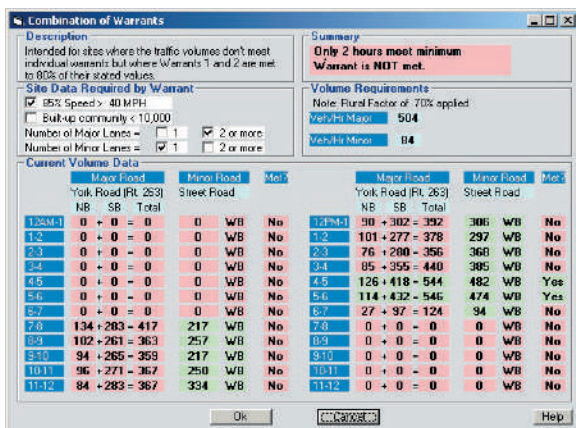


Figure 2.17

Warrant 1-Combination of Warrants

Click on the button to the left of **Warrant 1 - Combination of Warrants**. This brings up the screen shown to the left. Note that this warrant corresponds to Warrant 8 in the 1988 MUTCD mode.

This screen is almost identical to the Warrant 1A and Warrant 1B screens; again the only visible difference is in the Volume Requirements. Click on Cancel to return to the Warrant Summary screen.

You can examine the other warrants in a similar manner. Below are the screens for the warrants along with a few comments on each one.

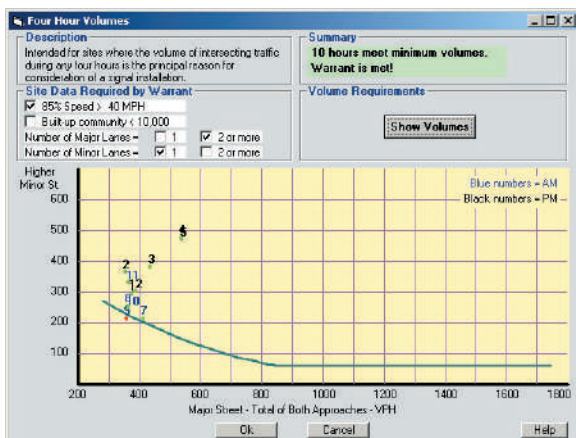


Figure 2.18

Warrant 2-Four Hour Volumes

Warrant 2 - Four Hour Volumes

This is the first of the curve warrants, where the total major approach volume and the higher minor approach volume are plotted on a graph and compared to a curve. Figure 2.18 shows the graph screen. You can see where the numbers come from if you click on the **Show Volumes** button.

Note that this warrant corresponds to Warrant 9 in the 1988 MUTCD mode.

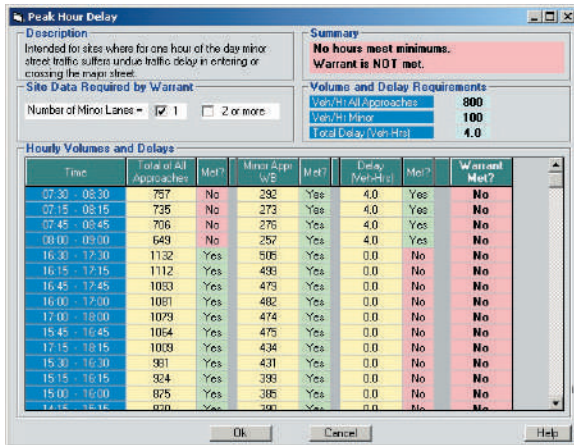


Figure 2.19
Warrant 3A-Peak Hour Delay

Warrant 3A - Peak Hour Delay

This warrant requires delay data for at least one hour. This can be annoying to collect, so this warrant isn't as popular as others. It also requires volume data which is usually available. The software finds all of the possible hour totals (total approach and higher minor approach) using the 15 minute data, if available. If you only have hourly approach counts, then it just uses the hourly data. It also shows the delay data for those hours (based on delay data entered in the Site Data screen). It then compares the data to the requirements to see if any hours meet the warrant.

Note that this warrant corresponds to Warrant 10 in the 1988 MUTCD mode.

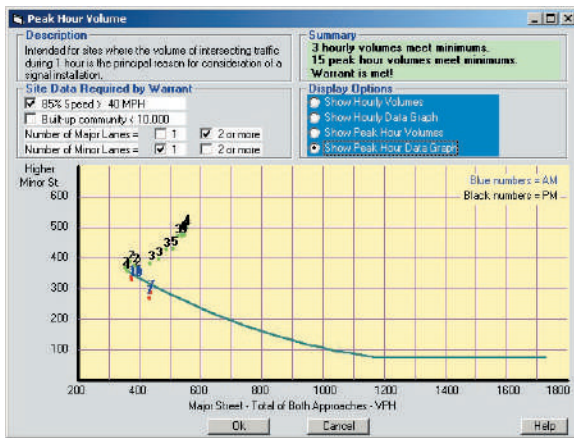


Figure 2.20
Warrant 3B-Peak Hour Graph

Warrant 3B - Peak Hour Volume

This is the second of the curve warrants and is based on the same volume data as the other, with the exception that any four consecutive 15 minute volumes can make up the peak hour. The software finds all possible peak hours (there are 96 possible in one day), sorts them in descending order (by total approach volume), and then plots the top 20 on the graph, as shown in the figure to the left. This gives you an idea of how many possible peak hours meet, or don't meet, the warrant. You can see sorted hourly volumes by selecting the **Show Peak Hour Volumes** option in the Display Options window.

If you only have hourly approach data, then the logic is a little different. The software simply plots the 24 hourly volumes on the graph and compares them to the curve. You can see the data that is plotted by selecting the **Show Hourly Volumes** option

in the Display Options window. The screen is essentially identical to the screens used in Warrants 1, 2, & 8. The software looks at the total major volume and calculates the value of the curve at that point. It then compares the minor approach volume and shows the results in the **Met?** column.

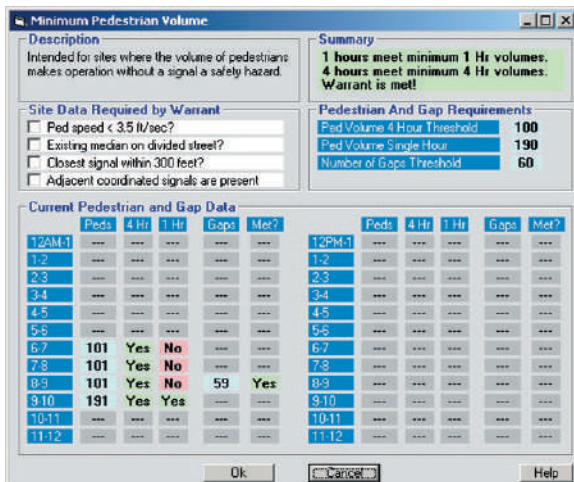


Figure 2.21
Warrant 4-Pedestrian Volumes

Warrant 4 - Pedestrian Volumes

This warrant requires pedestrian counts, which are often collected when turning movement studies are done, and gap data, which is almost never collected. The data shown here was faked to have something interesting to show on the screen. You should get the idea from this screen, however. If you don't have gap data, the software will tell you if the pedestrian counts alone would meet the warrant. You can then decide to do a formal gap study, or just use the data as is.

Note that this warrant corresponds to Warrant 3 in the 1988 MUTCD mode.

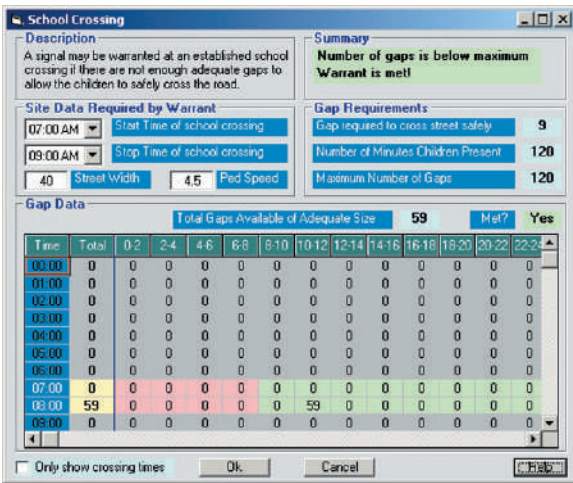


Figure 2.22
Warrant 5-School Crossing

Warrant 5 - School Crossing

The primary data for this warrant are the number of children that use the school crossing and the number of adequate gaps available during that time frame. The software asks for the beginning and ending time when the school crossing is used and also the street width and approximate ped speed (which is used to calculate the required gap). The software checks the gap data, which is in a binned format as shown in Figure 2.22, and calculates the number of gaps of usable size during the school crossing times. Normally, this warrant is done as a special case separate from the other warrants. Refer to the Appendix for more information on how adequate gaps are determined.

Note that this warrant corresponds to Warrant 4 in the 1988 MUTCD mode.

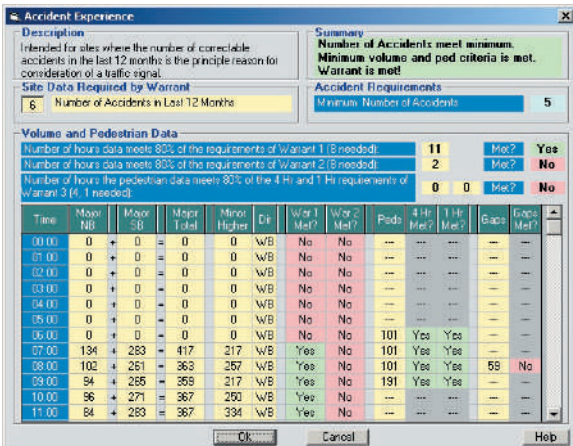


Figure 2.23
Warrant 7-Crash Experience

Warrant 7 - Crash Experience

The primary data for this warrant is the number of correctable accidents, which is simply entered into the Site Data screen, or entered here on this screen. The warrant also requires vehicle volume, pedestrian, and gap data as well. The bottom section shows all of this data, which is taken from Warrants 1, and 4, and whether the reduced requirements (normally 80%) are met.

Note that this warrant corresponds to Warrant 6 in the 1988 MUTCD mode.

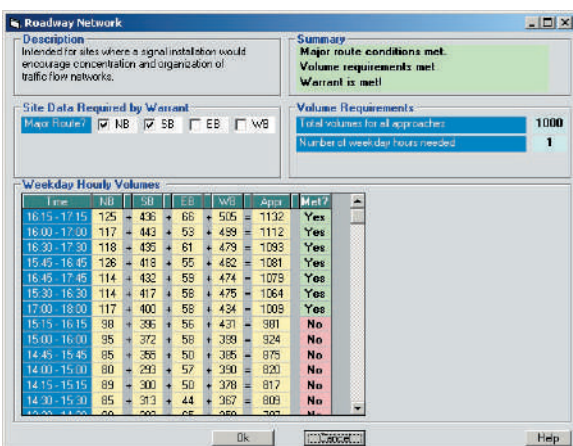


Figure 2.24
Warrant 8-Roadway Network

Warrant 8 - Roadway Network

The primary requirement for this warrant is that at least two of the approaches meet the definition of a major route, which you must determine using your own engineering judgement. However, the MUTCD does provide some guidance for this. The current standards are:

- A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow; or
- B. It includes rural or suburban highways outside, entering, or traversing a city; or
- C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

There also is a weekday peak hour requirement, which is shown on this screen, and a weekend volume requirement which is disabled in this study (*check the Preferences screen and notice that the weekend data requirement for Warrant 8 is disabled*). This warrant corresponds to Warrant 7 in the 1988 MUTCD mode.

that the weekend data requirement for Warrant 8 is disabled).

This was a very quick introduction to the standard warrants supported in the software. Some of the screens may seem complicated but, remember, you don't necessarily ever have to look at the detail screens. They are there to help you understand why a particular warrant is met or not, but only if you are interested.

Return to the **Warrant Summary** screen. The final part of this tutorial is to print a report which, after all, is the point of the software.

Click on the **Print** toolbar at the top of the screen. This will bring up the report selection screen.

Producing Reports

The report selection screen shows the options you have when producing a report. The Report Options are for either a one-page summary or for a two-page summary. Select *Two Page Summary*.

Note that the first page in each of the reports is exactly the same. The two-page summary merely adds some additional details.

The Photo Options allow you to include intersection photos with the report. Since we added a photo to our file, we'll include it in the report by selecting *Print Intersection Photos with Report*. Note that if you select the option *Print Intersection Photos Only*, the summary page options are disabled and will not print.

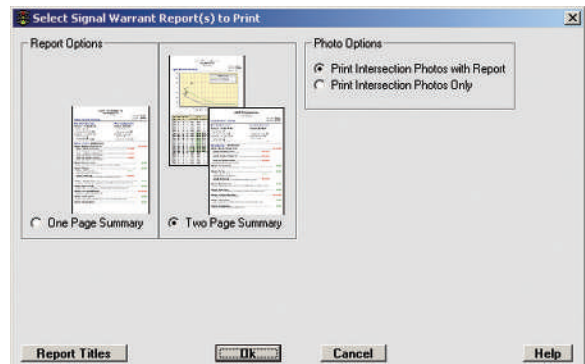


Figure 2.25 – Select Report Options

Another option in this screen is to check the titles to be used with the report by clicking on the Report Titles button. The titles listed are read in from what has been entered in the Preferences. You can edit them if you want them changed for this report.

Once you are done with the titles, click on the Ok button in the report selection screen. The software will generate the report and show it on the screen before you actually print the pages. You'll see a screen similar to the one shown in Figure 2.26.

You can select different views of the reports with the **Zoom** button at the top of the screen. You move from page to page with the **Next** and **Previous** buttons. You can choose which printer on your system to use by clicking on the **Printer** button, then clicking the Print button to print the report. Alternatively, you can output the report as a PDF file by clicking the PDF button.

That's the end of this tutorial. In it, you learned the basic of how to use the program to do a Signal Warrant study.

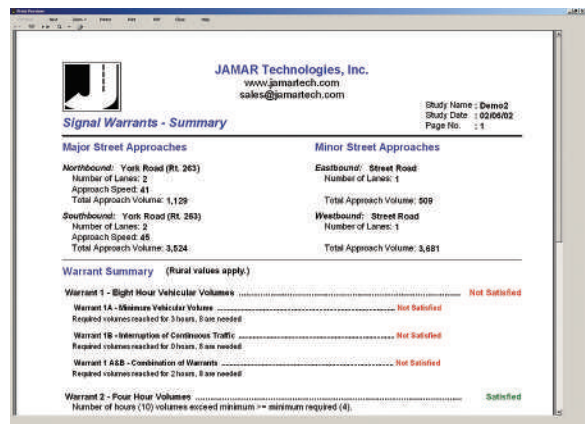


Figure 2.26 – Print Preview

Chapter 3



Advanced Lessons

Tutorial 2 - How to Import Volume Data from Automatic Traffic Recorders

One of the most important parts of doing a warrant study is dealing with the volume data that is required. In general you need at least 8 hours of data for each active approach, and more is generally recommended. There are two basic ways to collect the volume data:

1. You can use automatic traffic recorders (ATRs), such as the TRAX line, to count the vehicles at each approach. You typically need four ATRs, each using one or two road tubes. It is recommended that you collect the data for at least 24 hours, and preferably more, on a Tuesday, Wednesday and/or Thursday. You will end up with 4 studies that have the volume data you need, usually in four different files on your computer.
2. You can do a manual turning movement count using equipment like the JAMAR hand-held data collectors (DB-400 & TDC-12). Ideally you would collect 8 or more hours of continuous data at the intersection. This usually requires two or more crews, which can be expensive. Still, it is the best way to get the proper volume data so many users do it.

PC-Warrants allows you to manually enter the volume data into the computer, but a more efficient way is to import the data from existing files on your computer.

As of this writing you can import several types of volume files from JAMAR software, including PETRAPro/PETRA for Windows turning movement study files and TAS Plus/TAS for Windows/ TRAXPro ATR volume counts. Other formats supported include Streeter/Peek/ITC style .prn files, Mitron .xls files, Numetrics .mdb files and TimeMark .log files.

In this tutorial you will import volume data from TRAXPro files. Note that the import procedure for files from other ATRs is very similar, so you can follow along even if you use other types of files. A separate tutorial (Tutorial 3) will show you how to import data from turning movement files.

Run PC-Warrants and select **Define/Edit Program Preferences** from the Startup Options screen. This brings up the Preferences screen, with the **Signal War Options** sub-screen visible.

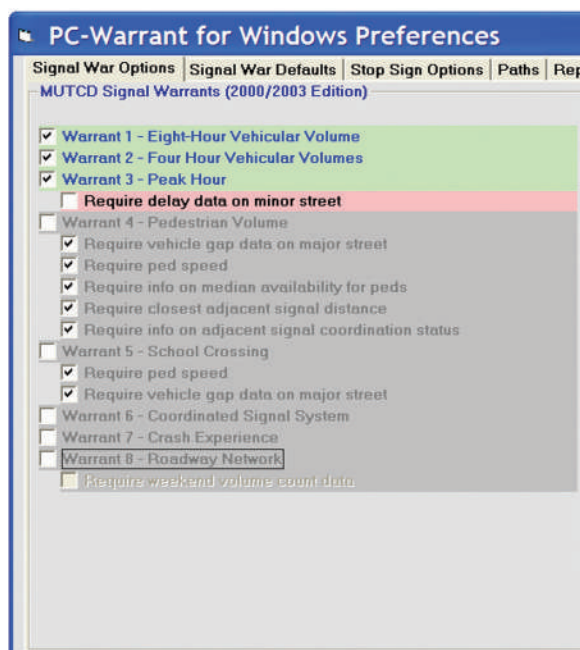


Figure 3.1 – Set Preferences

To simplify things for this tutorial, we only want to deal with the warrants that deal with volume data, which are Warrants 1, 2 & 3 in MUTCD 2003 mode. We'll disable the other warrants so the program won't ask for data (like gaps, delays and pedestrian volumes) that we don't have. For this tutorial we'll be using MUTCD 2000/2003 mode.

Click on the boxes next to Warrants 4 through 8 to disable them (the background color is set to gray). Also make sure the **Require delay data on minor street** option is disabled in Warrant 3 (background color is set to red).

When you are done the screen should look like the one shown in Figure 3.1.

Click the **Ok** button to return to the **Startup Option** screen.

Click on the **Start a New Signal Warrants Study** button.

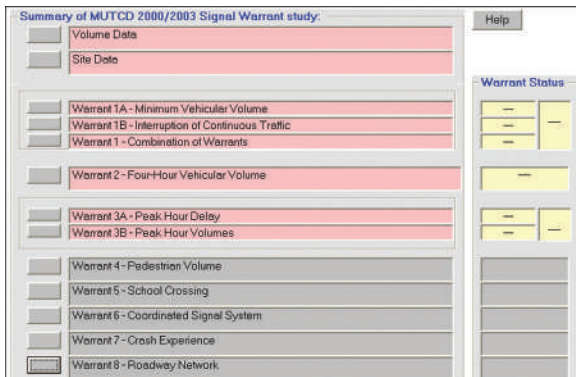


Figure 3.2 – Summary Screen

This brings up the Summary Screen with Warrants 4 through 8 shown with a gray background, which means they are disabled. The other Warrants have a red background, which means that the software doesn't have enough data yet to evaluate the warrants.

Click on the **Volume Data** button near the top of the screen.

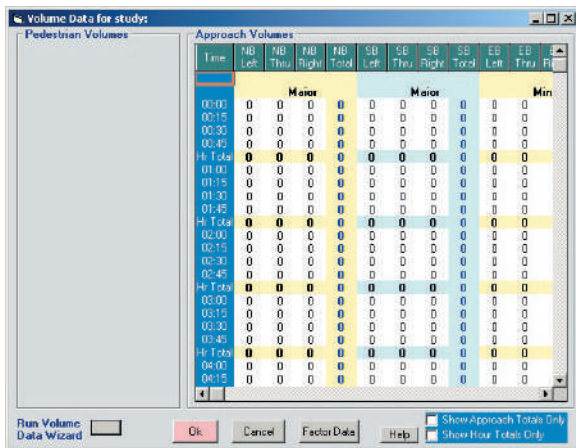


Figure 3.3 – Volume Screen

This screen shows the empty volume data matrix that we need to populate. The matrix is one day of data starting at midnight, at 15 minute intervals, with separate columns for each movement for each approach. There is a separate row for each hourly total, plus a separate column for the total of each approach.

You can manually enter the volume data by typing in the volumes for each interval in the appropriate spots, but that is time consuming. We want to import the volume data from data files that already exist on our computer. To do this we will run the Volume Data Wizard.

Click on the **Run Volume Data Wizard** button in the lower left corner of the screen.

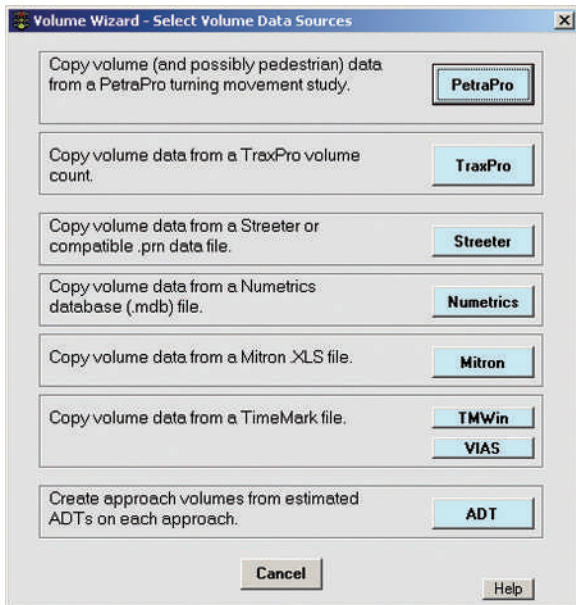


Figure 3.4
Volume Wizard - Select Volume Data Sources

Volume Data Wizard

Figure 3.4 shows the **Volume Wizard - Select Volume Data Sources** screen. The software currently can import volume data from JAMAR PETRA for Windows or PETRAPro files, and JAMAR TRAXPro volume count files. It will also import volume count files using the common .prn file format used by Streeter/Peek and ITC, Mitron .xls volume files, Numerics .mdb volume files and TimeMark .log volume files. (If you have a data format you would like us to support, please let us know.)

There is also a selection for creating volume data from estimated ADTs. This is generally used for planning purposes and is discussed in detail in Tutorial 4.

For this tutorial, we will import data from four TRAXPro count files, so click on the **TRAXPro** button.

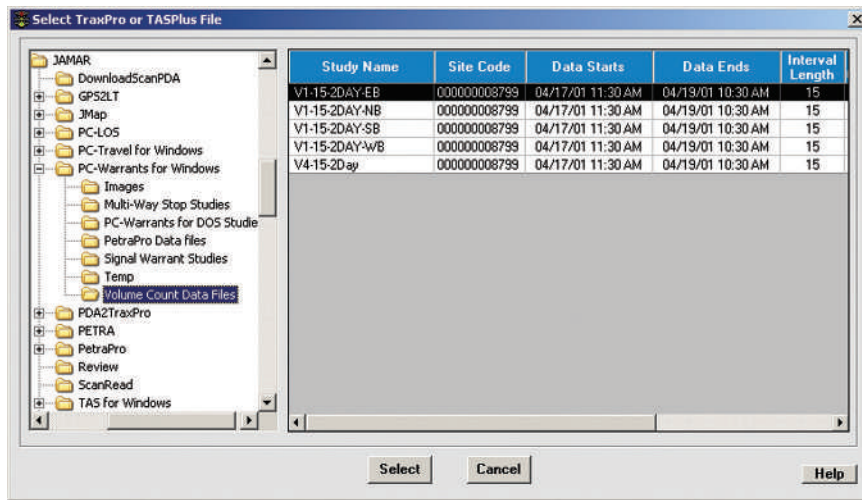


Figure 3.5 – Select File to Import

On the left side of the screen is the common tree showing the folders on your computer. The folder specified in the Preferences: Path screen for the TRAXPro Data Path is open. If you haven't changed anything since you installed the software, the folder should be at C:\Program Files\PC-Warrants\Volume Count Data Files. You may need to navigate to this folder if you see something different on your computer.

The right side of the screen shows a list of the TRAXPro volume counts in that folder, along with some information about each count. Notice that you can scroll to the right using the scroll bar at the bottom to see more of the information for any of the counts.

The volume counts shown were copied to your computer when you installed PC-Warrants. There are four one channel volume counts that were taken for the same 2 day period at one intersection using four different counters, one for each approach. They are named V1-15-2Day-XB, where X represents the approach direction. We will use these files in this tutorial.

Click on the *V1-15-2DAY-NB* count so that the row is highlighted, then click **Select**.

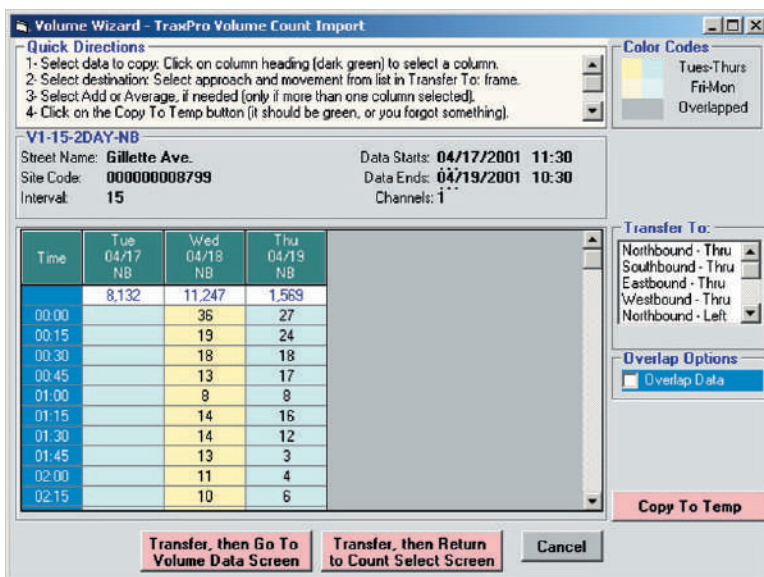


Figure 3.6 – Import Screen

This opens the **Volume Wizard - TRAXPro Volume Count Import** screen, as shown in Figure 3.6. It can be a little intimidating the first time you see it, but once you have used it a couple of times it will be very simple.

The screen has several sections:

- At the top are **Quick Directions** to remind you of the procedures used on this screen. Just follow the directions and you'll do fine.
- Below the directions is the **File Information** about the count you selected. This is just to help you make sure you selected the correct count.
- Below the File Information is a **Data Grid** showing the count data. Each column is one day of data starting at midnight for one channel. The

heading of the column shows the day of week, the date, and the channel heading from the data file. The white box below the heading shows the total volume for the day. You can scroll through the data using the scroll bars if you want to make sure the data looks ok.

- To the right of the volume data grid is the **Transfer To:** list. The list shows the four thru movements first, since those are the movements you are likely to want to pick the most often.

Transferring Data

The basic idea of this screen is for you to pick one column of data from the volume data grid then select where to transfer that data by picking a destination approach and movement from the list. Occasionally, you may have a column of data to transfer that is from a left turn or right turn lane (if you used a short tube-long tube setup for example, or had a separate counter just for a left turn bay). That's why the list shows Left and Right turn options.

- Below the *Transfer To:* list selection box is a checkbox labeled **Overlap Data**. It allows you to copy data from one day to the previous day so you have 24 hours of continuous data to transfer. For example, if you start collecting data at 12 PM on a Tuesday and end the data collection at 12 PM on Wednesday, the overlap would take Wednesday's data and copy it to the start of Tuesday. You can then select Tuesday for the transfer with a full 24 hours of data. We don't need to do this for this tutorial, so we'll leave this unchecked.

- Near the bottom of the screen are several buttons. These will be explained as we go along.

The data you selected started on Tuesday at 11:30 AM and ended on Thursday at 10:30 AM. There is only one channel of data, so there are three columns. The center column, Wednesday, has a full 24 hours of data, so we will use that day as the source of our volume data for the warrants.

1. Click on the heading for the Wednesday data (the dark green box at the top of the column of data). The column should change colors showing that it is selected.
2. From the heading, we can see that this is the Northbound data, so click on the **Northbound - Thru** option in the **Transfer To:** list. Notice that the **Copy to Temp** button turns green. This tells you that the software now knows the source and destination for the transfer.
3. Click on the **Copy To Temp** button. The software copies the data from the highlighted column in the volume data grid and stores it in a temporary matrix that looks exactly like the volume data matrix. This temporary matrix will be copied to the final matrix later.

Notice that several things happened. The selected column in the volume data grid changed colors, to a muted gray. This tells you (and the software) that the data from that column has been used so you should not try to use it again. The Copy to Temp button color went back to red. The Northbound - Thru option in the *Transfer To:* list is not selected anymore. And the two Transfer buttons at the bottom of the screen are now green. By now you know what that means; it is ok to click them now.

Since there is only one channel of data in this file, there is nothing else we can do with this count data. If this were a multi-channel count, then we could select another column, which might be a different approach, or a different movement in the same approach, and select another *Transfer To:* option, and repeat the process shown above.

However, we need to go get more data, which is in a different count file. So we need to go back to the screen where we select a TRAXPro file so we can pick the next count.

4. Click on the **Transfer, then Return to Count Select Screen** button. This does two things. First, the software transfers the data from the temporary matrix to the real volume data matrix. Second, the software pops you back to the screen where you can select a new count file.

Select the V1-15-2Day-SB count and follow the same steps shown above to transfer the Wednesday data. Select **Southbound-Thru** from the **Transfer To:** list this time.

Follow the same procedure for the EB count.

Do almost the same thing for the WB count, but instead of pressing the Transfer, then Return to Count Select Screen button, press the **Transfer, then Go To the Volume Data Screen** button since you don't need to select any more count files.

You'll see the Volume Data screen, with the volumes from the four counts shown in the Thru movements for the four approaches. The names of the approaches are listed at the top of each approach. The software also tried to figure out which are the major and minor approaches.

You can get a better overall picture of the volume data if you click on the **Show Approach Totals Only** checkbox and the **Show Hour Totals Only** checkbox in the lower right corner of the screen. When you do this, you will see the Volume Data screen shown below in Figure 3.7.

Time	NB Total	SB Total	EB Total	WB Total
	Gillett... Major	Gillett... Major	Druid H... Minor	Druid H... Minor
00:00	86	59	12	7
01:00	49	19	7	3
02:00	35	22	9	3
03:00	26	18	3	1
04:00	26	46	1	2
05:00	70	159	6	27
06:00	256	487	26	123
07:00	414	954	78	327
08:00	528	985	87	353
09:00	529	760	93	222
10:00	543	624	100	162
11:00	646	644	109	144
12:00	695	692	141	155
13:00	681	734	126	195
14:00	802	724	160	169
15:00	935	808	185	190
16:00	1075	862	232	213
17:00	1135	1018	272	252
18:00	768	701	172	165
19:00	571	489	110	102
20:00	492	336	104	57
21:00	466	230	102	41
22:00	259	182	28	34

Figure 3.7 – Volume Screen with Data

Notice the Ok button is now green. That means there is enough volume data to evaluate the warrants.

Technically, that's the end of the tutorial since we have finished the procedure to import volume count data. But if you've gone this far, you might as well finish the analysis.

Click on the Ok button. This brings up the main screen, and the Volume Data row is now green. However, the software still needs some Site Data information before any warrants can be evaluated.

Click on the **Site Data** button. Initially, the Ok button is red, which means there is something missing. If you're not sure what, then click on the **What's Missing** button. In this case, the only thing missing is the approach speed for the two major approaches.

Gillette Ave is a somewhat busy street and the 85% Speed is around 35 MPH. Enter 35 in each of the 85% Speed boxes. The minor approach, Druid Hills Road, is only one lane so set the # of Lanes checkboxes for them to 1 lane. This will result in a screen similar to the one shown in Figure 3.8.

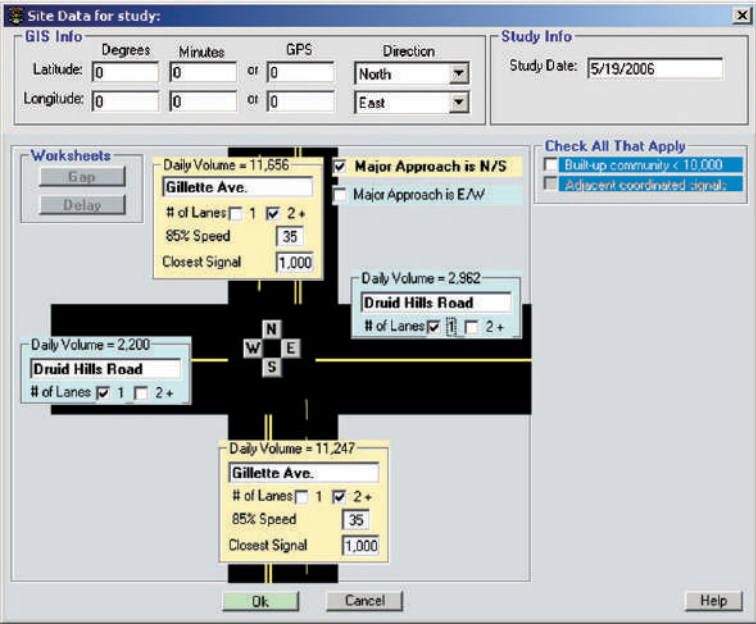


Figure 3.8 – Site Data

Notice the Ok button is now green, and the What’s Missing button isn’t visible; the site data is complete.

Click the Ok button. This brings up the Summary Screen again, but now both the Volume Data row and the Site Data rows are green. This means the software has enough information to evaluate the warrants. First it set the background colors of the warrants to green, then it evaluated the warrants and showed the results in the Warrant Status window.

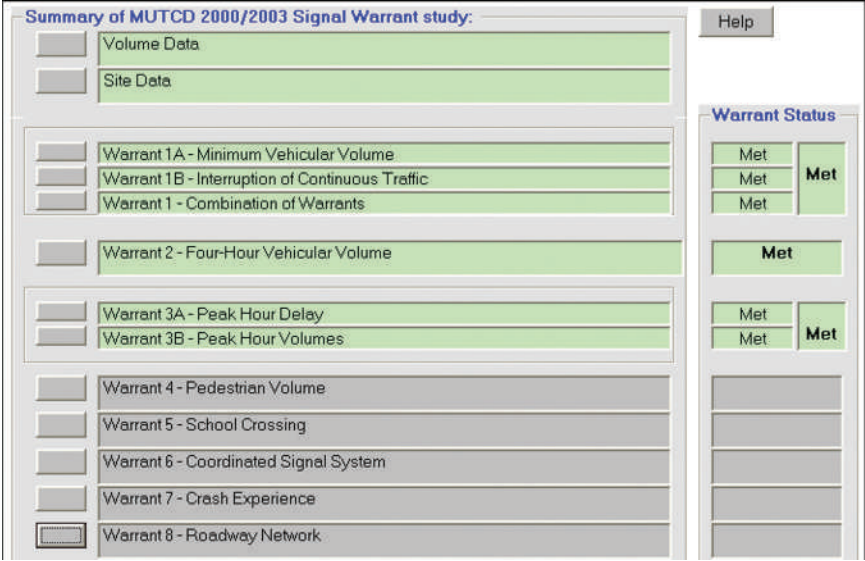


Figure 3.9 – Final Summary

In this case the volumes were more than sufficient to meet the warrants. You can see the details of any of the warrants by pressing the buttons next to any of the active warrants. *That’s the end of this tutorial.* In it, you learned how to import volume data from ATR files.

Tutorial 3 - How to Import Volume Data from PETRAPro\PETRA Files

One of the most important parts of doing a warrant study is dealing with the volume data that is required. In general you need at least 8 hours of data for each active approach, and more is generally recommended. There are two basic ways to collect the volume data:

1. You can use automatic traffic recorders (ATRs), such as the JAMAR TRAX line, to count the vehicles at each approach. You typically need four ATRs, each using one or two road tubes. It is recommended that you collect the data for at least 24 hours, and preferably more, on a Tuesday, Wednesday and/or Thursday. You will end up with 4 studies that have the volume data you need, usually in four different files on your computer.
2. You can do a manual turning movement count using equipment like the JAMAR hand-held data collectors (DB-400 & TDC-12). Ideally you would collect 8 or more hours of continuous data at the intersection. This usually requires two or more crews, which can be expensive. Still, it is the best way to get the proper volume data so many users do it.

PC-Warrants allows you to manually enter the volume data into the computer, but a more efficient way is to import the data from existing files on your computer.

As of this writing you can import several types of volume files from JAMAR software, including PETRAPro/PETRA for Windows turning movement study files and TAS Plus/TAS for Windows/ TRAXPro ATR volume counts. Other formats supported include Streeter/Peek/ITC style .prn files, Mitron .xls files, Numetrics .mdb files and TimeMark .log files.

In this tutorial you will import volume data from a PETRA turning movement file. A separate tutorial (Tutorial 2) shows you how to import data from ATRs.

Run PC-Warrants and select **Define/Edit Program Preferences** from the Startup Options screen. This brings up the Preferences screen, with the **Signal War Options** sub-screen visible.

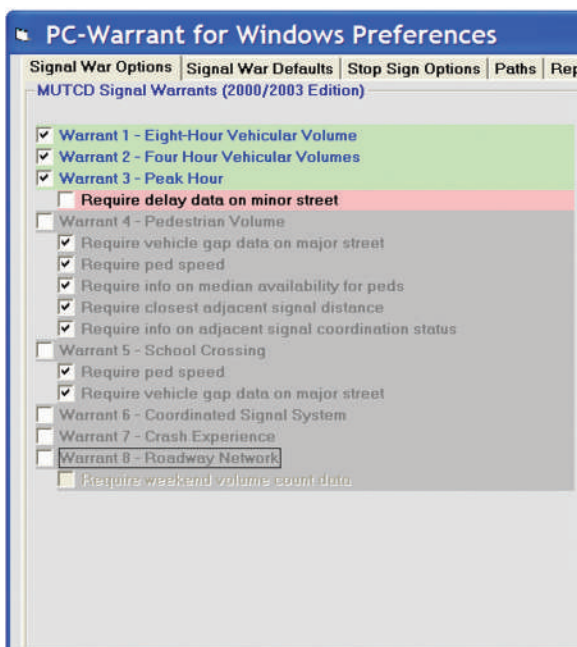


Figure 3.10 – Set Preferences

To simplify things for this tutorial, we only want to deal with the warrants that deal with volume data, which are Warrants 1, 2 & 3 in MUTCD 2003 mode. We'll disable the other warrants so the program won't ask for data (like gaps, delays and pedestrian volumes) that we don't have. For this tutorial we'll be using MUTCD 2000/2003 mode.

Click on the boxes next to Warrants 4 through 8 to disable them (the background color is set to gray). Also make sure the **Require delay data on minor street** option is disabled in Warrant 3 (background color is set to red).

When you are done the screen should look like the one shown in Figure 3.10.

Click the **Ok** button to return to the **Startup Option** screen.

Click on the **Start a New Signal Warrants Study** button.

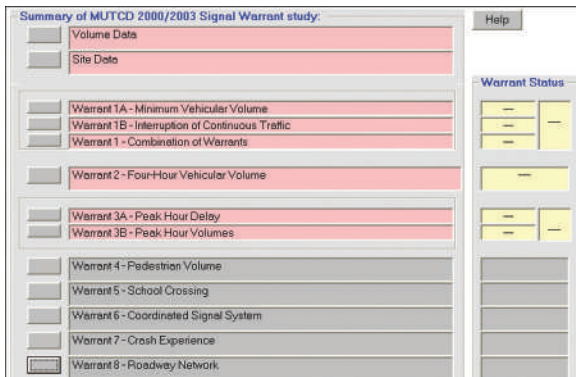


Figure 3.11 – Summary Screen

This brings up the Main Screen with Warrants 4 through 8 shown with a gray background, which means they are disabled. The other Warrants have a red background, which means that the software doesn't have enough data yet to evaluate the warrants.

Click on the **Volume Data** button near the top of the screen.

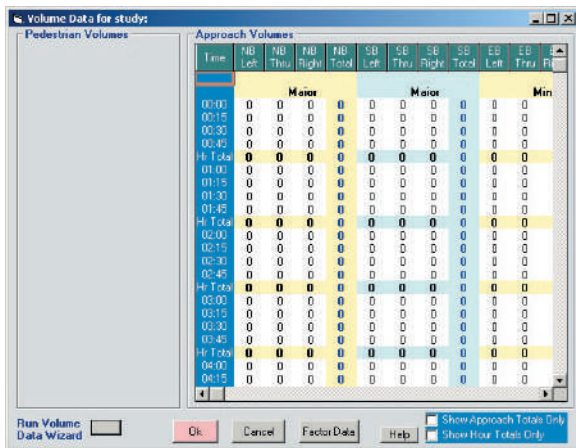


Figure 3.12 – Volume Screen

This screen shows the empty volume data matrix that we need to populate. The matrix is one day of data starting at midnight, at 15 minute intervals, with separate columns for each movement for each approach. There is a separate row for each hourly total, plus a separate column for the total of each approach.

You can manually enter the volume data by typing in the volumes for each interval in the appropriate spots, but that is time consuming. We want to import the volume data from data files that already exist on our computer. To do this we will run the Volume Data Wizard.

Click on the **Run Volume Data Wizard** button in the lower left corner of the screen.

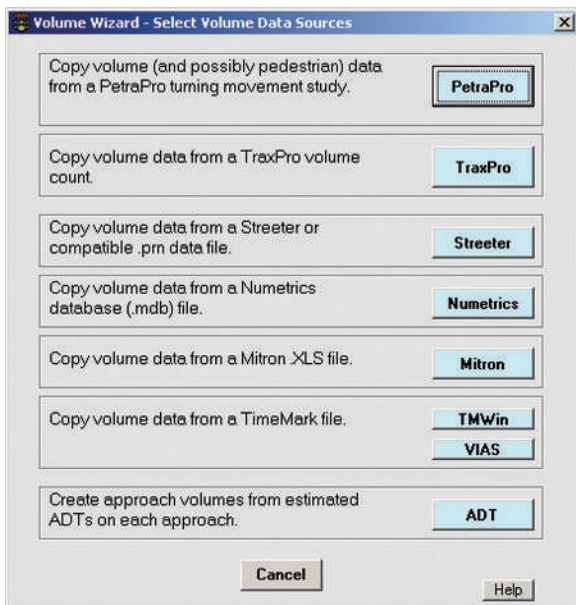


Figure 3.13
Volume Wizard - Select Volume Data Source

Volume Data Wizard

Figure 3.13 shows the **Volume Wizard - Select Volume Data Sources** screen. The software currently can import volume data from JAMAR PETRA for Windows or PETRAPro files, and JAMAR TRAXPro volume count files. It will also import volume count files using the common .prn file format used by Streeter/Peek and ITC, Mitron .xls volume files, Numerics .mdb volume files and TimeMark .log volume files. (If you have a data format you would like us to support, please let us know.)

There is also a selection for creating volume data from estimated ADTs. This is generally used for planning purposes and is discussed in detail in Tutorial 4.

For this tutorial, we will import data from a PETRAPro turning movement count file, so click on the **PETRAPro** button.

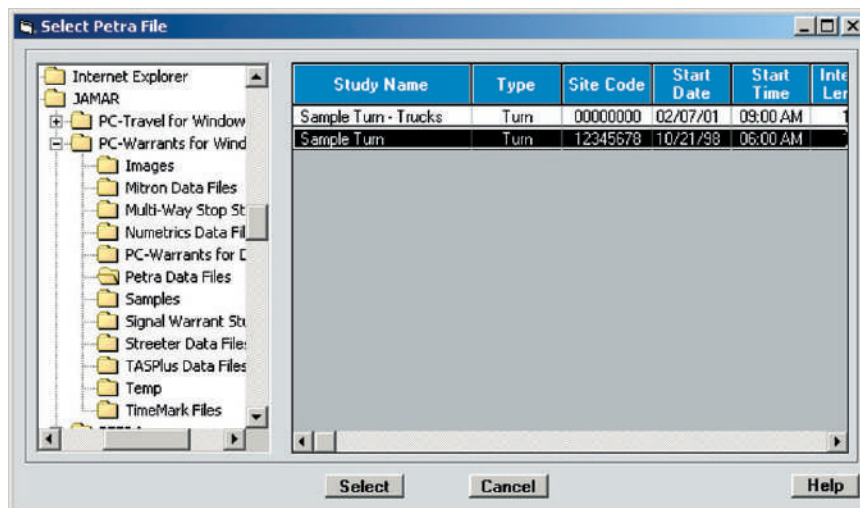


Figure 3.14 – Select File to Import

On the left side of the screen is the common tree showing the folders on your computer. The folder specified in the Preferences: Paths screen for the PETRAPro Data Path is open. If you haven't changed anything since you installed the software, the folder should be at C:\Program Files\PC-Warrants\PetraPro Data Files. You may need to navigate to this folder if you see something different on your computer.

The right side of the screen shows a list of the PETRAPro turning movement counts in that folder, along with some information about each count. Notice that you can scroll to the right using the scroll bar at the bottom to see more of the information for any of the counts.

The counts shown were copied to your computer when you installed PC-Warrants. There are two turning movement counts. Click on the **Sample Turn** count so that the row is highlighted, then click **Select**. This opens the **Volume Wizard - PETRA Import** screen, as shown here in Figure 3.15.

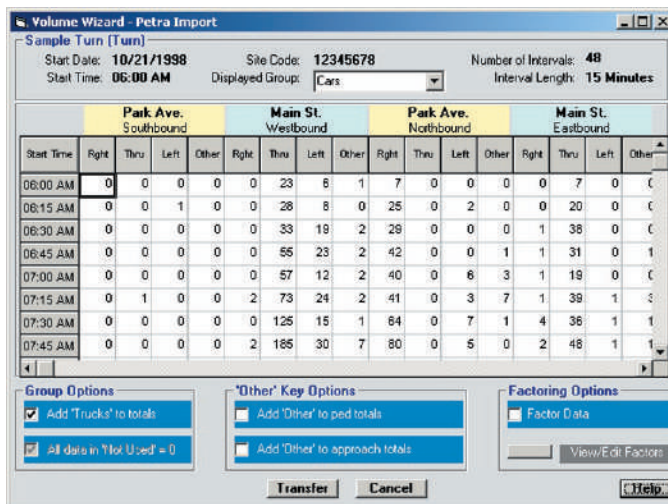


Figure 3.15 – PETRA Import

• At the very top is the **File Information**, which contains the name of the study (Sample Turn) and the study type (Turn). It also contains additional information about the count you selected. This is just to help you make sure you selected the correct count.

Part of this information is the **Displayed Group** field. PETRAPro files can have three groups of data. Typically the first group is for cars. The second group is often used to count trucks by movement, but can be used in many different ways. The third group isn't used very often, but it too can be used in different ways. The groups correspond to the bank keys used with the JAMAR count boards to collect the data.

• Below the File Information is a **Data Grid** showing the count data. The grid is designed to look like the editing/viewing grid in PETRAPro. The data shown is the group that is selected in the Displayed Group field in the File Information area. Click on the down arrow and select the group you want to display. You can scroll through the data using the scroll bars if you want to make sure the data looks ok.

• Below the Data Grid are three sets of options, **Group Options**, **'Other' Key Options**, and **Factoring Options**.

These options give you control over how the data is transferred to the volume data matrix.

Group Options

As mentioned above, PETRAPro files can have three groups of data. The data in the primary group is always assumed to be part of the data that is transferred. You have the option of choosing whether to include the data in the other two groups as well.

The software checks the contents of the second and third groups to see if they were used in this count. *Used* means any non-zero count in *any* interval or *any* movement. If the software finds any non-zero values then it enables the checkbox for that group and displays the message **Add X to totals** where X is the title of the group. If the group data contains all zeros, then the checkbox is disabled with the message **All Data in X = 0** where again, X is the title of the group. In the example shown in Figure 3.16, the second group title is *Trucks* and there is non-zero data in that group so the checkbox is enabled. The third group is not used in this count, so the check box is disabled.

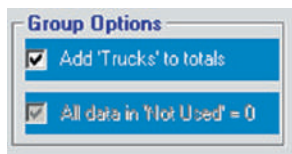


Figure 3.16 – Group Options

If you want the data in the group added to the totals that are transferred, then click the checkbox so there is a check visible. In this case, *Trucks* should be part of the approach totals for the warrant analysis, so the checkbox should have a check in it.

‘Other’ Key Options

JAMAR data collectors, and therefore PETRAPro as well, support 4 buttons per approach per group. Normally, the buttons are used for Right, Thru, & Left turns and the fourth button, called the *Other* button, can be used for a variety of things. Common uses include pedestrians by approach, right turns on red, trucks by approach, u-turns, a second left turn lane or right turn lane, and many more. The most common use is to count pedestrians by approach.

PC-Warrants checks the headings of the approaches in the PETRAPro file and tries to determine if the *Other* keys are used, and if so, how they are used. This isn’t as easy as it may seem because PETRAPro allows the user great latitude in how the headings are organized. In the file we are working with the *Other* keys are the 4th, 8th, 12th, and 16th columns and the title is ‘Other’, as shown in Figure 3.15. That is nice and simple, but in another file the order could be different and the title could be something obscure.

The software checks the data in the columns under the *Other* keys. If any of the values in *any* of the intervals of *any* of the approaches is non-zero, then the ‘Other’ Key Options box is enabled, otherwise the box is not shown at all.

If the *Other* key heading is ‘Peds’ then the ‘Other’ Key Options box will show one checkbox with the message **Add Peds to ped totals**.

If the *Other* key heading is ‘Truks’ or ‘Trucks’ then the ‘Other’ Key Options box will show one checkbox with the message **Add Trucks to approach totals**.

Otherwise, the ‘Other’ Key Options box will show two checkboxes with the message **Add X to ped totals** in the first checkbox, and the message **Add X to approach totals** in the second checkbox, where X in both cases is the heading of the Other keys. The default value for the checkboxes will be off (no check).

In the example shown in Figure 3.17, the *Other* key heading is ‘Other’, and there is non-zero data in those columns. The ‘Other’ Key Options box is visible, with the two checkboxes enabled, but not checked.

If you know that the *Other* keys were actually used to count Pedestrians, and the heading was never set in PETRAPro, then you would click the first checkbox. If the *Other* keys were actually some type of vehicle, like buses,

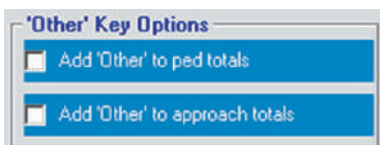


Figure 3.17 – Other Key Options

then you might want to have those totals added to the approach totals.

Let's assume that the *Other* keys were used to count peds. Since in this tutorial we are not worried about Warrant #4 - Minimum Pedestrian Volume, we don't need to check the first checkbox. We definitely don't want the counts added to the approach totals, so make sure the second box is not checked as well.

Factoring Options

The final choices you need to make involve whether you want to factor the data before it is transferred to the volume data matrix. Factoring means adjusting the data in a particular movement to give it more, or less, weight. The typical application would be to factor right turns down (figuring they have less impact on traffic flow) or factor left turns up (figuring they have more impact). The factor numbers are multipliers; a factor of 2.00 will double the data, while a factor of 0.50 will divide it in half.

PC-Warrants lets you factor each movement of each approach with a separate factor if you want. If you don't want to factor the data, then just set the **Enable Factoring** checkbox off. If you want to factor the data, then set the Enable Factoring checkbox on, click on the **Edit/View Factors** button, and enter the values you want for the movements.

For this tutorial, we will assume we don't want to factor the movement data, so leave the Enable Factoring checkbox off.

Transferring Data

Now that we have decided on the Group Options, the 'Other' Key Options, and the Factoring Options just click on the **Transfer** button. The software copies the data from the PETRAPro file, applying the settings we made including any factoring, and then displays the Volume Data screen which shows the counts in the appropriate movements. The names of the approaches are listed at the top of each approach. The software also figures out which are the major and minor approaches.

You can get a better overall picture of the volume data if you click on the **Show Approach Totals Only** checkbox and the **Show Hour Totals Only** checkbox in the lower right corner of the screen.

When you do this you will see the Volume Data screen shown in Figure 3.18.

Notice the **Ok** button is now green. That means there is enough volume data to evaluate the warrants.

Technically, that's the end of the tutorial since we have finished the procedure to import the PETRAPro count data. But if you've gone this far, you might as well finish the analysis.

Time	Park Ave.		Main St.	
	Minor	Minor	Major	Major
00:00	0	0	0	0
01:00	0	0	0	0
02:00	0	0	0	0
03:00	0	0	0	0
04:00	0	0	0	0
05:00	0	0	0	0
06:00	2	13	136	231
07:00	21	17	241	642
08:00	14	19	243	598
09:00	0	9	196	315
10:00	8	16	223	300
11:00	9	17	367	364
12:00	17	18	392	439
13:00	34	33	365	393
14:00	10	17	363	431
15:00	15	24	475	532
16:00	21	21	585	613
17:00	10	22	655	608
18:00	0	0	0	0
19:00	0	0	0	0
20:00	0	0	0	0
21:00	0	0	0	0
22:00	0	0	0	0

Figure 3.18 – Imported Volume Data

Click on the **Ok** button. This brings up the main screen, and the Volume Data row is now green. However, the software still needs some Site Data information before any warrants can be evaluated.

Click on the **Site Data** button. Initially, the Ok button is red, which means there is something missing. If you're not sure what, then click on the **What's Missing** button. In this case, the only thing missing is the approach speed for the two major approaches.

Main Street is a somewhat busy street and the 85% Speed is around 35 MPH. Enter **35** in each of the **85% Speed** boxes.

Park Ave is a small street with just one lane per approach. Change the number of lanes from 2 to 1 for both Park Ave approaches. This will result in a screen similar to the one shown in Figure 3.19.

Figure 3.19 – Site Data

Notice the Ok button is now green, and the What's Missing button isn't visible. This means the site data is complete

Click the Ok button. This brings up the Summary Screen again, but now both the Volume Data row and the Site Data rows are green. This means the software has enough information to evaluate the warrants. First it set the background colors of the warrants to green, then it evaluated the warrants and showed the results in the **Warrant Status** window.

Figure 3.20 – Final Summary

In this case the volumes were not sufficient to meet the warrants. You can see the details of any of the warrants by pressing the buttons next to any of the active warrants.

That's the end of this tutorial. In it, you learned how to import volume data from PETRAPro files.

Tutorial 4 - How to Create Volume Data from Estimated ADTs

Occasionally you may need to do a warrant study for an intersection that doesn't exist yet, which is tricky since there is no real data to apply to the warrant criteria. Suppose, for example, that a new intersection is planned for a new community. Does that intersection need traffic signals installed, or would stop sign control be better? To answer this, you need to do a warrant analysis. As with any warrant analysis, you need information about the site, and information about the traffic volumes.

You know most of the site data you'll need to evaluate the warrants; the number of approaches, the number of lanes per approach, etc. This you could easily enter into the PC-Warrants software.

The volume data is a little more difficult. You need some way to generate the volume data. You could do this if you have an estimated ADT (Average Daily Traffic) total for the proposed intersection. But this isn't quite enough. Warrants require hourly data. You can't just take the ADT and divide by 24 to get the hourly volumes. You need some sort of volume profile that takes into account the fact that traffic at 3 AM is not the same as 3 PM. The profile would just be an estimate of course, but then so is the ADT. Once you have the volumes you then have to type the numbers into the Volume Data screen. Then you could do the warrant analysis. You can do all of this manually, but there is an easier way...

In this tutorial you will create volume data for an intersection that is just a gleam in the planner's eye.

Run PC-Warrants and select **Define/Edit Program Preferences** from the Startup Options screen. This brings up the Preferences screen, with the **Signal War Options** sub-screen visible.

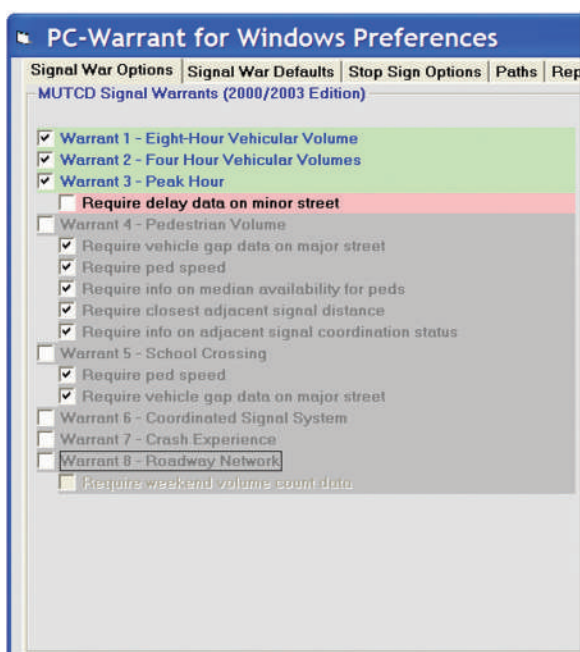


Figure 3.21 – Set Preferences

To simplify things for this tutorial, we only want to deal with the warrants that deal with volume data, which are Warrants 1, 2 & 3 in MUTCD 2003 mode. We'll disable the other warrants so the program won't ask for data (like gaps, delays and pedestrian volumes) that we don't have. For this tutorial we'll be using MUTCD 2000/2003 mode.

Click on the boxes next to Warrants 4 through 8 to disable them (the background color is set to gray). Also make sure the **Require delay data on minor street** option is disabled in Warrant 3 (background color is set to red).

When you are done the screen should look like the one shown in Figure 3.21.

Click the **Ok** button to return to the **Startup Option** screen.

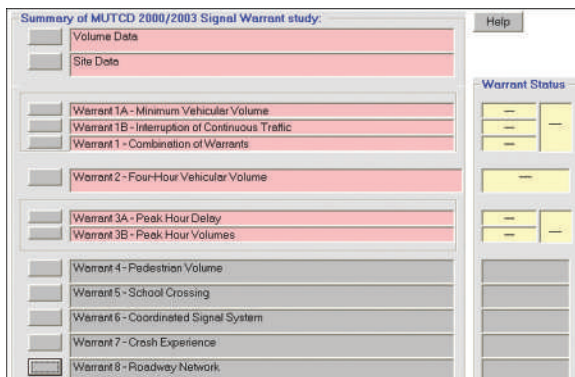


Figure 3.22 – Initial Summary Screen

Click on the **Start a New Signal Warrants Study** button.

This brings up the Main Screen with Warrants 4 through 8 shown with a gray background, which means they are disabled. The other Warrants have a red background, which means that the software doesn't have enough data yet to evaluate the warrants.

Click on the **Volume Data** button near the top of the screen.

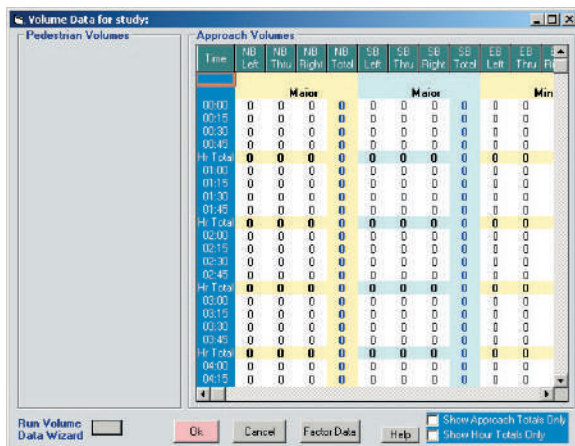


Figure 3.23 – Volume Screen

This screen shows the empty volume data matrix that we need to populate. The matrix is one day of data starting at midnight, at 15 minute intervals, with separate columns for each movement for each approach. There is a separate row for each hourly total, plus a separate column for the total of each approach.

You can manually enter the volume data by typing in the volumes for each interval in the appropriate spots, but that is time consuming. We want to import the volume data from data files that already exist on our computer. To do this we will run the Volume Data Wizard.

Click on the **Run Volume Data Wizard** button in the lower left corner of the screen.

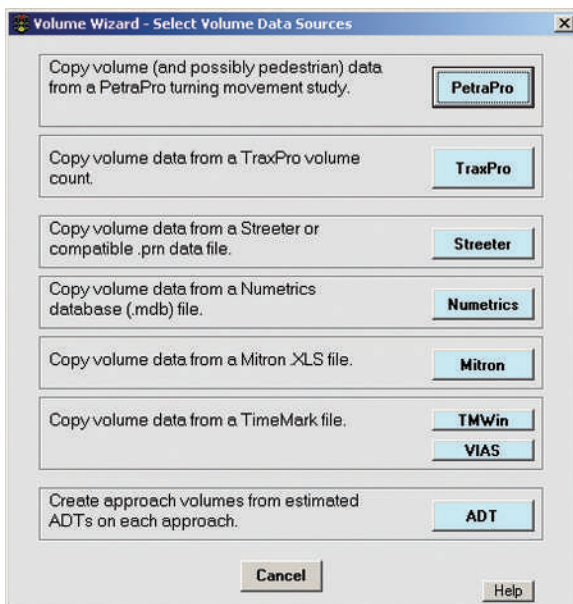


Figure 3.24 – Volume Data Wizard

Volume Data Wizard

Figure 3.24 shows the **Volume Wizard - Select Volume Data Sources** screen. The software currently can import volume data from JAMAR PETRA for Windows or PETRAPro files, and JAMAR TAS Plus, TAS for Windows or TRAXPro volume count files. It will also import volume count files using the common .prn file format used by Streeter/Peek and ITC, Mitron .xls volume files, Numerics .mdb volume files and TimeMark .log volume files. These don't do us any good right now, since there is no traffic to measure.

For this tutorial, we will create data from an estimated ADT, so click on the **ADT** button.

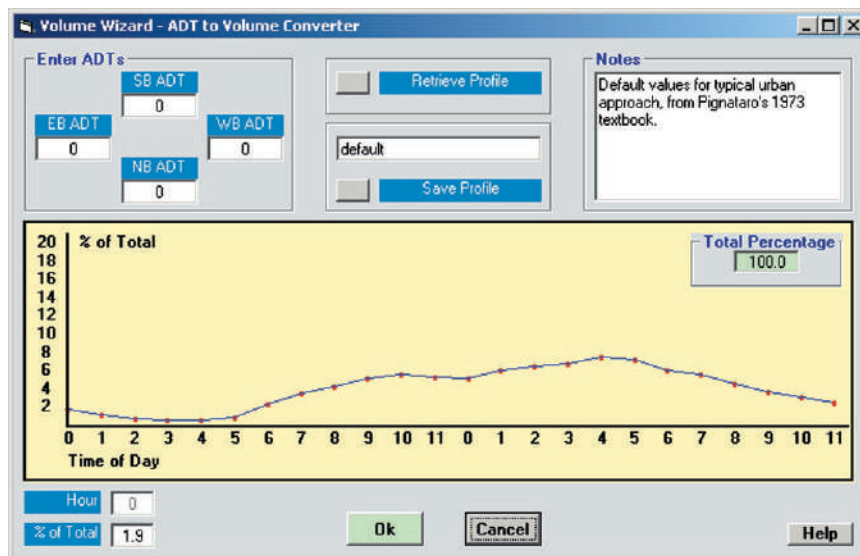


Figure 3.25 – ADT to Volume Converter

ADT to Volume Converter

Figure 3.25 shows the **Volume Wizard - ADT to Volume Converter** screen.

The **Enter ADTs** field contains four text boxes where you can enter the estimated ADTs for each approach. The software takes the values from each of these text boxes and uses the volume profile to calculate the hourly volumes for each approach.

The rest of the screen deals with the **Volume Profile**, which is plotted in the center of the screen. This is a graph of the percentage of the total volume for each hour of the day. The graph goes from 0% to 20%, which is probably the highest percentage you will need for a single hour.

The total percentage, the sum of the 24 hourly percentages, should add up to 100%. Since you can edit the graph easily (this is explained in detail a little later), the total percentage is shown in a little frame in the upper right corner of the graph.

There is no single perfect volume profile that will be right for every proposed intersection. For this reason you can edit the volume profile to fit your needs, and then save it for use at a later time. If you can save a profile, then you also need to be able to retrieve a profile. The **Save Profile** and **Retrieve Profile** buttons at the top center of the screen control these actions.

You can give a profile a name and add notes that are saved with the profile. The name and the notes will make it easier to find a particular profile long after you forgot why you edited the profile the way you did. These controls are also at the top of the screen.

There are two ways you can edit the volume profile:

1. The easiest way is to use the mouse to grab a data point and drag it to the percentage you want for that hour.
2. You can also edit a particular data point by typing in the value for the percentage in the text box in the lower left corner of the screen.

As you edit the profile, the total percentage for this volume profile is re-calculated and displayed in the **Total Percentage** frame in the top right corner of the graph.

The basic idea to use this screen is pretty simple:

1. Create the volume profile you want, either by retrieving an existing profile, or editing an existing profile to match your needs. If you edit an existing profile you can save the new profile to use again at a later time. As you edit the profile, you watch the total percentage box to make sure that when you are done the total is 100%.

2. Enter the ADTs for each approach. You may only have a total ADT for the intersection. You can take this and divide it up into four approaches in a way that makes sense to you. Most intersections aren't equally balanced so it makes sense to have separate calculations for each approach.

Note: You might argue that each approach probably doesn't have the same volume profile, and you'd be right. The question is do you want to have to deal with a separate graph for each approach? If the answer is yes, let us know. It isn't hard to add from a programming point of view. The only question is whether the extra work required to create the volumes is warranted (excuse the pun).

3. Click on Ok. The software takes the percentage for each hour and multiplies it by the ADT for each approach. This is the volume in that hour for that approach. This volume is transferred to the Volume Data screen.

That is a quick overview of the screen. Now let's go through a typical example step by step to see how it works in practice.

If you were happy with the volume profile shown on the screen, then you would just enter the ADTs, click **Ok**, and be done with it. But that wouldn't make this tutorial very interesting.

Let's assume that your urban planner thinks that there will be a strong morning and evening peak hour rush at this intersection, so the volume profile needs to be edited. Click the data point at 7:00 AM. Notice the datapoint turns green. Now click and drag the point up until the display in the lower left shows 8.0. If you have trouble clicking and dragging to get the point to 8.0, you can also click on the data point then type 8.0 directly into the **% of Total** box at the lower left. Your screen should look similar to the one shown here.

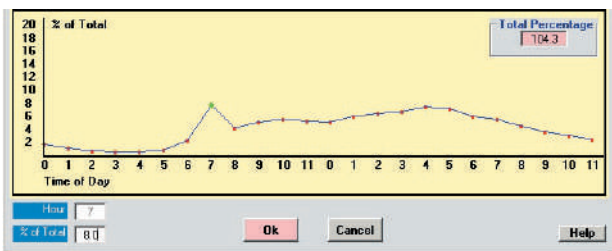


Figure 3.26 – Adjust 7 AM data point

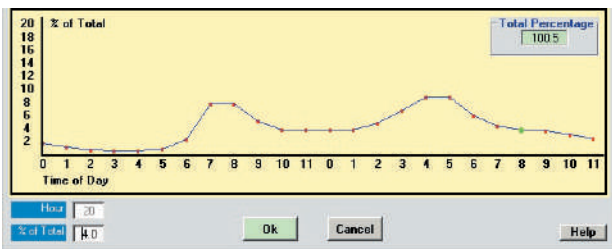


Figure 3.27 – All Data Points Adjusted

Notice the Total Percentage now shows 104.3 and the background is red. The Ok button is also red. This is to let you know that the percentage is not what it should be.

Continue to edit the data by grabbing the 8 AM data point and setting it to 8.0 as well. We'll also supply an evening peak by setting the 4 PM and 5 PM data points to 9.0.

Now that we've increased the percentages on four of the data points our overall percentage is up to 110.8. We have to lower this back down to around 100 before proceeding, so next we'll lower some of the others data points. Set the 10 AM, 11 AM, 12 PM and 1 PM data points to 4.0, and the 2 PM data point to 5.0. Next, set the 7 PM data point to 4.5 and the 8 PM data point to 4.0. Notice that once you set the last data point the OK button and Total Percentage box have turned to green, letting you know that it is okay to proceed. Your screen should now look like Figure 3.27.

Let's assume we like this particular volume profile and want to save it to use some other time. We need to do two things: give the profile a new name and type in some notes.

Click on the text box above the **Save Profile** button and edit the name to something descriptive, like ‘AM and PM Peaks’ (ok, so maybe that’s not very descriptive). Then type in some notes if you want to say more about this particular profile, such as ‘Two peaks, between 7-8 in AM and 4-5 in PM’.

Next, click the **Save Profile** button. You’ll see a confirmation message telling you the profile has been saved. The profile is saved in a file that is stored in the same folder as your PC-Warrants.exe file. Now that the profile is edited and safely saved, we can enter the ADTs and create the volume counts for the warrant study.

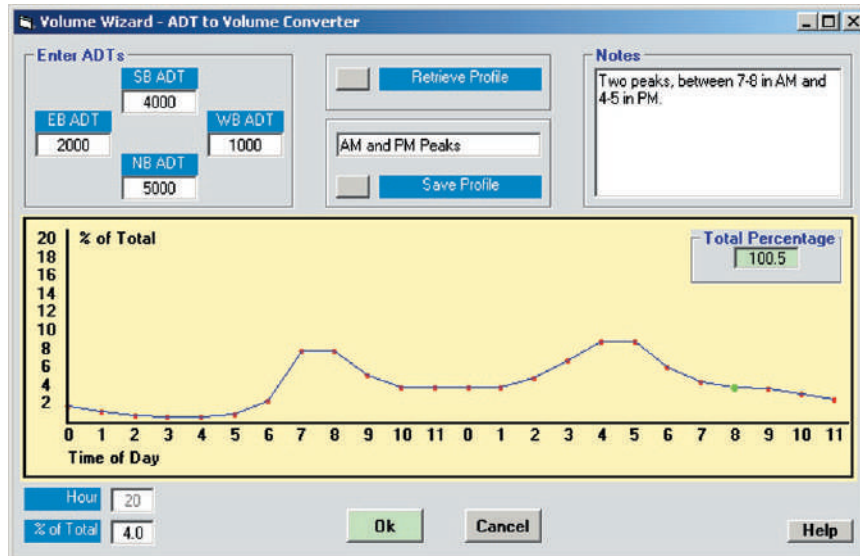


Figure 3.28 – ADT to Volume Converter with Profile Information

Let’s assume that the estimate for this intersection is for 12,000 vehicles per average weekday, with the NB approach = 5000, SB = 4000, EB = 2000, WB = 1000. That means the N-S corridor is expected to handle considerably more volume than the E-W corridor. Type these values into the appropriate text boxes in the upper left corner of the screen, as shown in figure 3.28 above. Once the ADTs have been entered, click **Ok**.

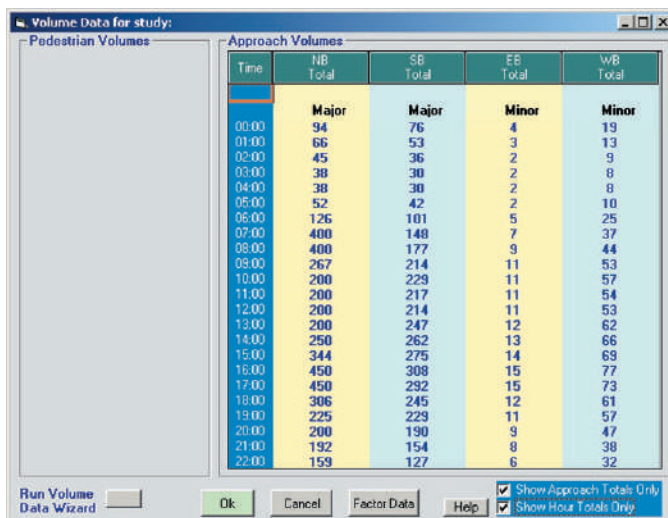


Figure 3.29 – Volume Screen with Data

The software takes the percentage for each hour and multiplies it by each ADT. This is the volume for that approach for that hour. That volume is transferred to the through movement of the first 15 minute interval for that hour in the Volume Data matrix. The software does this 24 times for each approach, resulting in a full Volume Data matrix.

Next you will see the Volume Data screen, with the new volumes. To see the volumes clearer, place a check in the **Show Approach Totals Only** and **Show Hour Totals Only** checkboxes.

Once you have the Volume Data matrix populated, you can go to the Site Data screen to finish entering the data about the planned intersection. Once that is done, you can see the results of the warrant analysis. That’s it. You have done a warrant analysis for an intersection that doesn’t exist.

How to Retrieve a Volume Profile

It is simple to retrieve a volume profile you have saved in a previous session.

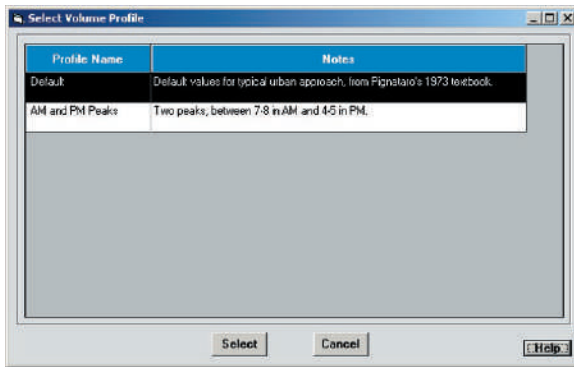


Figure 3.30 – Volume Profile Retrieval

Follow the directions on pages 3.14 & 3.15 until you are at the **ADT to Volume Converter** screen. Click on the **Retrieve Profile** button at the top of the screen. This will bring up the **Volume Profile Select** screen, shown in Figure 3.30. This screen shows two profiles, the **default** profile that is installed with PC-Warrants, and the **AM and PM Peaks** profile that was created during this tutorial. The screen shows the Profile Name, and the Notes that were entered when the profile was saved.

Click on the profile you want to use and then click on the **Select** button. The profile (name, notes, and graph) is loaded into the **ADT to Volume Converter** screen, ready for you to use.

That's the end of this tutorial. In it, you learned how to create volume data from Estimated ADTs.

Tutorial 5 - Introduction to Multi-Way Stop Sign Warrants

PC-Warrants includes support for Multi-Way Stop Sign warrants, based on the procedures in the MUTCD (Manual of Uniform Traffic Control Devices). The software supports the MUTCD 2003/2000 versions, and also the MUTCD 1988 version.

While not as complex as Signal warrants, Multi-Way Stop Sign warrants still require many of the same data requirements, including volumes on all of the approaches, speeds, delays, and site details. If you have learned how to do signal warrants with PC-Warrants, you will have no trouble learning to do Multi-Way Stop Sign warrants as well.

This tutorial will show you how to do a basic Multi-Way Stop Sign (MWSS) warrant analysis. To keep things simple we will retrieve an existing study that was installed when the rest of the program was installed. This tutorial assumes you have installed PC-Warrants and are familiar with the basic operation of the software. It also assumes you are familiar with the basic ideas in the MUTCD for Multi-Way Stop Sign warrants.

Run the software. After the initial sign-on screen that shows the licensing information, you will see the **Startup Options** screen.

Setting Preferences

Before we retrieve a MWSS study, we should take a look at the **Preferences** screens for MWSS studies, so click on the blue **Define/Edit Program Preferences**, then click on the tab at the top of the screen marked **Stop Sign Options**. You'll see the screen shown below in Figure 3.31.

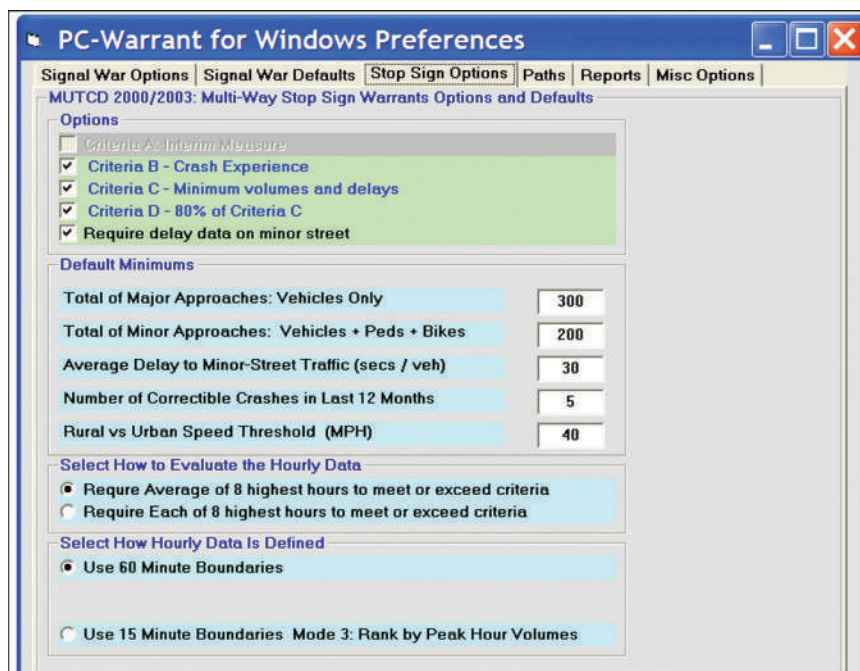


Figure 3.31 – Stop Sign Options

If you are familiar with the Signal warrant operation in PC-Warrants you'll notice that this screen is a combination of the two Preferences screens used for the Signal warrants. The top section shows the **Options** you can enable or disable, the middle section shows the **Default Minimums** used in the program, and the bottom section (which is unique to MWSS studies) lets you **Select How Hourly Data is Defined** in the program.

Options

The MUTCD 1988 version defines 3 different ways (or criteria) an intersection can warrant multi-way stop control. The MUTCD 2000/2003 version has an additional 4th criteria.

The first criteria is that if an intersection is warranted for a signal, then you can install stop signs until the signals are installed. This criteria isn't evaluated in the software, since there really isn't anything the software could do. It is listed in the software and on the report, but only for completeness.

The second criteria is for a site where accidents or crashes have occurred. This *is* evaluated in the software; in the Site Data screen you can enter the number of crashes in the last 12 months and if that number exceeds the minimum, the warrant is met. You don't need software to evaluate this criteria either, but it is included for completeness.

The third criteria involves volumes and delays. This, obviously, is where the program becomes useful. You need the volume information, without it you really can't begin to evaluate the warrant. You *should* collect the delay data as well, but since many (if not most) users don't, you can tell the software to ignore the delay requirements.

The MUTCD 2000/2003 has a fourth criteria, which says that if criteria 2 and 3 are not met completely by themselves, but 80% of the values are met for *both*, then the warrant is satisfied. If you select MUTCD 2000/2003 mode in the program, then this criteria is shown, evaluated, and printed on the report.

You have the option to disable Criteria B, C, and/or D if present, although chances are you will always leave them all enabled.

A more common decision will be to choose to not require delay data on the minor street if you don't have delay data but want to see if the rest of the criteria are met.

Default Minimums

The MUTCD 1988 and 2000/2003 versions define the minimum values for various parameters specified in the warrant. The software assumes you will want to use the federal values. However, if in a year or two the feds, or your state or local agency, decides to change one or more of the values of these parameters, then you just have to change the value on this screen and the software will use the new values. For now we suggest that unless you have a very good reason, leave them alone.

Select How to Evaluate the Hourly Data

Select How Hourly Data is Defined

The MUTCD uses the phrase "averages at least 300 vehicles per hour for any 8 hours of an average day". This seemingly simple sentence has caused much confusion over the years, resulting in different interpretations of what should be done. This is explained in greater detail in the Appendix. For this tutorial, set the first option to **Require Average of 8 highest hours to meet or exceed criteria**.

It also isn't clear what an hour of data means. Some users take this to mean that you can define an hour on 15 minute boundaries, such as from 7:15-8:15 (assuming you have volume data in 15 minute intervals). Other users say no, you have to use just hourly volumes 7:00-8:00, 8:00-9:00, etc. Frankly, we don't care which way you interpret it; you can choose either and the software will know what to do. However, **this is not a trivial decision to make**. An intersection may not meet the warrant if **Use 60 Minute Boundaries** is selected, but will if **Use 15 Minute Boundaries** is selected. There are many more possible hours (96) that could be part of the 8 needed when using 15 minute boundaries. You can have 8 hours meet the warrant in only about 3 hours of real time (7-8, 7:15-8:15,...8:45-9:45). You have to decide if this is how the MUTCD should be interpreted.

For this tutorial, select **Use 15 Minute Boundaries** if it not already selected. Later you can go back and change this and see what effect it makes on the warrant status for the same data.

Click **Ok** at the bottom of the screen to return to the **Startup Options** screen.

Now that the Preferences are set, we can retrieve an existing Multi-Way Stop Sign study to see how the program evaluates the warrant.

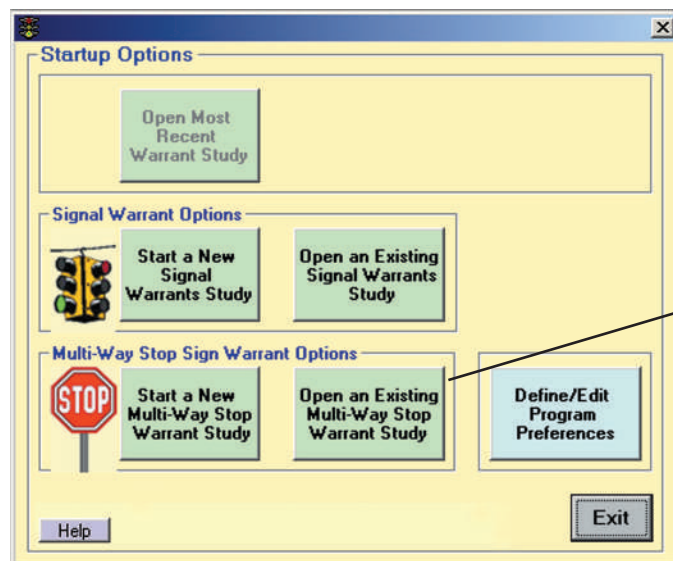


Figure 3.32 – Startup Options

Click on the button labeled **Open an Existing Multi-Way Stop Warrant Study** on the line with the stop sign image.

This brings up the **Select Multi-Way Stop Study** screen, shown in Figure 3.33 below.

Select Study

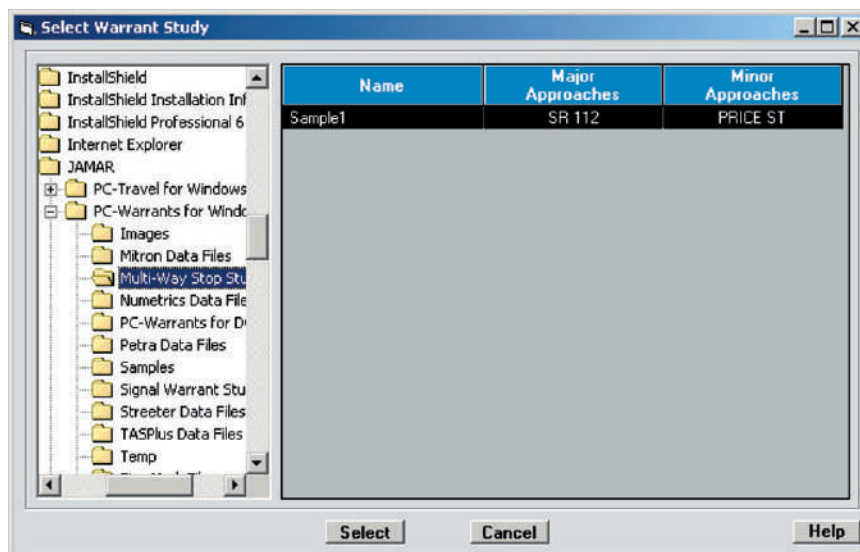


Figure 3.33 – Select Multi-Way Stop Sign Study

This screen has the familiar Windows tree structure of the folders on your computer on the left side of the screen. The **Multi-Way Stop Studies** folder should be highlighted. If it isn't, click on the folder to highlight it. In the right hand window are any studies in that folder. In this case, there is only the one study, named **Sample1**, that is installed with the program.

Since there is only one study in this folder, it is already highlighted. Click on the **Select** button at the bottom of the screen to open the study.

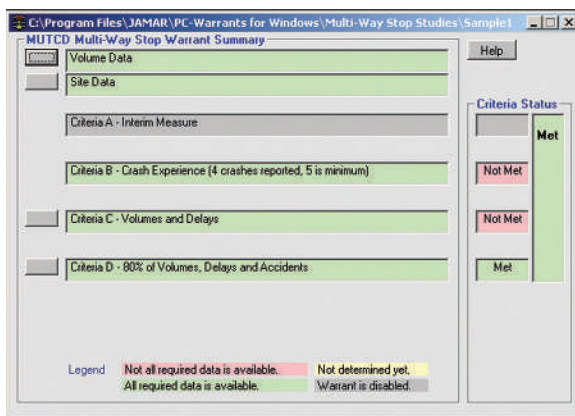


Figure 3.34 – Stop Sign Summary Screen

check the volume data or site data by clicking on the respective button.

Figure 3.35 – Volume Data Screen

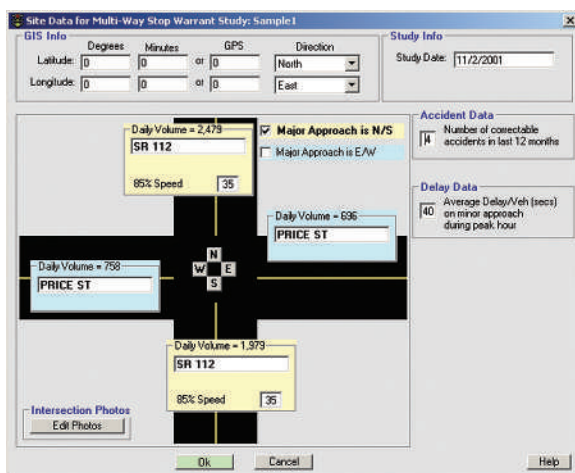


Figure 3.36 – Site Data Screen

Accident Data is where you enter the number of accidents or crashes that occurred in the last 12 months. This is used to evaluate Criteria 2, and if you have enabled the MUTCD 2000/2003 version, part of Criteria 4.

Delay Data is where you enter the Average Delay Per Veh (in seconds) on the minor approach during the peak hour.

For this tutorial, just acquaint yourself with this screen, and then click **Ok** to go back to the Summary Screen.

Study Summary

Figure 3.34 shows the **Summary Screen** when you are in Multi-Way Stop Sign warrant mode. *Since by now you should be familiar with the program from evaluating signal warrants, we won't go into details about features of this screen.*

Notice the first criteria is listed, but disabled. Criteria 2 (or B) is enabled, but since there are only four crashes, the warrant is not met for this criteria. Criteria C is enabled, and the warrant is not met in this case, but Criteria D is met.

Near the top of the screen are the Volume Data and Site Data status lines and buttons. Since the background color is green, we know that there is sufficient data to evaluate the warrant. You can

Volume Data

Click on the Volume Data button, which brings up the **Volume Data** screen shown in Figure 3.35. This screen is identical for both Signal Warrants and Multi-Way Stop Warrants. Any pedestrian volumes are shown in the window on the left side, vehicle volumes are shown in the larger window on the right. You can import data into the Volume Data screen using the Volume Data Wizard, just like you do for signal warrants. The **Show Approach Totals Only** and **Show Hour Totals Only** checkboxes can be used to see the volume more clearly.

Since you are familiar with the way this screen works from earlier tutorials, just click **Ok** to go back to the Summary Screen.

Site Data

Now click on the Site Data button near the top of the screen. This brings up the **Multi-Way Stop Sign Site Data** screen shown in Figure 3.36.

This is a somewhat simplified version of the Site Data screen used for signal warrants. The large window shows a graphic of the intersection. You can enable or disable approaches by clicking on the N,E,S,W buttons in the center of the intersection. You can define approaches as major or minor (the software uses the approach volumes to guess which are the major or minor approaches but you can set them yourself if necessary). You need to enter the names for all enabled approaches, and for the major approaches, you need to enter the approach speeds.

The right side of the screen has two small frames:

You should be back at the Summary Screen. You can see that Criteria C is not met, but there aren't any details at this level. Click on the button next to the Criteria C status line. This brings up the **Criteria C - Minimum Volumes and Delays** screen, shown in Figure 3.37.

Figure 3.37 – Criteria C Screen

Warrant Criteria

This screen is very similar to the detail screens for the various volume based signal warrants. There are several sections to it:

Site Data Required by Criteria

This section is where you can make corrections to the entries in the Site Data screen if you notice they are incorrect. You can set whether the **85% Speed** is greater or less than 40 MPH (it isn't important what the speed is, just whether it is > 40 MPH or not), and you can enter or change the **Average Delay Per Vehicle**. Any changes made to these values will also be shown the next time you go back to the Site Data screen. Normally you will have already set these values in the Site Data screen so they are primarily on this screen for your reference.

Criteria Minimums

This section shows the values that must be met for the criteria to be met. The values will vary depending upon the settings in the Site Data.

Summary

This section in the upper right corner shows how many hours meet the criteria and whether the criteria is met or not. It is color coded, green for met, red for not met.

Hourly Volumes and Delays

This section, which takes up the majority of the screen, shows the volumes for the approaches (including any pedestrian volumes) for each time period. Remember that you can set the way hourly data is defined in the program. In this case, hourly data is defined on 15 minute boundaries, and we are looking for the average of the 8 highest hours. Each line is one 15 minute period. One column shows the **Total Minor Units** (units are the sum of vehicles and pedestrians). Another column shows the **Total Major Vehicles**. The first eight lines are shown with a blue background. Next to the Total Major and Total Minor columns are columns that show the average of the 8 highest hours. It are these averages that are used to evaluate the criteria. The last column, **Criteria Met?** shows if both of the two averages meet the criteria. The software looks for 8 hours that will average the highest number. It tries several combinations by sorting the various columns and calculating the averages and shows you the one with the highest value. In the screen shown in Figure 3.37 above the software found the highest value by sorting the data by the **Total Minor Units**, but the warrant is still not met.

Time	Total Major Vehicle	Average	Met?	Total Minor Units	Average	Met?	Total All Vehicles	Criteria Met?
17:00 - 18:00	604	446.2	Yes	72	149.5	No	668	No
12:00 - 13:00	539			185			718	
11:00 - 12:00	446			201			640	
08:00 - 09:00	429			246			667	
16:00 - 17:00	414			40			445	
07:00 - 08:00	402			209			607	
13:00 - 14:00	392			72			464	
09:00 - 10:00	344			171			513	
10:00 - 11:00	319			181			500	
14:00 - 15:00	314			62			376	
15:00 - 16:00	255			59			314	
23:00 - 00:00	0			0			0	
22:00 - 23:00	0			0			0	
21:00 - 22:00	0			0			0	
20:00 - 21:00	0			0			0	
19:00 - 20:00	0			0			0	
18:00 - 19:00	0			0			0	
06:00 - 07:00	0			0			0	

Figure 3.38 – Sorted Criteria C Screen

You can check the various options yourself. Click on the top of the column labeled **Total Major Vehicles**. This re-sorts the data in the grid based on the values in that column, as shown in the screen shot here. The averages are re-calculated and shown in the **Averages** columns. It doesn't change the result here, but you can see that the average values change.

You can re-sort the grid this way using several of the column headings.

Now click on the checkbox in the lower left corner of the screen labeled **Show Totals Only**. The grid expands to show more columns so that you can see how the total column values were calculated. The checkbox is initially set to On so that you can see the Criteria Met? column without scrolling. If you need more detail, click on the checkbox to expand the grid.

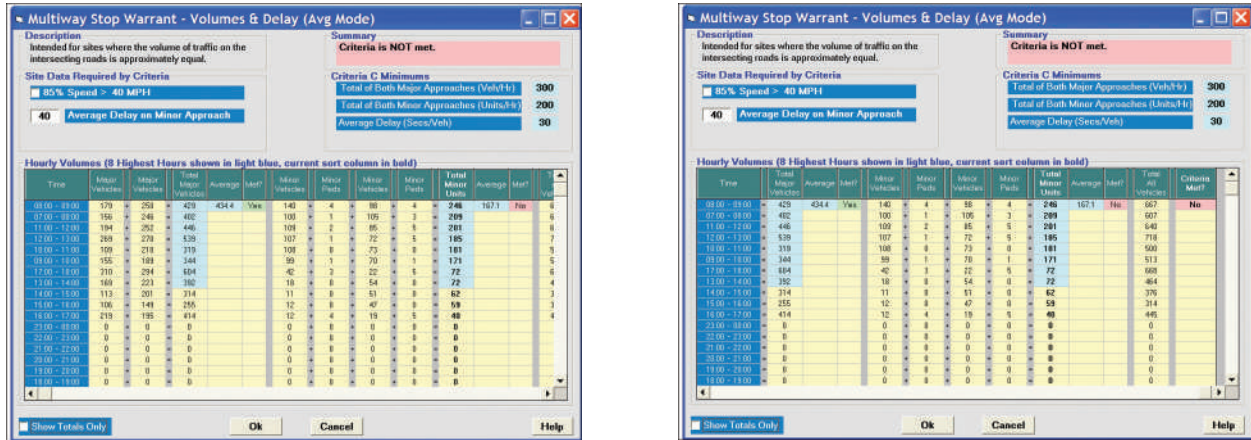


Figure 3.39 – Expanded Criteria C Screen

Shown above are two screen shots of the same grid, but the one on the left shows the left most columns and the one on the right is scrolled over to see the last column. You can see exactly how each total was calculated for each hour.

Use the scroll bars at the bottom of the grid to show the various columns. When you are done, click on the **Ok** button to go back to the **Summary Screen**.

You should be back at the Summary Screen. There is nothing left to do with this analysis except to print the report. Click on the **Print** icon in the toolbar near the top of the screen. This brings up the report selection screen, shown in figure 3.40.

Producing Reports

The screen shows the possible reports you can print. Currently, only one report is available for Multi-Way Stop Sign studies. Additional reports may be available in later versions.

You can check the titles for the reports and edit them if needed. Click on the **Report Options** button to show a screen with the current report titles. Edit them if you want.

Click the **Ok** button. The software generates the page to print and shows you the Print Preview screen.

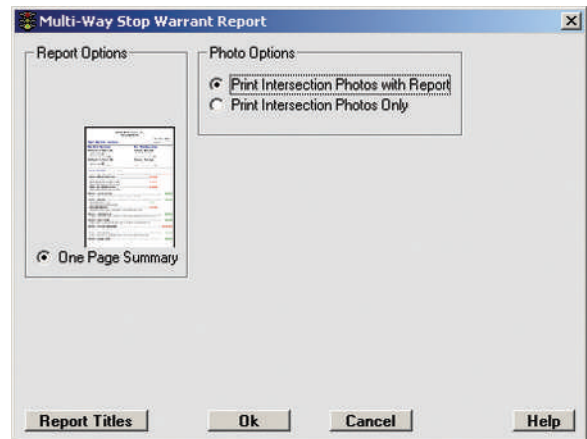


Figure 3.40 – Select Report Screen

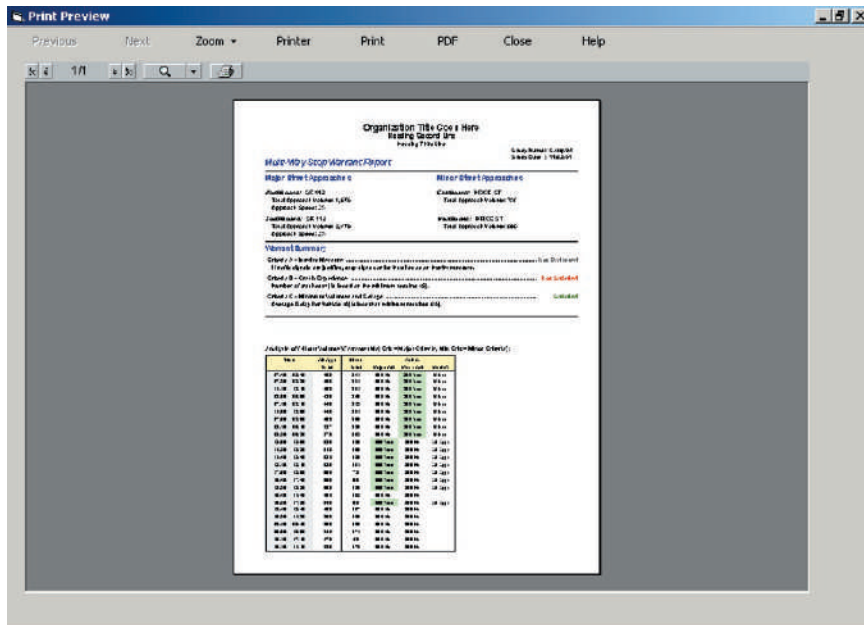


Figure 3.41 – Print Preview

You can select different views of the reports with the **Zoom** button at the top of the screen. Figure 3.41 shows the Whole Page view. You move from page to page with the **Next** and **Previous** buttons. You can choose which printer on your system to use by clicking on the **Printer** button. When you are ready to print, click on the **Print** button.

That's the end of this tutorial. In it, you learned the basic of how to use the program to do a Multi-Way Stop Sign Warrant study.



Appendix

Appendix 1: Differences between MUTCD 1988 & 2000/2003 Editions

The Manual on Uniform Traffic Control Devices, or MUTCD, defines the standards used by road managers nationwide to install and maintain traffic control devices on all streets and highways. The MUTCD is published by the Federal Highway Administration (FHWA) under 23 Code of Federal Regulations (CFR), Part 655, Subpart F.

A small section of it the MUTCD (Chapter 4C) deals with Signal Warrants. For years, the MUTCD specified 11 warrants for signal, but in 2000 a major rewrite of the MUTCD was completed. A close look at the changes to the warrants shows that there were no fundamental changes in the signal warrants; rather, the warrants from the 1988 MUTCD version were re-packaged a little bit.

There are now 8 warrants, instead of 11. Warrants 1, 2, & 8 from the 1988 version (the three 8 hour volume warrants) are combined into a single warrant (Warrant 1). Warrants 10 & 11 (the two peak hour warrants) are combined into a single warrant (Warrant 3). The other warrants are essentially identical in both versions, although a couple of the names are different.

Both versions require the same data to evaluate the warrants, and the default values for the data were not changed. Locations that met or didn't meet a warrant under the 1988 version will still meet or not meet the equivalent warrant in the new version. Although some parts of the MUTCD underwent radical changes, the signal warrant section just got a slight make-over.

The MUTCD was updated again in 2003. The 2003 MUTCD clarified a few of the details on how warrants should be evaluated, as covered in the 2000 MUTCD, but otherwise made no changes from the 2000 version. The latest versions of PC-Warrants are fully compliant with the MUTCD 2003 guidelines. In general, the software and this manual makes no distinction between the 2000 and 2003 MUTCD versions.

PC-Warrants supports both the MUTCD 1988 version and the MUTCD 2000/2003 version. You can switch back and forth between the versions without affecting the data in any way. The only difference you'll see is the organization of the warrants on the screen and on the reports.

You probably won't need to switch back and forth between versions. Rather, you probably will pick (or be told) which version you want to use. You may choose to continue to use the 1988 version because you are used to it and the warrant numbers are embedded in your brain. More likely, at some point your agency will be told that they have to use the formalism of the MUTCD 2000 or 2003 version in all of your work, and this will include the signal warrant definitions. At this point, you can simply change the setting in the software to the MUTCD 2000/2003 mode and your reports will be printed with the new warrant numbers and titles.

PC-Warrants data files are not stored with any MUTCD version information in them. This means you can take an older study saved when you were using the MUTCD 1988 version and re-print the reports in the 2000/2003 format.

Appendix 2: Differences in PC-Warrants from 1988 to 2000/2003 mode

The most obvious difference between the MUTCD 1988 and 2000/2003 modes of PC-Warrants is in the summary screen, shown below.

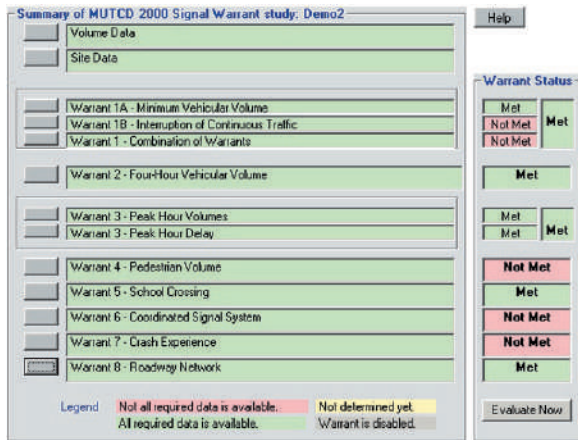


Figure A.1 – MUTCD 2000/2003 Summary Screen

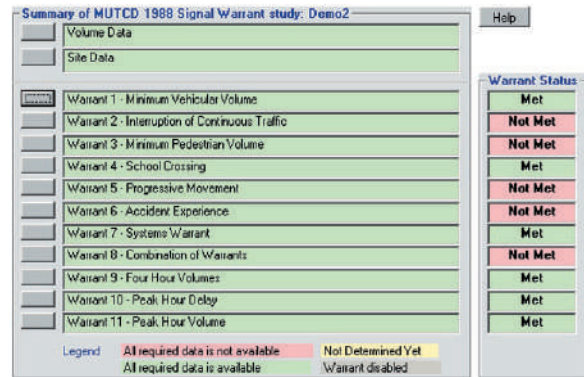


Figure A.2 – MUTCD 1988 Summary Screen

Figure A.1 shows the warrants as described in the MUTCD 2000/2003. Warrant 1 has three parts that correspond exactly to Warrants 1, 2, & 8 in the MUTCD 1988 warrants. If any one part of the three is met, the warrant is met. The software shows the three parts separately, and you can click on the buttons to the left of the description to see the details for that part of the warrant.

The Warrant Status section (on the right side of the summary screen) shows the results of the evaluation of each part separately, and then whether the entire warrant is met.

Warrant 3 is handled in a similar way. The two parts of the MUTCD 2000/2003 warrant correspond exactly to Warrants 10 & 11 in the MUTCD 1988 warrants.

The other six warrants are identical to the MUTCD 1988 warrants, although the numbering is different, and the titles of a few of the warrants have changed a bit. For example, Accident Experience is now called Crash Experience. (That must have been an interesting meeting when they discussed that change.)

Naturally, the signal warrant reports are a little different when you are in MUTCD 2000/2003 mode. The figures below show the standard two page summary report for the new MUTCD 2000/2003 mode (top) and the MUTCD 1988 mode (bottom). The first page of the MUTCD 2000/2003 mode report shows the eight warrants, and also includes the three parts of Warrant 1 and the two parts of Warrant 3 broken out separately. The second page is essentially identical in both modes, with just a few titles changing from one mode to the other.

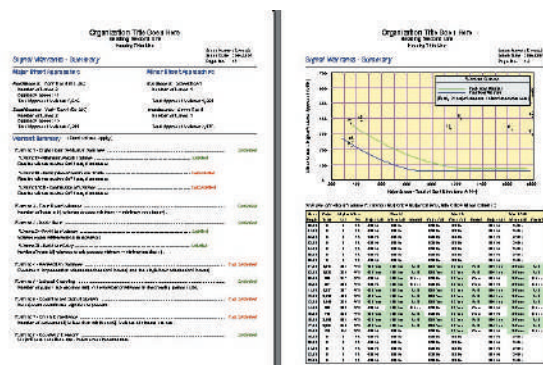


Figure A.3 – MUTCD 2000/2003 Mode Report

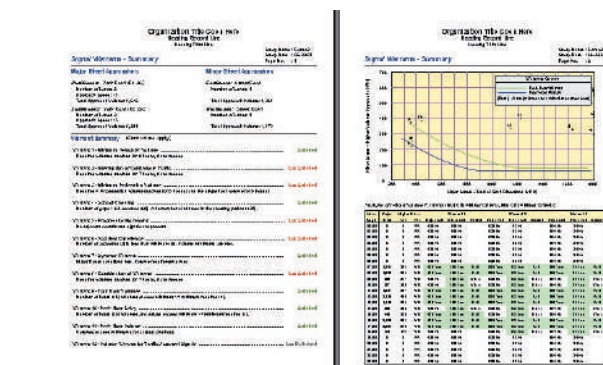


Figure A.4 – MUTCD 1988 Mode Report

The Preferences screens are also a little different in the two modes, to accommodate the small organizational differences in the two versions of the MUTCD warrants. Settings made in one mode will automatically be carried over to the other mode, if you need to go back and forth.



Figure A.5 – MUTCD 2000/2003 Options

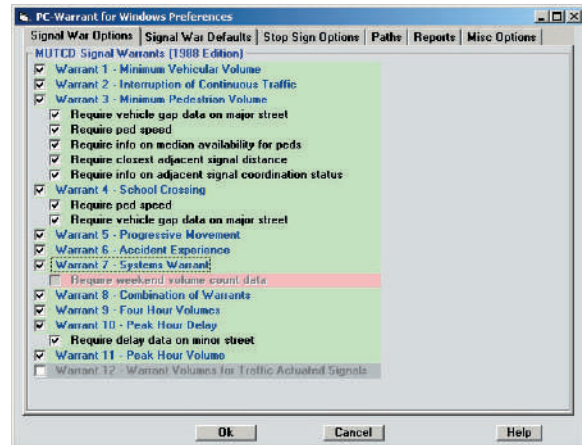


Figure A.6 – MUTCD 1988 Options

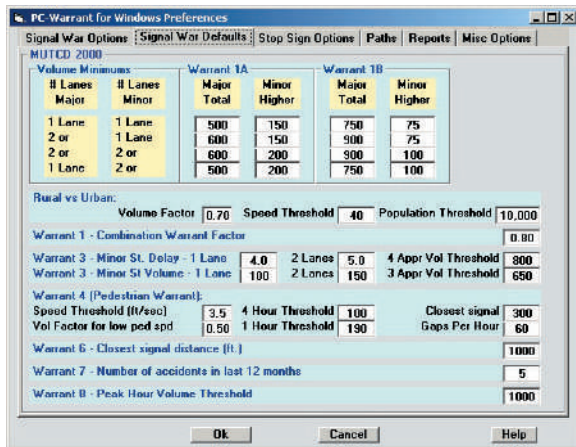


Figure A.7 – MUTCD 2000/2003 Defaults

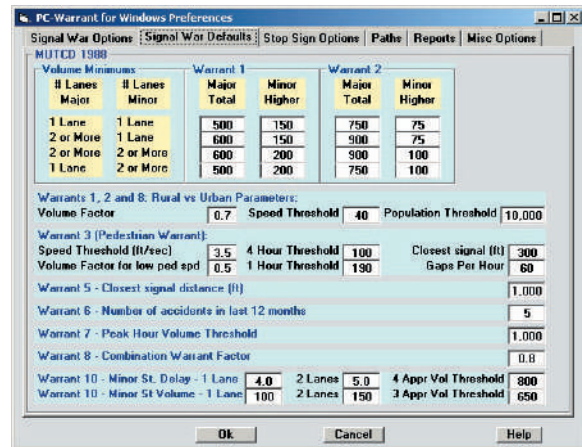


Figure A.8 – MUTCD 1988 Defaults

How to Change MUTCD Modes

1. Go to the **Preferences** screen. To do this select the Preferences icon from the toolbar on the main screen or select Define/Edit Program Preferences from the Startup Options screen.
2. Select the **Program Options** tab at the top of the screen. This will display a screen similar to the one shown here in Figure A.9. The current MUTCD version will be shown with a filled in circle.
3. Select the MUTCD version to use.

(Optional)

4. Select the **Signal Warrant Options** tab at the top of the screen and check the settings.
5. Select the **Signal Warrant Defaults** tab at the top of the screen and check the settings.
6. Select **Ok**.

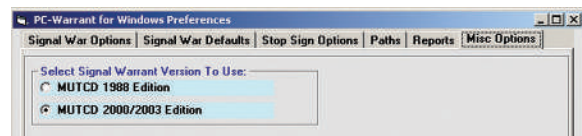


Figure A.9 – MUTCD Mode Setting

Once you select an MUTCD mode the various screens you see will reflect the new setting. If you had a study in memory when you made the change, the new screens will show the values of the data in memory. And when you print your reports, the reports will be in the format appropriate for the new setting.

Appendix 3: 2003 MUTCD Traffic Signal Warrants

The following is excerpted from chapter 4C of the 2003 edition of the Manual on Uniform Traffic Control Devices.

CHAPTER 4C. TRAFFIC CONTROL SIGNAL NEEDS STUDIES

Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Standard:

An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location. The investigation of the need for a traffic control signal shall include an analysis of the applicable factors contained in the following traffic signal warrants and other factors related to existing operation and safety at the study location:

Warrant 1, Eight-Hour Vehicular Volume.

Warrant 2, Four-Hour Vehicular Volume.

Warrant 3, Peak Hour.

Warrant 4, Pedestrian Volume.

Warrant 5, School Crossing.

Warrant 6, Coordinated Signal System.

Warrant 7, Crash Experience.

Warrant 8, Roadway Network.

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Support:

Sections 8D.07 and 10D.05 contain information regarding the use of traffic control signals instead of gates and/or flashing light signals at highway-railroad grade crossings and highway-light rail transit grade crossings, respectively.

Guidance:

A traffic control signal should not be installed unless one or more of the factors described in this section are met.

A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.

A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.

The study should consider the effects of the right-turn vehicles from the minor-street approaches.

Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the above signal warrants. Engineering judgment should also be used in applying various traffic signal warrants to cases where approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic characteristics dictate whether an approach should be considered as one lane or two lanes. For example, for an approach with one lane for through and right-turning traffic plus a left-turn lane, engineering judgment could indicate that it should be considered a one-lane approach if the traffic using the left-turn lane is minor. In such a case, the total traffic volume approaching the intersection should be applied against the signal warrants as a one-lane approach. The approach should be considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane is of sufficient length to accommodate all left-turn vehicles.

Similar engineering judgment and rationale should be applied to a street approach with one lane plus a right turn lane. In this case, the degree of conflict of minor-street right-turn traffic with traffic on the major street should be considered. Thus, right-turn traffic should not be included in the minor-street volume if the movement enters the major street with minimal conflict. The approach should be evaluated as a one-lane approach with only the traffic volume in the through/left-turn lane considered.

At a location that is under development or construction and where it is not possible to obtain a traffic count that would represent future traffic conditions, hourly volumes should be estimated as part of an engineering study for comparison with traffic signal warrants. Except for locations where the engineering study uses the satisfaction of Warrant 8 to justify a signal, a traffic control signal installed under projected conditions should have an engineering study done within 1 year of putting the signal into stop-and-go operation to determine if the signal is justified. If not justified, the signal should be taken out of stop-and-go operation or removed.

For signal warrant analysis, a location with a wide median, even if the median width is greater than 9 m (30 ft), should be considered as one intersection.

Option:

At an intersection with a high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the “minorstreet” volume and the corresponding single direction of opposing traffic on the major street as the “major-street” volume.

For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians.

Support:

When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually counted as pedestrians.

Option:

Engineering study data may include the following:

- A. The number of vehicles entering the intersection in each hour from each approach during 12 hours of an average day. It is desirable that the hours selected contain the greatest percentage of the 24-hour traffic volume.
- B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations, bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the afternoon during which total traffic entering the intersection is greatest.
- C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in Item B above and during hours of highest pedestrian volume. Where young, elderly, and/or persons with physical or visual disabilities need special consideration, the pedestrians and their crossing times may be classified by general observation.
- D. Information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities, including requests from persons with disabilities for accessible crossing improvements at the location under study. These persons might not be adequately reflected in the pedestrian volume count if the absence of a signal restrains their mobility.
- E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to the location.

F. A condition diagram showing details of the physical layout, including such features as intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and routes, parking conditions, pavement markings, roadway lighting, driveways, nearby railroad crossings, distance to nearest traffic control signals, utility poles and fixtures, and adjacent land use.

G. A collision diagram showing crash experience by type, location, direction of movement, severity, weather, time of day, date, and day of week for at least 1 year.

The following data, which are desirable for a more precise understanding of the operation of the intersection, may be obtained during the periods specified in Item B of the preceding paragraph:

- A. Vehicle-hours of stopped time delay determined separately for each approach.
- B. The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.
- C. The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.
- D. Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.
- E. Queue length on stop-controlled approaches.

Section 4C.02 Warrant 1, Eight-Hour Vehicular Volume

Support:

The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

It is intended that Warrant 1 be treated as a single warrant. If Condition A is satisfied, then the criteria for Warrant 1 is satisfied and Condition B and the combination of Conditions A and B are not needed. Similarly, if Condition B is satisfied, then the criteria for Warrant 1 is satisfied and the combination of Conditions A and B is not needed.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:

- A. The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or
- B. The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

In applying each condition the major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of these 8 hours.

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume									
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% ^a	80% ^b	70% ^c	56% ^d	100% ^a	80% ^b	70% ^c	56% ^d
1.....	1.....	500	400	350	280	150	120	105	84
2 or more ...	1.....	600	480	420	336	150	120	105	84
2 or more ...	2 or more ...	600	480	420	336	200	160	140	112
1.....	2 or more	500	400	350	280	200	160	140	112

Condition B—Interruption of Continuous Traffic									
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% ^a	80% ^b	70% ^c	56% ^d	100% ^a	80% ^b	70% ^c	56% ^d
1.....	1.....	750	600	525	420	75	60	53	42
2 or more ...	1.....	900	720	630	504	75	60	53	42
2 or more ...	2 or more ...	900	720	630	504	100	80	70	56
1.....	2 or more	750	600	525	420	100	80	70	56

^a Basic minimum hourly volume.
^b Used for combination of Conditions A and B after adequate trial of other remedial measures.
^c May be used when the major-street speed exceeds 70 km/h or exceeds 40 mph or in an isolated community with a population of less than 10,000.
^d May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 70 km/h or exceeds 40 mph or in an isolated community with a population of less than 10,000.

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 70 percent columns in Table 4C-1 may be used in place of the 100 percent columns.

Guidance:

The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that both of the following conditions exist for each of any 8 hours of an average day:

- A. The vehicles per hour given in both of the 80 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; and
- B. The vehicles per hour given in both of the 80 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied in Condition B. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.03 Warrant 2, Four-Hour Vehicular Volume

Support:

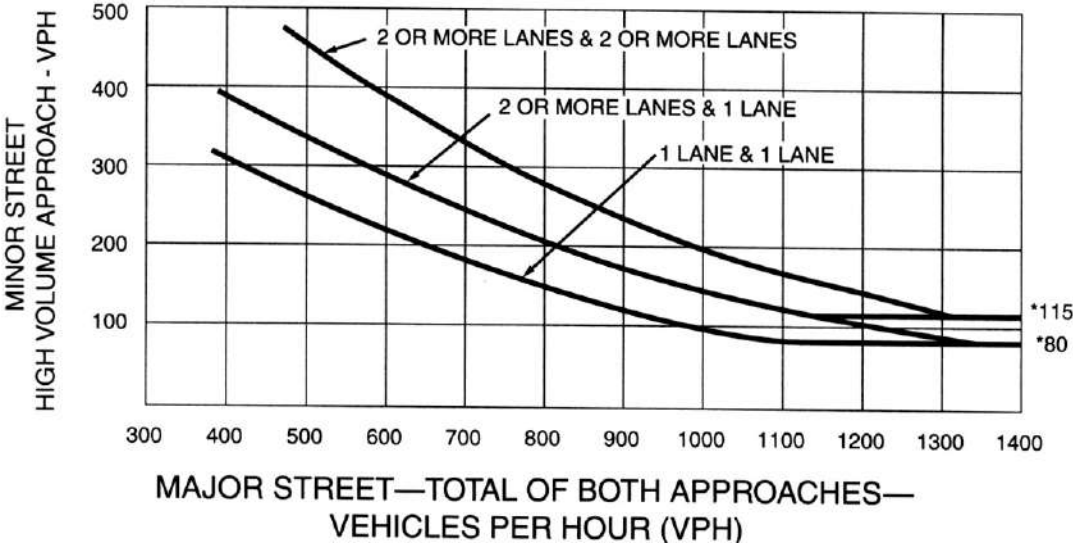
The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.

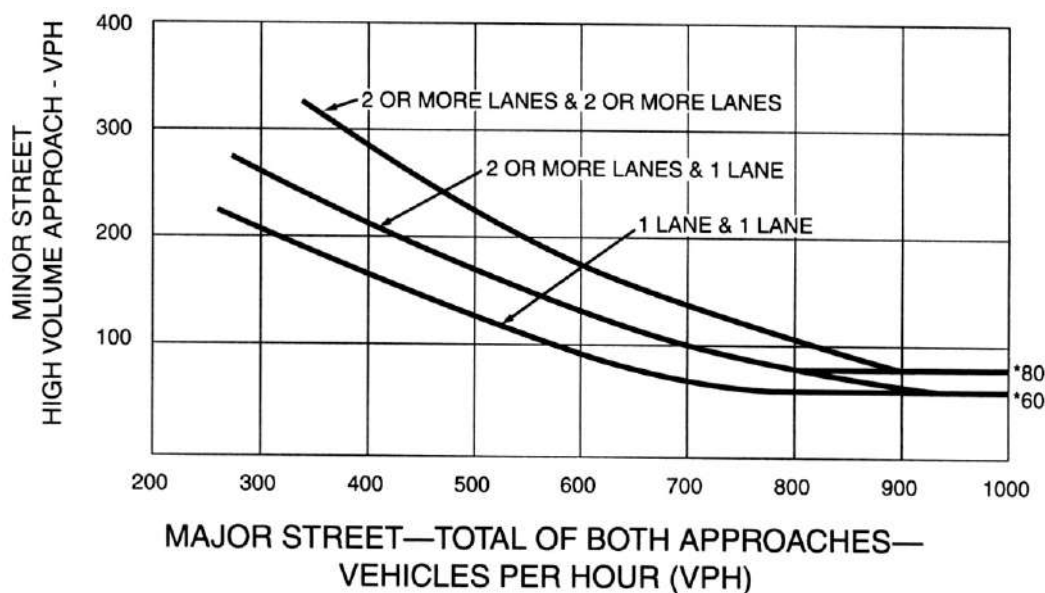
Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h (40 mph) or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-2 may be used in place of Figure 4C-1.



*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-1, Warrant 2, Four-Hour Vehicular Volume



*Note: 80 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)
(Community Less Than 10,000 Population or Above 70 km/h (40 mph) on Major Street)

Section 4C.04 Warrant 3, Peak Hour

Support:

The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

Standard:

This signal warrant shall be applied only in unusual cases. Such cases include, but are not limited to, office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:

A. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach; or 5 vehicle-hours for a two-lane approach, and
2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes, and
3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

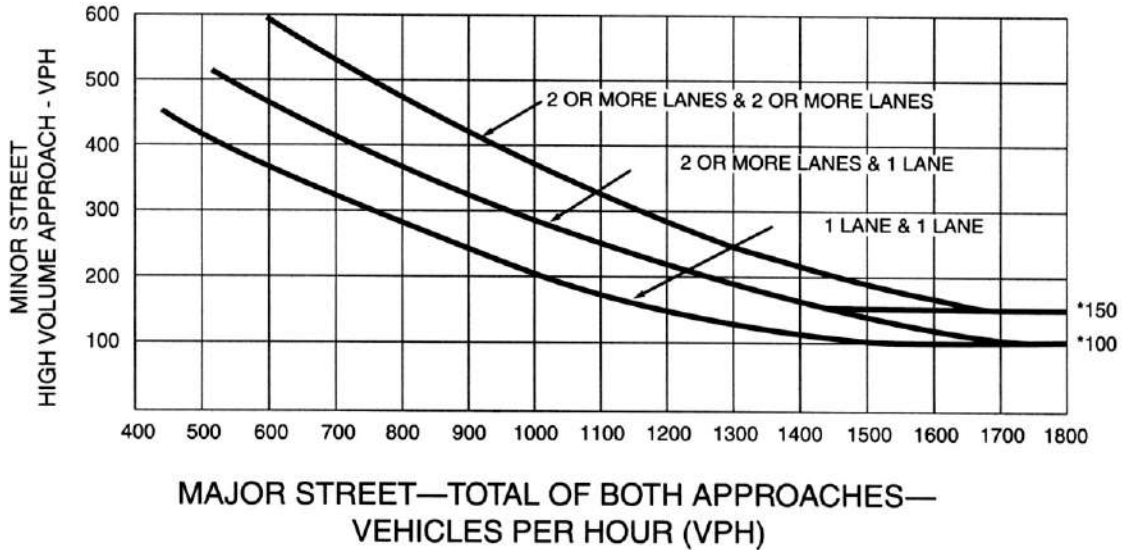
B. The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3 for

the existing combination of approach lanes.

Option:

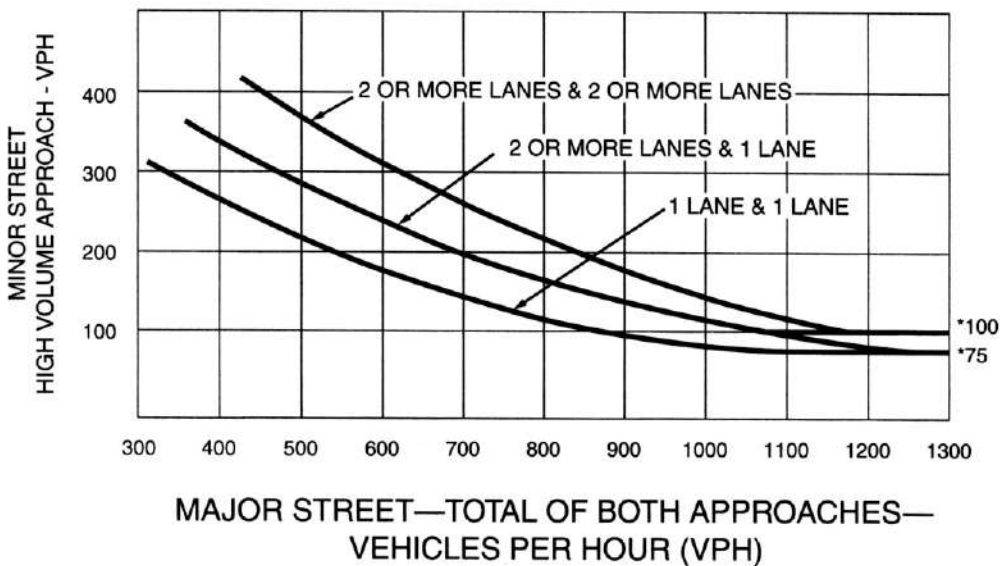
If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h (40 mph), or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-4 may be used in place of Figure 4C-3 to satisfy the criteria in the second category of the Standard.

Section 4C.05 Warrant 4, Pedestrian Volume



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-3. Warrant 3, Peak Hour



*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(Community Less Than 10,000 Population or Above 70 km/h (40 mph) on Major Street)

Support:

The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Standard:

The need for a traffic control signal at an intersection or mid-block crossing shall be considered if an engineering study finds that both of the following criteria are met:

- A. The pedestrian volume crossing the major street at an intersection or mid-block location during an average day is 100 or more for each of any 4 hours or 190 or more during any 1 hour; and
- B. There are fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied. Where there is a divided street having a median of sufficient width for pedestrians to wait, the requirement applies separately to each direction of vehicular traffic.

The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 90 m (300 ft), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

If a traffic control signal is justified by both this signal warrant and a traffic engineering study, the traffic control signal shall be equipped with pedestrian signal heads conforming to requirements set forth in Chapter 4E.

Guidance:

If this warrant is met and a traffic control signal is justified by an engineering study, then:

- A. If at an intersection, the traffic control signal should be traffic-actuated and should include pedestrian detectors.
- B. If at a nonintersection crossing, the traffic control signal should be pedestrian-actuated, parking and other sight obstructions should be prohibited for at least 30 m (100 ft) in advance of and at least 6.1 m (20 ft) beyond the crosswalk, and the installation should include suitable standard signs and pavement markings.
- C. Furthermore, if installed within a signal system, the traffic control signal should be coordinated.

Option:

The criterion for the pedestrian volume crossing the major roadway may be reduced as much as 50 percent if the average crossing speed of pedestrians is less than 1.2 m/sec (4 ft/sec).

A traffic control signal may not be needed at the study location if adjacent coordinated traffic control signals consistently provide gaps of adequate length for pedestrians to cross the street, even if the rate of gap occurrence is less than one per minute.

Section 4C.06 Warrant 5, School Crossing

Support:

The School Crossing signal warrant is intended for application where the fact that school children cross the major street is the principal reason to consider installing a traffic control signal.

Standard:

The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of school children at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the children are using the crossing is less than the number of minutes in the same period (see Section 7A.03) and there are a minimum of 20 students during the highest crossing hour.

Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.

The School Crossing signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 90 m (300 ft), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

Guidance:

If this warrant is met and a traffic control signal is justified by an engineering study, then:

- A. If at an intersection, the traffic control signal should be traffic-actuated and should include pedestrian detectors.
- B. If at a nonintersection crossing, the traffic control signal should be pedestrian-actuated, parking and other sight obstructions should be prohibited for at least 30 m (100 ft) in advance of and at least 6.1 m (20 ft) beyond the crosswalk, and the installation should include suitable standard signs and pavement markings.
- C. Furthermore, if installed within a signal system, the traffic control signal should be coordinated.

Section 4C.07 Warrant 6, Coordinated Signal System**Support:**

Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that one of the following criteria is met:

- A. On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.
- B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.

Guidance:

The Coordinated Signal System signal warrant should not be applied where the resultant spacing of traffic control signals would be less than 300 m (1,000 ft).

Section 4C.08 Warrant 7, Crash Experience**Support:**

The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:

- A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and
- B. Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and
- C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1 (see Section 4C.02), or the vph in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.09 Warrant 8, Roadway Network**Support:**

Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:

- A. The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an average weekday; or
- B. The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a nonnormal business day (Saturday or Sunday).

A major route as used in this signal warrant shall have one or more of the following characteristics:

- A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow; or
- B. It includes rural or suburban highways outside, entering, or traversing a city; or
- C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

Appendix 4: 2003 MUTCD Multi-Way Stop Sign Criteria

The following is excerpted from chapter 2B of the 2003 edition of the Manual on Uniform Traffic Control Devices.

Section 2B.07 Multiway Stop Applications

Support:

Multiway stop control can be useful as a safety measure at intersections if certain traffic conditions exist. Safety concerns associated with multiway stops include pedestrians, bicyclists, and all road users expecting other road users to stop. Multiway stop control is used where the volume of traffic on the intersecting roads is approximately equal.

The restrictions on the use of STOP signs described in Section 2B.05 also apply to multiway stop applications.

Guidance:

The decision to install multiway stop control should be based on an engineering study.

The following criteria should be considered in the engineering study for a multiway STOP sign installation:

- A. Where traffic control signals are justified, the multiway stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of the traffic control signal.
- B. A crash problem, as indicated by 5 or more reported crashes in a 12-month period that are susceptible to correction by a multiway stop installation. Such crashes include right- and left-turn collisions as well as right-angle collisions.
- C. Minimum volumes:
 1. The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day, and
 2. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour, but
 3. If the 85th-percentile approach speed of the major-street traffic exceeds 65 km/h (40 mph), the minimum vehicular volume warrants are 70 percent of the above values.
- D. Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition.

Option:

Other criteria that may be considered in an engineering study include:

- A. The need to control left-turn conflicts;
- B. The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes;
- C. Locations where a road user, after stopping, cannot see conflicting traffic and is not able to safely negotiate the intersection unless conflicting cross traffic is also required to stop; and
- D. An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multiway stop control would improve traffic operational characteristics of the intersection.

Appendix 5: Gap & Delay Worksheets

Gap Worksheet

Gaps are a measure of when there is no traffic at a specific location. They are measured in seconds and are often used to determine if there is ample time for pedestrians to cross a street. This data is used in the warrants for Minimum Pedestrian Volumes and School Crossings and should be measured on the major approach.

The Gap Worksheet is accessed by clicking on the Gap button in the Worksheets field of the Site Data screen.

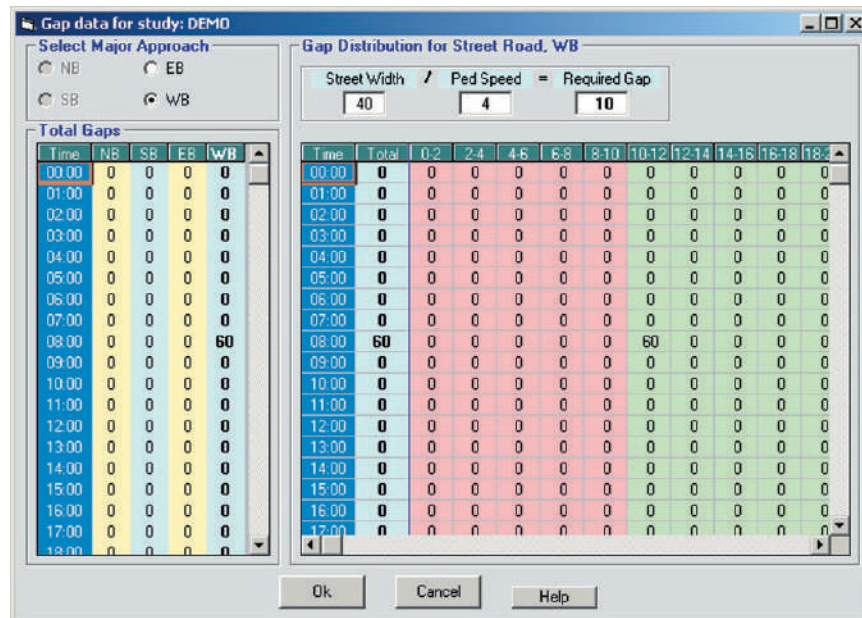


Figure A.10 – Gap Worksheet

The **Select Major Approach** field is used to pick which of the major approaches the gap data will be entered for. Only approaches that have been designated as major approaches in the Site Data screen are selectable. Choosing the approach highlights the appropriate column in the **Total Gaps** frame. The gap information that is used in the program is what appears in this column.

The **Gap Distribution for...** field is used to generate the numbers that appear in the Total Gaps column. The top of the field is used to calculate how long a gap must be for it to be considered usable. For a gap to be usable, it must meet or exceed the minimum amount of time it takes to walk across the street. To arrive at this number, enter the street width (in feet) and the speed of the pedestrian (in feet per second). In the example shown in Figure A.10, the street is 40 feet wide and the pedestrian speed is 4 feet per second, which means a gap of at least 10 seconds is required for the pedestrian to cross safely.

Enter the lowest pedestrian speed you expect to routinely find at this intersection. *If this crossing is used by children or the elderly be sure to enter a relatively low pedestrian speed.* Note that values must be entered in whole numbers.

Once the Required Gap has been calculated the software adjusts the background colors on the **Gap Data Grid**. All gap columns that fall below the Required Gap are shaded red. These are excluded from consideration (since they do not allow enough time for a pedestrian to cross safely) and are not added to the Total Gaps column. All gap columns that exceed the required gap are shaded green. These are considered usable gaps (since they allow enough time for a pedestrian to cross safely) and are added to the Total Gaps column.

When adding usable gaps to the Total Gaps column the software also takes into account the length of the gap and factors it accordingly. If a gap exceeds the Required Gap by double, it is added twice to the Total Gaps. For example, if the Required Gap is 10 and a gap of 20 seconds is recorded, it is added as if it were two 10-second gaps. For a gap to be factored it must meet or exceed the required gap by at least double. In our example a gap of 18 seconds would still only be counted as 1.

Currently, gap data must be manually entered. You can either enter it directly in the Total Gaps column or enter it in the Gap Data Grid. Data entered in the Gap Data Grid is evaluated and transferred to the Total Gaps column accordingly.

Delay Worksheet

Delay is a measure of the amount of time vehicles must wait while stopped at the intersection before crossing or entering the traffic flow of the major approaches. This data is used in the warrant analysis for Peak Hour Delay and should be measured on a minor approach. Only data for 1 hour (the peak hour) is needed in order to evaluate the warrant. The data should be recorded and entered as vehicle-hours of delay.

The Delay Worksheet is accessed by clicking on the Gap button in the Worksheets field of the Site Data screen.

Time	NB	SB	EB	WB
08:00	York Road (Rt. 263) Minor 0.0	York Road (Rt. 263) Minor 6.8	Street Road Major 0.0	Street Road Major 0.0

Figure A.11 – Delay Worksheet

The **Select Minor Approach To Use** field is used to pick which of the minor approaches the delay data will be entered for. Only approaches that have been designated as minor approaches in the Site Data screen are selectable. Choosing the approach highlights the appropriate column in the **Delays by Interval** field. The delay information that is used in the program is what appears in this column.

Currently, delay data must be manually entered. Data is entered in 15-minute intervals so that the true peak hour can be used. The **Show Only Non-Zero Delays** check box at the bottom of the screen hides all intervals that don't have data. Uncheck this to enter your data, then re-check it once the data has been entered. The software takes the entered data and then applies it to the Peak Hour Warrant when needed.

Appendix 6: Volume Data Options in Multiway Stop Warrants

PC-Warrants includes support for Multi-Way Stop Sign warrants, based on the procedures in the MUTCD (*Manual of Uniform Traffic Control Devices*). The software supports the MUTCD 2003 version and also the older 200 and 1988 versions.

You would think that since the procedures are specified in a federally produced publication that the rules would be very explicit, with no room for interpretation about how the procedures are implemented. But unfortunately, this isn't the case.

The Multi-Way Stop Sign warrants include traffic volumes as a major factor in evaluating a warrant. The sentence that causes problems says, in part "...averages at least 300 vehicles per hour **for any 8 hours** of an average day."

The question is, what does "any" mean? It seems it depends whom you ask. If you collect your volume data in hourly intervals, then there isn't any problem. An hour of data is an hour of data, such as 7:00AM to 8:00AM. However, if you collect your data in 15 minute intervals, which is very common, then there is room for interpretation.

During the development of PC-Warrants, four different ways of finding an hour of data from 15 minute volume counts have evolved. Each way has users who think that it is the appropriate way to evaluate the data. Since we are not in the business of making traffic policy, we have provided the option for you to choose the method you want to use.

This appendix will explain the various options for evaluating volume data and show you how to choose the option that makes the most sense to you. You probably will only need to set the option once and not think about it again.

Read through the descriptions of the different options in the next several pages and decide for yourself which option makes the most sense. Then set the option in the software and let the software do the rest.

At some point the relevant parts of the MUTCD may be amended to clear up the ambiguities that currently exist. When that happens, we will, of course, make any modifications needed to make sure that PC-Warrants follows the MUTCD guidelines. But since that may not happen any time soon, you probably will need to use your best judgment and pick one of the options provided in the software. Good Luck!

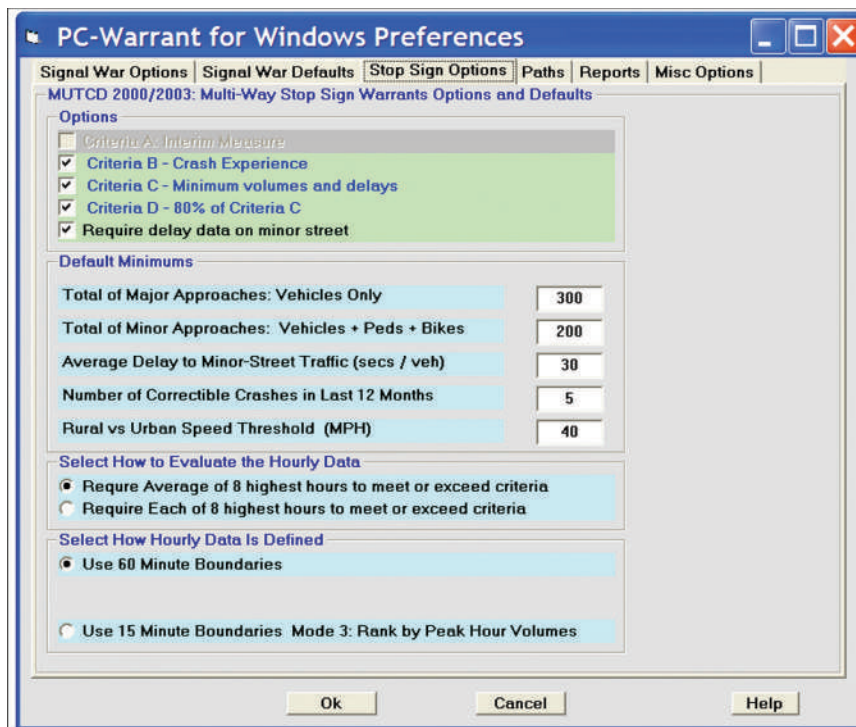


Figure A.12 – Multi Way Stop Sign Options

The figure above shows the **Multi Way Stop Sign Option** screen in the **Preferences** section of the software. At the bottom is a box labeled **Select How Hourly Data Is Defined**. In the box are several options. There may be two options shown if you have selected the **Require Average of 8 Highest Hours to Meet or Exceed Criteria** option (this is explained in more detail in Appendix 7). Or there may be four options if you have selected the other option in that section. You simply select the option you want to use (after reading this tutorial) and the software will use that option when it evaluates the volume data parts of the warrants.

These options only apply when you have 15 minute interval volume data. If you always use 60 minute interval volume data then this whole discussion is moot. Simply select the **Use 60 Minute Boundaries** option and don't worry about it again.

The software stores the value you check, along with all of the other options in the **Preferences** screens, so that the next time you run PC-Warrants these options will automatically be selected.

You can change the option at any time even after you have evaluated the warrants with a different option. The software will re-evaluate the warrants with the new option when you go back to the **Main** screen. If you want, you can evaluate the same data four different ways and potentially get four slightly different results.

The next several pages explain each of the options shown above. Each page shows the results of evaluating the same data with that particular option. The data used is from a sample study called Sample2.mss.

Use 60 Minute Boundaries

The simplest option is to take your 15 minute volume counts and re-organize them into hourly intervals, then apply the evaluation criteria to each of the 24 possible hours. That is what this first option does. The screen below shows the **Criteria C- Minimum Volumes** screen when this option is selected.

Notice that all of the times shown on the left side of the screen are hours that start at 00 minutes; the 15 minute volumes have been re-organized into hourly intervals and shown on the screen. In this case there are ten that meet the Total Major Vehicles criteria, but only three that meet the Total Minor Units criteria. The result is only three hours meet both criteria. Since 8 hours are required, the warrant is not met.

Discussion:

This is certainly the simplest of the options to understand. It also might make sense to use if you normally collect volume counts in hourly intervals, but occasionally want to use 15 minute interval data. You may want the logic used to evaluate the warrants to be consistent for all cases regardless what interval was used to collect the volume data.

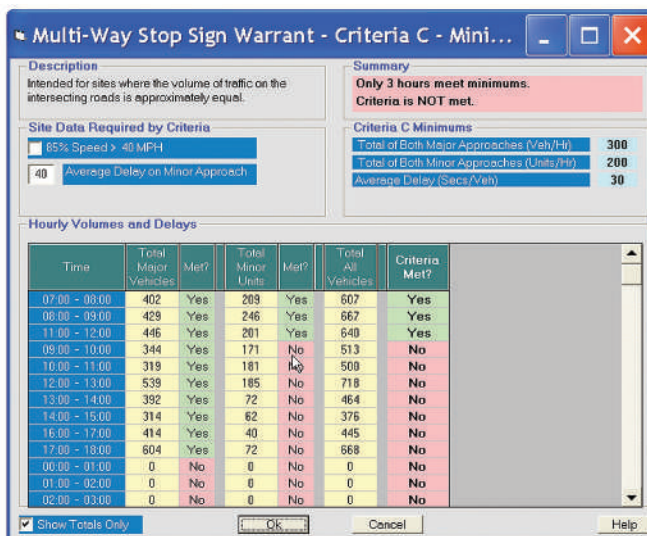


Figure A.13 – Criteria C: 60 Minute Boundaries

This option does away with the idea that “any” hour can be an hour like 7:15-8:15. As such it somewhat limiting in the number of possible hours that can meet the minimum criteria.

This option has been in PC-Warrants from the beginning. It is the safe option if you can’t decide between one of the other options.

Use 15 Minute Boundaries - Mode 1: Overlapping Intervals Ok

This is the most controversial option, and probably the one with the least support. However, it has its proponents so we have included it in the software.

In this option, an hour can be on any 15 minute boundary, so 7:00-8:00 is one possible hour, and 7:15-8:15 is another possible hour, etc. The software takes the volume data and forms all of the possible hours from that data. If you have 24 hours of 15 minute data, it turns out there are 93 possible hours. The software then evaluates each possible hour against the warrant criteria and lists the hours that meet the criteria at the top of the screen.

You can see the result of this analysis on the screen shown in Figure A.14.

Notice that there are many hours that meet the Total Major Vehicles minimums (39) and 10 that meet the Total Minor Units minimums. Since 10 hours meet both criteria, the warrant is met. This is the same data we saw in the last option where only three hours met both criteria and the warrant wasn’t met. What’s going on?

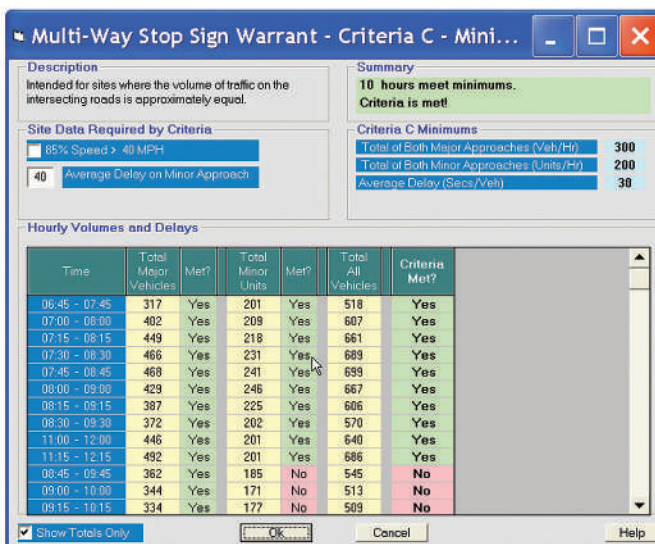


Figure A.14 – Criteria C: 15 Minute Boundaries, Overlapping Intervals

The first hour shown is from 6:45-7:45, which meets both criteria. The second hour shown is from 7:00-8:00, which also meets the minimums, and which uses 3 of the same intervals as the first hour shown. In fact the first 8 hours that meet the warrant minimums only occupied 2.75 hours of data time. But each hour tested is a unique separate hour of data.

Discussion:

Proponents of this option say that the MUTCD doesn't specifically forbid this interpretation, in fact, the wording of "any 8 hours" would imply this is ok. Other users think this *double-dipping* or overlapping as we call it, isn't correct.

This is certainly the most liberal option, since there are 93 possible hours that can be tested to meet the warrant criteria. If you really want a warrant met, this is your best option.

This option has been in the software from the beginning. It was comments from users who didn't like this procedure that led to the development of the next two options.

Use 15 Minute Boundaries - Mode 2: No Overlapping Intervals

Many users of PC-Warrants agree that hours to evaluate can be on any 15 minute boundary, but they don't think the same 15 minute interval should be used more than once to meet the minimum volume criteria. This thinking leads to this option.

This option uses the following logic:

- 1- Find all 93 possible hours, like Mode 1.
- 2- Start at midnight and scan through the possible hours. If an hour is found that meets both the Total Major and Total Minor minimums, **then skip over the used intervals in that hour** and start scanning again at the next un-used interval.
- 3- Continue scanning until the entire day is scanned.
- 4- Show the hours that meet both criteria at the top of the screen., sorted by time.
- 5- Next show the hours that meet only the Total Major criteria, sorted by time.
- 6- Finally, show the rest of the hours, sorted by time.

The result of this logic is shown in Figure A.15.

Notice that the first hour shown is 6:45-7:45. That means that all of the possible hours before 6:45 AM didn't meet both criteria. The hour is displayed at the top of the list. The software skips over the intervals used and starts checking again at 7:45-8:45. This hour meets both criteria so the software skips the used intervals and checks 8:45-9:45 next, which doesn't meet both the criteria. The same is true at 9:00-10:00, 9:15-10:15, 9:45-10:45, etc.. The next (and last) hour that meets both criteria is at 11:00-12:00. The software continues scanning, but no other hour meets both criteria. There are only three hours that meet both criteria, so the warrant is not met.

Discussion:

The software checks every possible 15 minute bounded hour. It only skips over intervals if an hour is found to meet both criteria. The result is that **no two hours that meet the criteria use the same intervals**. This logic is probably closer to what the MUTCD intends. Some users however don't like the fact that the software starts at midnight and works down. This won't necessarily find the worst case hours (*traditional peak hours*) because the intervals making up the peak hour may be included in an earlier hour, and therefore skipped over.

Time	Total Major Vehicles	Met?	Total Minor Units	Met?	Total All Vehicles	Criteria Met?
06:45 - 07:45	317	Yes	201	Yes	518	Yes
07:45 - 08:45	468	Yes	241	Yes	699	Yes
11:00 - 12:00	446	Yes	201	Yes	640	Yes
08:45 - 09:45	362	Yes	185	No	545	No
09:00 - 10:00	344	Yes	171	No	513	No
09:15 - 10:15	334	Yes	177	No	509	No
09:30 - 10:30	325	Yes	178	No	501	No
09:45 - 10:45	319	Yes	186	No	503	No
10:00 - 11:00	319	Yes	181	No	500	No
10:15 - 11:15	335	Yes	178	No	512	No
10:30 - 11:30	363	Yes	185	No	546	No
10:45 - 11:45	401	Yes	192	No	590	No
12:00 - 13:00	539	Yes	185	No	718	No

Figure A.15 –
Criteria C: 15 Minute Boundaries, No Overlapping

Use 15 Minute Boundaries -Mode 3: Rank by Peak Hour Volumes

This option is the latest to be added to the software. It is based on the comments of a few users who explained how they manually evaluate multi-way stop sign warrants.

In this option, the logic is as follows:

- 1- Find the peak hour from all of the volume data.
- 2- Evaluate the criteria for that hour, and show the hour at the top of the list.
- 3- Discard those intervals from the volume data.
- 4- Repeat steps 1-3 and find the peak hour from the remaining volume data. Continue until no more peak hours can be formed.

Peak hours are based on the total of all vehicles for all approaches and do not include pedestrians. The peak hour is the time period for the four consecutive 15 minute intervals that have the highest total volume.

The results of this logic are shown in Figure A.16.

The first hour shown is the peak hour for the day. This is at 12:00-1:00 PM (*a total of 718 vehicles*). The Total Major criteria is met, but the Total Minor is not. The software throws away these intervals and then finds the next highest peak hour. This is at 7:45-8:45, which meets both criteria. Discarding these intervals, the next peak hour is at 5:00-6:00 PM, where again the Total Minor minimum is not met. Continuing like this, the software finds three intervals that meet both criteria.

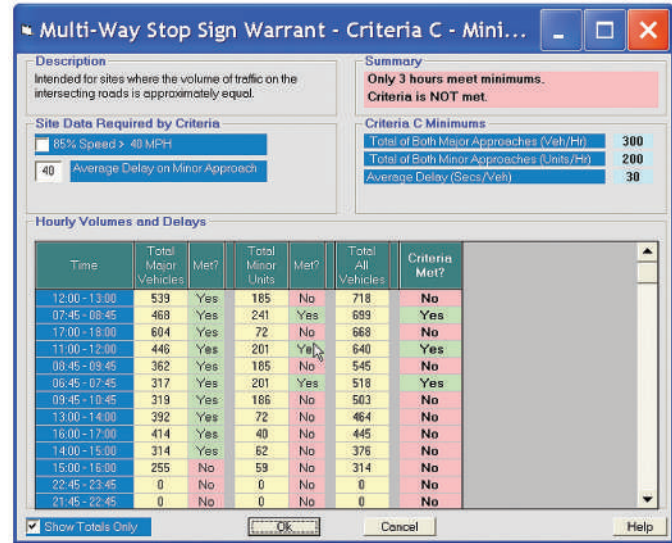


Figure A.16 – Criteria C: 15 Minute Boundaries, Peak Hour Rank

Discussion:

Note that these intervals are the same as the intervals found in Mode 2, but that doesn't always happen. The way the data is scanned determines which intervals get eliminated from inclusion in other hours, so it is possible for Mode 2 and Mode 3 to find different hours that meet the criteria. However it is unlikely that there will be a great difference in the number of hours that are found to meet the minimums, like you see with Mode 1.

You may find this option seems intuitively to make the most sense, since it looks for peak hours in a way that is similar to how you might do it manually.

There is a possible problem with the logic used in this option. It is possible, probable even, that some intervals of data are never evaluated because they become *orphaned* while finding the peak hours. To see how this works, look at the figure shown in Figure A.17.

This table is part of the PC-Warrants software. Normally it is not visible. It shows the volume data starting at midnight at the top and progressing down the table in 15 minute intervals. You can see the times in the far left column. The far right column is labeled Rank. The software scans through the volume data and finds the peak hour. In this case it is from 12:00-13:00. These intervals are given a rank of 1, which you can see in the Rank column for these intervals.

Time	Min V#B	Max V#B	Total V#B	Min Ped V#B	Min Ped V#B	Min Ped V#B	Min Ped V#B	Total Min List	Total All Veh.	Rank
28 06:45	19	36	54	24	0	24	0	48	102	6
29 07:00	31	50	81	24	0	28	0	52	133	6
30 07:15	34	51	85	24	0	28	0	52	137	6
31 07:30	32	65	97	23	0	26	0	49	146	6
32 07:45	59	88	139	29	1	23	3	56	191	2
33 08:00	45	83	128	36	1	23	1	61	167	2
34 08:15	46	66	102	36	1	26	1	65	165	2
35 08:30	46	53	99	33	1	24	1	59	156	2
36 08:45	42	58	100	36	1	23	1	61	159	5
37 09:00	39	47	86	23	0	17	0	46	126	5
38 09:15	40	47	87	23	0	19	0	42	129	5
39 09:30	43	46	89	27	0	15	0	42	131	5
40 09:45	33	48	82	26	1	19	1	47	127	7
41 10:00	29	47	76	24	0	22	0	46	122	7
42 10:15	39	48	87	25	0	19	0	43	121	7
43 10:30	26	57	83	30	0	20	0	50	133	7
44 10:45	24	58	82	29	0	13	0	42	124	4
45 11:00	34	58	92	24	0	18	1	43	134	4
46 11:15	45	61	106	27	0	22	1	50	155	4
47 11:30	53	68	121	32	0	24	1	57	177	4
48 11:45	62	65	127	26	2	21	2	51	174	4
49 12:00	62	76	138	24	0	16	1	43	189	1
50 12:15	59	68	127	22	0	22	1	45	171	1
51 12:30	66	63	129	30	0	15	1	46	174	1
52 12:45	82	63	145	31	1	17	2	51	193	1
53 13:00	53	76	129	6	0	13	0	19	148	8
54 13:15	46	53	99	5	0	15	0	20	105	8
55 13:30	38	47	85	3	0	14	0	17	102	8

Figure A.17 – Orphaned Interval

Orphaned Row

process continues. The fourth highest hour is found at 11:00-12:00. The seventh highest hour is found at 9:45-10:45. Notice that this leaves an interval at 10:45 in an *orphaned* state. It is a single interval surrounded by intervals already used and therefore can't be part of a new peak hour which requires four consecutive unused intervals. There are other orphans in this data which aren't visible in this screen shot. You can have 1, 2 or 3 orphans in a row.

Other studies can and will have orphans, and they could be 3 intervals in a row in the middle of the *active* part of your data. For example, your first peak hour may be from 7:00-8:00. Your second peak may be from 8:45-9:00. This leaves three orphan intervals at 8:00, 8:15, and 8:30, which for all intents and purposes don't exist. There isn't any way to tell in advance how the data will be distributed in the various peak hours, and therefore no way to avoid the occasional orphaned intervals.

You may or may not consider this a problem. If you do, then you might be happier with the logic used in Mode 2, which doesn't have this problem.

Conclusion

You have seen four different ways to take your 15 minute volume counts and use them to evaluate the Multi-Way Stop Sign warrants. One of them probably makes a little more sense to you than the others. Select that option in the Preferences screen, as shown on Page 2, and then leave it.

It is unfortunate that we have this complication in what seems like a fairly simple process. We could have picked one of the options and said that's the way it's going to be. But we aren't in the business of setting traffic policy, and we found strong opinions from our users about this issue (usually the comment we get is, "How could anybody in their right mind not see that the obvious way to do this is ...", and then they would mention one of the options.)

Since there isn't any consensus, and since the MUTCD has not been changed to clarify this issue, we chose to give you the option. In a couple of years, when the MUTCD is modified (with probably a fifth option, sigh), we can change the software and take out the options.

What About Signal Warrants?

You might ask, "Isn't this an issue with Signal Warrants as well?". The short answer is "not really". This is because the language used in the Signal Warrant section of the MUTCD is a little more precise and there is more user consensus on how the language is interpreted. In general, all volume data is organized into hourly data on hourly boundaries, except for the Peak Hour Warrant, which specifically mentions and allows for hourly data on 15 minute boundaries. Since you only need one hour to meet the minimum for the Peak Hour Warrant, it doesn't really matter if you overlap intervals when you create the possible hours.

If the MUTCD is changed to allow a more liberal organization of hourly data, then PC-Warrants will be changed as well. Until then, we'll leave well enough alone.

Appendix 7: Averaging Mode Option in Multiway Stop Warrants

PC-Warrants includes support for Multi-Way Stop Sign warrants, based on the procedures in the MUTCD (*Manual of Uniform Traffic Control Devices*). The software supports the MUTCD 1988 version and also the newer Millennium or MUTCD 2000, 2003 versions.

Since the 1988 version the MUTCD has stated (*in part*) “...vehicular volume entering the intersection from the major street approaches (total of both approaches) **averages** at least 300 vehicles per hour...” and “ from the minor street approaches (total of both approaches) **averages** at least 200 units per hour...”.

The key word in those two sentences is the word *averages*, which implies the user should take the eight highest hours and find the average of those eight numbers and use that average value to compare to the minimum volume criteria. In fact, when PC-Warrants was first developed this is what we did. The beta testers told us that this is not the way they normally evaluated the Multiway Stop warrants; they used the same logic as in the signal warrant section which requires all eight hours to meet the minimum. They felt the wording used was just not as precise as it should be. So this is how we designed the software to work.

The MUTCD 2000 was a major update but the wording didn't change. There was another update in 2003 and again the wording didn't change. Finally a few users of PC-Warrants suggested that maybe the intent of the MUTCD was truly to use averages of the volumes. Since we are not in the business of making policy, the software was changed so that you can choose whether to use the old procedure, which required that all eight hours meet the criteria, or the new procedure, which requires that the average of the eight highest hours meets the criteria.

This appendix shows you how the new option works in the software. If you are familiar with PC-Warrants already then the changes will not be difficult to follow.

This is the *Stop Sign Options* screen in the *Preferences* section in PC-Warrants. This is where you select the various options available in the software.

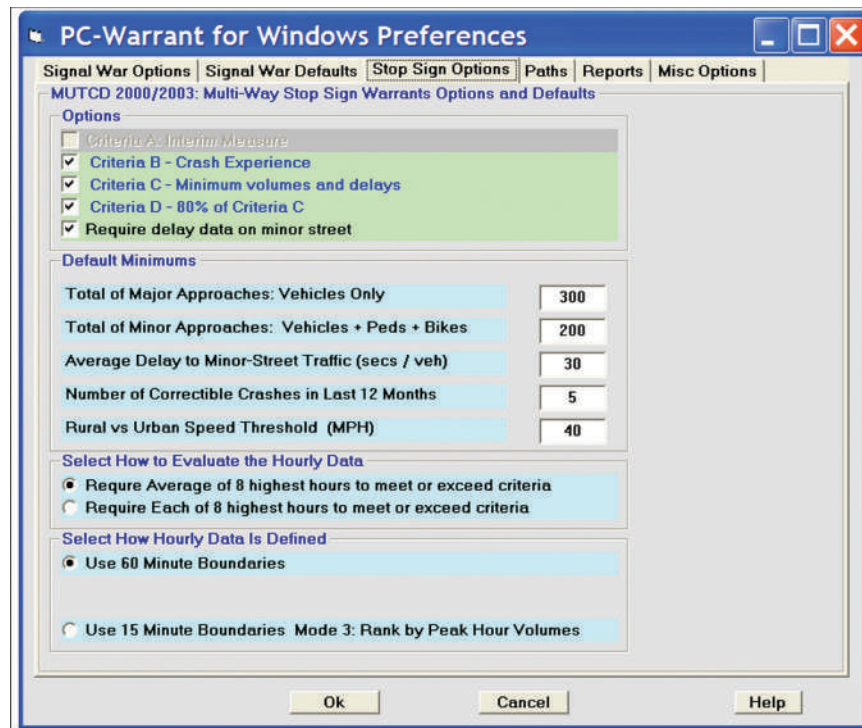


Figure A.18 – Multi Way Stop Sign Options

Near the bottom of the screen is a section labeled *Select How to Evaluate the Hourly Data*. There are two options:

Require Average of 8 highest hours to meet or exceed criteria. This is the default option now. Select this if you want to use the new procedure.

Require Each of 8 highest hours to meet or exceed criteria. This is the old procedure. If you want to continue to use this procedure then select this option.

You then have to decide how the hourly data is defined. It isn't clear what the MUTCD means by an hour of data. See *Appendix 6 - Understanding Volume Data Options in Multiway Stop Sign Studies* for a complete discussion of this topic. If the Average procedure is selected, then there are two options:

Use 60 Minute Boundaries. This is the option most users select. The volume data is forced to hourly boundaries, e.g. 7:00-8:00, 8:00-9:00, etc..

Use 15 Minute Boundaries - Rank by Peak Hour Volumes. This mode finds hourly volumes from 15 minute volume data in such a way that the maximum hourly volumes are found without using a 15 minute interval more than once (see *Appendix 6 for details*).

Click on the **Ok** button at the bottom of the screen once you have made your selections. You normally only make these choices once when you first run the updated software.

Figure A.19 shows the detail screen for Criteria C when you are in the Averaging Mode.

The top of the screen is the same as before; there are no changes there. The bottom section that shows the volumes has changed.

The software first finds the hourly volumes based on the setting discussed on the previous page and then shows them in the grid on the screen. These hours will either be on hourly boundaries or 15 minute boundaries. The software then sorts (*from highest to lowest*) the data in three different ways, first by **Total Major Vehicles**, second by **Total Minor Vehicles**, and third by **Total of All Vehicles**. The top eight lines of the grid are shown in light blue. These are the values that are used to find the average.

Each of these titles is a column in the grid shown on the screen. After each sort the software calculates the average of the highest eight hours and compares that to the warrant criteria. The software finds which of the three sort options either meets the warrant criteria or comes closest. It then takes that sort option and displays the volumes and the averages on the screen. You can see which sort option is used by checking the three columns. The one that is in bold is the current sort option used. In the screen above, it is the **Total Major Vehicles** column.

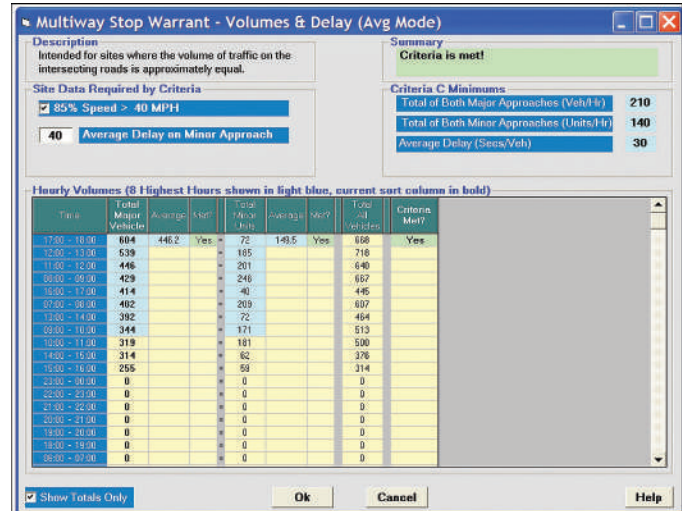


Figure A.19 – Criteria C: Averaging Mode

Why have three sorts? We found in our testing that different data sets could meet or not meet the criteria depending on how the data was sorted. In many cases the limiting factor is the minor approach volume; the major approaches easily meet the criteria but there isn't enough traffic on the minor approach. Sorting on the **Total Minor Vehicles** brings the hours that might meet the criteria to the top of the list. These hours often are not the highest volume hours for the major approach since minor approach traffic often has trouble crossing or turning when the major approach traffic is heaviest. For other intersections with more balanced traffic, sorting on the **Total Major Vehicles** or the **Total of All Vehicles** gives the best results.

Why not have the computer sort on all possible combinations of hours? After all, that's what computers are really good at. A little calculation will give you an idea why we couldn't do this.

The software has to take 8 hours from the pool of possible hours, find the average of those 8 hours for the major approaches and the minor approaches, and then compare the averages to the criteria. These hours don't have to be consecutive or during the same part of the day, you just can't use the same hour twice.

For hourly volume data there are 24 possible hours for the first of the eight hours, then there are 23 possible hours for the second (*since one is now in use*), then 22 for the third, etc. down to 17 possible hours for the eighth hour. That means there are $24 \times 23 \times 22 \times 21 \dots \times 17$ possible combinations to check. This turns out to be a big number - 30 billion combinations. Even if the software could evaluate each combination in one millisecond it would still take the computer 30 million seconds (*around 1 year*) to evaluate the warrant. This is probably not a good approach. It becomes much, much worse if you start with 15 minute data. It would take 130 million years to check all of the possible combinations. Clearly, a brute force approach is not going to work very well.

Of course most of the possible hours the computer would generate would not be likely candidates. Also, many of the combinations would be redundant. Hours 1,2,3,4,5,6,7,8 have the same average as hours 8,7,6,5,4,3,2,1, as does 8,1,7,2,6,3,5,4. This reduces the actual number of possible combinations considerably. But it still leaves a very large number.

It also is unlikely that hours early in the morning would be one of the highest hours of the day.

We looked at many real data sets and it seems that the three sorts we do use will find the hours that are likely to meet or exceed the criteria.

There are basically three scenarios when you look at the volume data:

- 1) The highest hourly volumes do not meet the minimum volume criteria. In this case the average of the eight highest hours will always be too low and the warrant won't ever be met.
- 2) There are many hours (*more than 8 anyway*) that exceed the minimum volume criteria for both the major and minor approaches. In this case it is easy to find 8 hours where the averages meet the criteria.
- 3) There are only a few hours where the major volumes, minor volumes, or both exceed the criteria. In this case it may make a difference how you sort the data. It is this scenario (*even though it doesn't happen very often*) where the software needs to find the best set of hours.

So far we haven't found any data sets where the software fails to find the proper answer. If your data falls into scenario 3 then it is possible that this might happen. This means you can manually find a set of eight hours where the warrant is met but the software says it isn't. If this happens to you let us know and we'll modify the software to fix it.

Notice that this procedure is much more complicated than the older procedure which just required that eight hours exceed both the major and minor criteria. In this procedure we have to deal with *combinations* of eight hours to find the averages. It probably doesn't sound like much, but it changes the number of combinations to check (*in theory*) from 24 to an unreasonably high number.

You can force the software to sort on different columns by clicking on the column title on the grid. You can sort on the **Total Major Vehicles** column, the **Total Minor Vehicles** column, and the **Total All Vehicles** column. You can't sort on any of the other columns. Click on the green box at the top of the column.

Figure A.20 has the same data as the screen on the previous page. In this case the data is sorted by **Total Minor Vehicles**. You can see the column is now in bold type. Notice the average is now 167.1, up from 149.5. The **Total Major Vehicles** average is now 434.4 down from 446.2. Since both of these sets of averages meets the criteria, it doesn't matter which you use.

If you choose to re-sort the data the software will remember that sort setting and use it in other screens and in the reports.

PC-Warrants initially sorts the data checking to see if the warrant is met for that sort choice. Since both Criteria C and Criteria D must both be met for the warrant to be met, the software checks both criteria. This is done in three steps:

- 1) If both Criteria C and Criteria D are met for a particular sort option then the software stops checking and sets the sort choice accordingly.
- 2) If *both* Criteria C and Criteria D are not met the software then checks to see if *either* Criteria C or Criteria D are met. If either are met, then the software sets the sort choice to the one that meets the criteria.

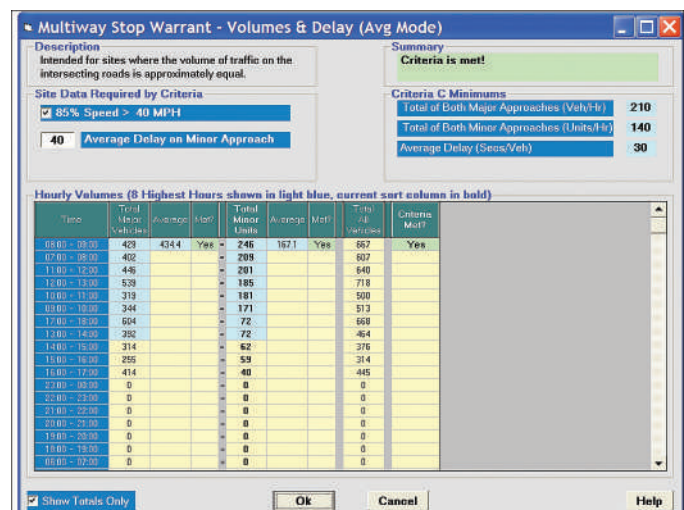


Figure A.20 – Criteria C: Minor Vehicles Sort

3) If neither Criteria C or Criteria D are met with any of the three sorts then the software finds the sort choice that produces the highest total average (*Major Average plus Minor Average*) and sets the sort choice accordingly.

At the end of this process the software has selected the sort option that gives the best possible result with the volume data available.

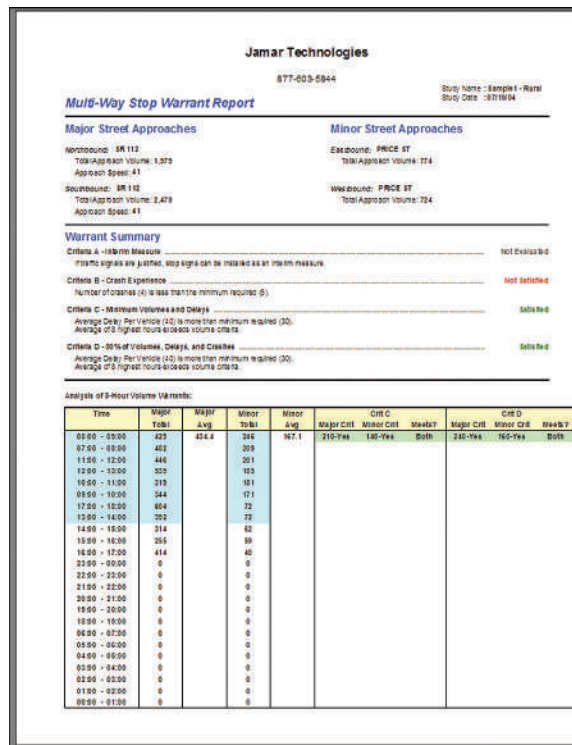


Figure A.21 – Report with Averaging Mode

Figure A.21 shows the report produced with the Averaging Mode selected. It is similar to the older report format except the bottom section is modified to show the sorted volumes along with the averages for the top eight hours for both the major and minor approaches. You also see the results of the evaluation for Criteria C and Criteria D in the space to the right of the volume data.

Conclusion:

If you want to be compatible with the current interpretation of the MUTCD then you probably should select the Averaging Mode for Multiway Stop warrants. As far as we can tell, this is what the MUTCD intended all along.

It is considerably easier to meet the warrant with this option. Before you needed to have all eight hours above the minimum. Now you just have to have the average above that value. That means a couple of busy hours can bring the average above the minimum even if several of the hours have very low traffic volumes.

If you don't think this is the proper interpretation of the MUTCD, or if you just don't like this interpretation, then you can continue to use the older procedure. As stated earlier, we are not in the business of setting policy. The option is yours.

