SELECTING A CENTRAL BUSINESS DISTRICT OR SUBURBAN MEDIAN TREATMENT

USER'S GUIDE

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Date: October 15, 1993

SUMMARY

The purpose of this guide is to assist in the use and interpretation of the "Selecting a Central Business District or Suburban Median Treatment" program. This program is intended to assist in selecting between raised curb median, two way left turn (TWLT) median or undivided cross-section on unlimited access arterials located in central business district (CBD) and suburban environments. It was developed through a project sponsored by the Federal Highway Administration which is fully documented in report number FHWA-RD-93-130 "Investigation of the Impact of Medians on Road Users."

The output of the program consists of estimated vehicular and pedestrian accidents and vehicular delay resulting from the installation of the different median types. The results of this program should be used with other factors such as construction cost, maintenance, aesthetics, utility placement and community goals in determining which median type is most appropriate for the urban arterial being analyzed. The program is not applicable to limited access arterials or arterials located in rural environments.

The Selecting an Urban or Suburban Median Type program is available from

McTrans Center for Microcomputers in Transportation
Transportation Research Center
University of Florida
512 Weil Hall
Gainesville, FL 32611-2083

INTRODUCTION

This guide describes the process for installing, applying and interpreting the output of the Design of Urban Median Arterial Program. This program, developed through a project sponsored by the Federal Highway Administration (FHWA), is intended to help urban designers select the most appropriate type of median. The program is applicable to unlimited access arterials located in central business district (CBD) or suburban environments. The output consists of data on the expected number of vehicular and pedestrian accidents and hours of vehicular delay. Documentation of the model development is contained in report number FHWA-RD-93-130 "Investigation of the Impact of Medians on Road Users."

The urban median analysis process consists of the following steps.

1) Select arterial to be analyzed
2) Obtain required data
3) Execute the Urban Median Selection Program
4) Examine Program Output
5) Determine Median Design

PROGRAM INSTALLATION

The program is designed to operate on an IBM or compatible system. The program diskette contains the following files.

1. urbmed.exe - The urban median arterial program.
2. opp.dbf - The master database file.
3. 00000001.dbf - The database definition primary file.
4. 00000002.dbf - The database definition secondary file.

Copies should be made of the source disk prior to beginning the installation process. If there are two identical floppy disk drives, put the source disk in drive A and blank disk in drive B. At the DOS prompt, do the following:

- **Type A:**
- **Press Enter**
- **Type DISKCOPY A: B:**
- **Press Enter**

If a single floppy disk drive, or different drives, are present then put the source disk in the drive. At the DOS prompt, do the following:

- **Type A:**
- **Press Enter**
- **Type DISKCOPY**
- **Press Enter**

The computer will prompt first for the source drive and then the target drive. The target disk will be the blank disk.

The original disks should be stored in a safe place after they have been successfully copied. Use the working disks for the remainder of the installation. Refer to the DOS manual if problems are encountered in copying the disks.

The program will operate faster if it is copied to the hard drive. To place the program on the hard drive, assuming the hard drive is C: and the working disk is in floppy drive A:, perform the following:

- **Create a directory on the hard drive by typing at the C prompt: MD \URBMED**
- **Press Enter**
- **Type COPY A: *.* C:\URBMED**
- **Press Enter**

Installation Verification

To verify that the program is functioning properly it is recommended that the input values for one of the examples in the back of this users guide be run as a test. If the program fails to execute or comparable output results are not obtained then perform a disk comparison between the source files and the files on the hard disk or working disk that were used to perform the test.

STEP 1 - DETERMINE ANALYSIS ARTERIAL

The program develops estimates of vehicular and pedestrian safety and vehicular delay for an entire arterial or for midblock segments. Selecting the entire arterial results in estimates of safety and delay that includes the effect of signalized intersections. For vehicular estimates this effect includes only those vehicles that are on the analysis arterial. Estimates of vehicular safety do not, therefore, include accidents which occur on the cross road approaches. The midblock option does not include accidents that occur within 100 feet (30.5 m) of the intersection centerline. A midblock segment is, therefore, defined as a length of arterial subtended by signalized intersections.

Estimates of pedestrian safety, for both the entire median arterial and midblock analyses include estimates of accidents on the arterial and within 100 feet (30.5 m) of the median arterial centerline that can be attributed to a median arterial vehicle. A pedestrian accident, for example, involving a vehicle turning right from the median arterial and striking a pedestrian on the cross road would be included in the estimate.

The predictive models of this program are intended for unlimited access arterials located in CBD or suburban locations. These roadways are typically classified as urban arterial, urban collector or urban secondary. Model estimates are not appropriate for Interstate freeways and expressways or other limited access roadways. In addition the models are not appropriate for rural arterials or rural collectors.

It is preferable to apply the program in the early stages of project development. Application at this time allows the quantitative model output to be part of the decision making process and can be helpful in supporting the decision on median type during any public hearings which may be required. The program can also be used to evaluate potential median countermeasures for identified safety problems. In this context the program can be used to determine the safety and delay consequences of a different median type for use in benefit/cost analysis.

Model Requirements

The accident estimates obtained from this program are based on nonlinear predictive models. The models use categorical independent variables such as environment area (CBD or suburban) and land use (residential, office or business), as well as operational and physical characteristics to develop estimates of vehicular and pedestrian accidents. It can be expected that many of these variables, summarized in table 1, will vary over the length of the arterial being analyzed. When variations do occur the arterial should be divided into homogeneous sections to increase predictive accuracy. The following guidelines are presented to assist in applying the models.

- Environmental Characteristics. The analysis arterial should be divided into CBD and suburban segments. The classification of an area as CBD is judgmental and based on the characteristics of the urban community being analyzed. The CBD areas analyzed for model development consisted of dense metropolitan areas characterized by multi-story buildings, high pedestrian activity and average daily traffic (ADT) of 11,500 vehicles or more. Small urban communities, of 200,000 residents or less, may not have a central city area sufficiently intense to be classified as CBD for this program. CBD's of small urban communities with structures three stories or less in height and speed limits of 35 mph (56 km/hr) or greater can obtain sufficient model accuracy by modeling the CBD as suburban. Large metropolitan areas that maintain large vehicle and pedestrian volumes with intensive development, regardless of the speed, along the entire length of the arterial should classify the area as CBD.

Table 1. Independent Variables included in the Nonlinear Regression Models.

Models for Segment Accident
x_1 = Accident report threshold in \$, for vehicle accident only; x_2 = Dummy variable for landuse (residence/office/business); is 1 for office; x_3 = Dummy variable for landuse (residence/office/business); is 1 for business; x_4 = Dummy variable for area (CBD/suburban), is 1 for CBD; x_5 = Number of lanes excluding TWLTL; x_6 = Median width in feet, for raised median and TWLTL only; x_7 = Number of minor cross roads (two way total) per mile; x_8 = Number of driveways per mile; x_9 = Number of crossovers per mile, for raised median only; x_{10} = Posted speed limit in mph; x_{11} = Number of signals per mile, including signals at two ends.
Models for Midblock Accident
x_1 = Accident report threshold in \$, for vehicle accident only; x_2 = Dummy variable for landuse (residence/office/business); is 1 for office; x_3 = Dummy variable for landuse (residence/office/business); is 1 for business; x_4 = Dummy variable for area (CBD/suburban), is 1 for CBD; x_5 = Dummy variable for parking, is 1 if parking allowed; x_6 = Number of lanes excluding TWLTL; x_7 = Median width in feet, for raised median and TWLTL only; x_8 = Number of minor cross roads (two way total) per mile; x_9 = Number of driveways per mile; x_{10} = Number of crossovers per mile, for raised median only; x_{11} = Posted speed limit in mph.

• Land Use Characteristics. If the project length is over one mile (1.6 km) long and there are distinct changes in environmental area and land use then the analysis segment should be divided into homogeneous sections. For example, if a median arterial is 2.25 miles (3.6 km) long with predominant residential land use on 1.5 miles (2.4 km) and business use on the remainder then the sections should be analyzed separated. Similarly arterials with large fluctuations in the number of driveways or other independent variables should be divided for analysis.

● Range of Model Variables. Tables 2 and 3 present the range of variables used to develop the prediction models for the entire arterial and midblock segment models, respectively. Since they are the ranges used to develop the models they should not be exceeded in application. In some instances, such as arterial length, analysis can be divided into segments to remain within the range. It should be recognized that the accuracy of the models outside will decrease for data exceeding the ranges of tables 2 and 3.

Table 2. Independent Variables Ranges Used in the Development of Median Arterials Models

Independent variable	Independent variable range	
	Minimum	Maximum
ADT (vpd)	3000	60000
Arterial Length (miles)	0.5	5.6
# Driveways per mile	4.3	90.00
# Minor Road approaches per mile	0.0	20.0
# Crossovers per mile RAISED	4.3	11.0
Median width (feet) RAISED TWLT	 3.0 10.0	 40.0 12.0
# Signals per mile	1.0	20.0
Speed (mph)	25.0	55.0
# Lanes	2.0	6.0

1 mi = 1.6 km

Table 3. Independent Variable Ranges Used in the Development of Midblock Segment Models

Independent variable	Independent variable range	
	Minimum	Maximum
ADT	3000	65,500
Segment Length (miles)	0.1	3.0
# Driveways per mile	0.0	150.0
# Minor Roads per mile	0.0	33.3
# Crossovers per mile RAISED	3.0	18.0
Median width (feet) RAISED TWLT	3.0 10.0	40.0 12.0
# Signals per mile	1.0	20.0
Speed (mph)	25.0	55.0
# Lanes	2.0	6.0

1 mi = 1.6 km

STEP 2 - OBTAIN DATA

The worksheet presented on page 17 should be completed prior to initiating the Design of Urban Medians Arterials program. The order and presentation of the worksheet follows the same format as required by the program. The majority of the required information is self evident. The following guidelines are provided as clarification to some items.

- <u>Date file</u>. The program saves the analysis input into its master database OPP.DBF. The program permits saving the analysis output into a disk file. The file name is specified by the user with the extension placed by the program. The user can specify the drive and up to an 8 character name. For example, **a:urbanl** would result in the input data being placed in drive a under **urbanl:in** and the output in drive a under **urbanl.out**. If no drive or directory is specified during the designation of a file name then the file will be saved to the current drive and directory. It is not necessary to create a disk file but it is recommended to do so. Disk data files can be edited and renamed thereby permitting additional analysis without reentering the complete data base.

- Project Identification. The program requests information on the analysis arterial including the project number, city and county name and project start and end points. These fields will accept any alpha numeric entry up to 20 characters long. While it is recommended that the appropriate fields be completed they can be left blank.

- Accident Reporting Threshold. The limit at which accidents are required to be reported should be entered as a dollar amount. If your agency has no limit, and police complete accident reports for all notified incidents, enter 50 as the threshold. If only personal injury or tow away accidents are reported; enter 500 as the threshold.

- Initial Year. The program uses the initial and design year information to develop annual volume estimates. If the ADT that will be entered is for the current year then the current year can be entered as the initial year. Prediction accuracy is increased, however, if the volumes which are used are for the first full year of project operation. If it is anticipated that construction will be completed in three years then the first full year of operation will be the fourth year. Using the first full year of operation becomes more important to model accuracy as the time between the planning and construction phases increases.

- Design Year. The design year is typically 20 years from the current year but can vary depending on the type of project, anticipated effective service life, and policies of the planning department. The program will provide estimates of average annual accidents and total accidents for the period between the initial and design years.

- Initial Year ADT. The initial year ADT should be the two way volume for the first full year of operation. If the volume changes along the analysis arterial by 5,000 or more vehicles, due to a major cross street, then the analysis should be broken into segments, if each segment is at least 0.5 mile (0.8 km) long. If the volume changes are due to changes in land use characteristics then the analysis should be performed in segments that reflect both the proper volume and land use.
- Design Year ADT. The design year ADT can be input as either the ADT estimate of the design year or as an annual growth percentage. The annual growth percentage can be obtained from the planning department or by determining the average annual growth from previous volume counts.
- Arterial Length. Median arterial and segment lengths must be input in miles, not stations or feet. The program will accept mile destinations to hundredths of a mile.
- Planned or possible median width. The program performs a comparative analysis between raised, TWLT and undivided cross-sections. Raised medians, for this analysis, consist of medians as wide as 40 feet (12.2 m) and as narrow as 3 feet (0.9 m). The narrow medians consist of elevated concrete surfaces. Raised medians installed with the partial purpose of providing pedestrian refuge should be curbed and at least 4 feet wide (1.2 m). TWLT medians should be the standard 12 foot (3.7 m) lane width but, where limited by available right-of-way, can be modeled as narrow as 10 feet (3.0 m).
- Type of area and land use. The analysis arterial should be homogeneous with regard to CBD or suburban area. If the arterial is over 1 mile (1.6 km) long, and the type of area changes, then it should be divided into separate segments. The type of land use (residential, office or business) should also remain relatively homogenous. Distinct changes in land use, resulting in different pedestrian volumes and characteristics, and different vehicle operating characteristics should be divided into separate segments. Where there is no distinct separation of land use it should be assigned by judgement using the considerations previously discussed on page 5.

- Cross road approaches. Record the number of unsignalized intersection approaches. A four way unsignalized intersection would be counted as two minor road approaches. If the project begins or ends at unsignalized intersections then these approaches should be included in the count. For the design year the count should include all existing approaches plus any new approaches that are anticipated during the design period. Judgement should be used in designating the approaches as minor roadways or driveways. Minor cross roads, for example, that serve only a few residential units on a cul-de-sac will have traffic volumes more representative of a driveway than a cross road. In these instances the cross road should be coded as a driveway. Driveways serving industrial plants, or commercial driveways serving a number of businesses, can have volumes more characteristic of cross roads. In these instances the driveways should be counted as cross roads.
- Number of Driveways. For initial conditions, enter the number of residential and commercial driveways which will be present during the first year that the project is in operation. In fully developed areas the number of driveways for the design year will be equal or approximately equal, to the initial year. For developing areas an estimate of the number of driveways should be based on the type of zoning and anticipated development intensity. The total number of driveways on both sides of the analysis arterial are counted. The designation of a driveway should follow the considerations presented in the discussion of minor road approaches.
- Crossovers. The number of planned or possible crossovers are requested to enable the evaluation of a raised median. Crossovers include all paved flush crossovers areas designed for the movement of traffic. These include median cuts for minor roads and midblock median cuts for one or two way directional change of traffic. Signalized intersections should not be counted as median crossovers. Greater prediction accuracy can be obtained by specifying the number of crossovers. If the number of crossovers is unknown, however, they can be approximated by

using the numbers presented on table 4.

Table 4 - Approximate designation of the number of crossovers.

Group	Level	Number of Crossovers/mile
A	low	3
B	medium	8
C	high	11

- Percentage left turns. The percentage of left turns is used by the delay model to obtain estimates of relative delay. The baseline for determining the relative delay is an undivided roadway. This entry should be the percentage of vehicles turning left per 1000-ft (305 m) segment. If it is unknown, the numbers in table 5 can be used to obtain approximate left turn percentages.

Table 5 - Approximate designation of the percentage of left turns

Group	Left Turn Volume Level	# Left turn vehicles
A	low	50 veh/hr
B	medium	75 veh/hr
C	high	100 veh/hr

- Number of signalized intersections. If the project begins or ends with a signalized intersection they should be included in the total number of signalized intersections. The number of signalized intersections is only needed when analyzing the entire median arterial since midblock segments are defined as roadway sections between signalized intersections.

STEP 3 - EXECUTE THE PROGRAM

The program is initialed by entering the Urbmed directory and entering urbmed as shown below:

Enter the drive on which the program has been stored.

C: CD\URBMED

C:\URBMED

The program displays a title screen while it is initializing and then displays a screen with a verbal description of the program purpose. The user is provided with instructions on each screen for continuing or exiting the program.

Valid input values have been designated for specific fields. These input values consist of alpha and/or numeric designations or value designations. In some instances the input of certain data will not be accepted requiring the input of correct data prior to continuing. For example, the program will not accept a month designation that is greater than 12.

When the input variables exceed the limits on which the model was constructed a warning message will be displayed. The message will state the exceeded variable similar to:

"Model development data did not exceed 90 driveways/mile"

When such a message occurs the user is provided the opportunity to enter another value or to continue. Using data outside the values of table 2 may provide inaccurate results.

STEP 4 - EXAMINE PROGRAM OUTPUT

The program output can be viewed on the screen and printed. The program provides quantitative information on the expected vehicle and pedestrian accidents and vehicle delay resulting from raised, TWLT and undivided cross-sections. The final decision on which median to use requires an evaluation of program results in conjunction with factors which may be unique to each project.

The output consists of:

- Project Description - A summary of the data items that were entered for the analysis.
- Annual Accident Estimates - The estimated number of vehicle and pedestrian accidents for the initial and design years. The annual increase in ADT is also used to estimate the total number of accidents expected to occur over the total design period.
- Delay and Travel Time Analysis - The program uses an undivided arterial as the base condition to determine the savings in delay and travel time resulting from the installation of raised and TWLT medians. A positive saving means that the median treatment will cause less delay than the undivided facility. A negative saving means that the median treatment will cause more delay than the undivided facility.
- Analysis Results - The last part of the output is a verbal description of the program results.

STEP 5 - DETERMINE MEDIAN DESIGN

The program output provides quantitative information that can assist in determining the most advantageous median treatment for CBD and suburban arterials. The final decision on which median to use, however, must consider factors in addition to just accidents and delay. Additional factors that should be considered in the design decision are:

- Safety. The total safety consequences should be given a high priority. The median type, therefore, that results in the lowest expected accidents should be given preference. A close inspection of the expected number of pedestrian accidents should be given close scrutiny. Pedestrian accidents typically result in personal injury. In high pedestrian activity areas, therefore, it may be advantageous to use the median type which reduces pedestrian accidents even if higher vehicle accidents and delay occur with that median type. In instances where there are no differences in vehicle or pedestrian accidents a TWLT median will often be the best choice.

- Cost. Raised medians are the most expensive to construct and maintain. TWLT medians typically reduce travel time and delay to lower levels than are achieved by both raised and undivided medians. The cost of accidents and delay can be used as benefits in a benefit/cost analysis to determine the most cost effective median. There are many different sources and strategies for determining the costs associated with accidents and vehicle delay. The cost of accidents can be obtained from the FHWA and the National Safety Council (NSC). The cost of delay, neglecting vehicle operating costs, is often valued at the minimum hourly wage.

- Sight Distance. The estimated accidents and delay resulting from the program are based on no midblock left turn restrictions. This indicates that sufficient sight distance be available along the entire TWLT median length and at raised median crossovers. When possible restrictions which provide insufficient sight distance for safe left turn or crossing maneuvers should be eliminated during the design phase. TWLT medians and raised median crossovers should not be used in areas with insufficient sight distance.

- Design Speed. Barrier curbs should not be used on raised medians when the design speed is greater than 45 mph (72 km/hr). Barrier curbs (6 to 8 inches, 15 to 20 cm) at the higher speeds are not effective in redirecting vehicles and can result in vaulting and driver loss of control. Mountable curbs should be used on raised medians with design speeds greater than 45 mph (72 km/hr).

- Development Intensity. In areas where the type of development uses large land parcels, and a relatively small number of median openings can serve the required entrances, it may be advantageous to install a raised median.

- Operational Flexibility. TWLT median arterials provide the opportunity to be responsive to large fluctuations in traffic volume and future growth. The relatively low cost enhancements of signing, pavement marking and lane use signals can turn a TWLT median into a reversible lane during peak periods. A raised median can also be turned into a reversible lane but to do so requires much higher construction costs.

● Continuity. Highway uniformity decreases driver confusion and accidents and results in improved operational characteristics. It is not, therefore, desirable to have short sections of roadway with different median types. If the roadway section is less than 0.5 mile (0.8 km) it is recommended that the same median design that is on the adjoining sections be used on the short section.

● Aesthetics. Raised medians are often used by City Planners as a landscape area to make a statement about the community.

● Fixed Objects. Trees, utility poles, ornamental boulders are fixed objects and should not be permitted within raised medians. When these objects can not be prevented from being placed within the median area they should be of breakaway design or appropriate barriers installed. Care must also be given to ensure that objects within the raised median do not restrict sight distance in the proximity of median crossovers.

● Median Design. Transitions to and from different median types must be properly designed with appropriate pavement markings and traffic signs in accord with the Manual On Uniform Traffic Control Devices.

EXAMPLE PROBLEM #1

A one mile section of roadway in a developing section of Tan City is being analyzed for reconstruction. The roadway currently consists of a 4-lane undivided roadway that will be reconstructed as a 6-lane facility. The existing land use is primarily store buildings with similar zoning and planned development for the remainder of vacant land. Sufficient right-of-way exists for the installation of raised or TWLT medians. Due to the multi-story development the environment is classified as CBD. The remainder of the site data is contained on the worksheet of example 1.

DESIGN OF URBAN ARTERIALS WORKSHEET

Analysis performed by: Date of Analysis:

Project Number: Median Arterial Identifier:

City and County:

Study Type (1=Median Arterial, 2=Midblock Segment):

Project Length (mile):

On street parking (0=No, 1=Yes):
(Required only if study type = 2)

Project Start: Project End:

Accident Reporting Threshold ($): Speed Limit (mph):

Initial Year of Analysis: Design Year of Analysis:

Initial Avg. Daily Traffic: Design Year Avg. Daily Traffic:

Annual Percentage Growth:

Median Type: 1=Raised, 2=TWLT, 3=Undivided
Median Type Prior to Start (1,2,3): Median Type After End (1,2,3):

Type of Area (1=CBD, 2=Suburban): Type of Land use (1=Res, 2=Off, 3=Bus):

Number of Through Lanes: Planned or Possible Median Width (ft):
RAISED:
TWLT:

Percentage of Left Turns (0-100)%*:

*If unknown, use the following number of left turns per hour:

(1) low level:	50 veh/hr
(2) medium level:	75 veh/hr
(3) high level:	100 veh/hr

$$\text{Percentage of left turns} = \frac{\text{number of left turns per hour}}{\text{directional peak hour traffic volume}} \times 100$$

Number of Minor Cross Road Approaches	Initial Year:	Design Year:
Number of Driveways -	Initial Year:	Design Year:
Number of Signalized Intersections - (Required only if study type = 1)	Initial Year:	Design Year:
Number of Planned/Possible Median Crossovers** -	Initial Year:	Design Year:

**If unknown, use the following number of crossovers per mile.

(1) low number	3 per mile
(2) medium number	8 per mile
(3) high number	11 per mile

Number of crossovers = number of vehicles per mile x project length:

The results of the accident estimates indicate that both raised and TWLT medians result in fewer vehicle accidents in the design year than an undivided roadway (98.06 for raised and 100.41 for TWLT versus 191.53 for undivided). Also, both raised and TWLT medians will result in less pedestrian accidents than the undivided alternative during the design year. These estimates are for the total one mile section of roadway and include accidents occurring on the arterial at both midblock and signalized intersections.

The results of vehicle delay analysis show that TWLT is the most efficient in operation which provides 28.95 and 11.85 vehicle hours less delay than the undivided cross section and raised median, respectively, in the peak hour of the design year. It is interesting to note that a raised median causes less delay (11.85 vehicle hours) than an undivided cross section during the peak hour of the design year. The reason is that the raised median reduces delay to through traffic caused by left turn vehicles and can be more efficient than an undivided cross section when traffic volume is high.

In determining which median to install the designer considered the following:

- A raised median will result in less vehicle and pedestrian accidents than both TWLT and undivided cross-sections.
- A TWLT median results in less vehicle and pedestrian accidents than an undivided cross-section.
- A TWLT median will result in less delay than a raised median.
- Raised medians have a higher installation and annual maintenance cost than TWLT medians.

These considerations resulted in the designer deciding to perform a cost analysis between the raised and TWLT median alternatives. The analysis was based on the 1991 National Safety Council cost of $3,500 for vehicle property damage with minor injuries and $8,900 personal injury cost for pedestrian accidents. Cost of delay was valued at $4.25 per hour.

Raised versus TWLT Accident Cost Benefit over 20 Year Design Life

VEHICLE ACCIDENTS

TWLT	1733.14 @ $3500 =	$6.07 M
RAISED	1692.55 @ $3500 =	5.92 M
(Raised-TWLT)		0.15 M

PEDESTRIAN ACCIDENTS

TWLT	73.25@ $8900 =	$0.65 M
RAISED	15.78 @ $8900 =	0.14 M
(Raised-TWLT)		0.51 M
NET RAISED ACCIDENT SAVINGS		$0.66 M

DELAY REDUCTION SAVINGS OF TWLT VERSUS RAISED

TWLT	28.95 ($4.25/hr) * 20 yrs *(260 working days/yr) =	$0.64 M
RAISED	11.85 ($4.25/hr) * 20 yrs *(260 working days/yr) =	0.26 M
NET TWLT DELAY SAVINGS		$0.38 M

NET BENEFIT OF RAISED MEDIAN = $0.28 M

After considering the incremental installation and maintenance cost of raised medians and the reduction in pedestrian accidents it was decided to install a raised median. Other factors considered were the ability to add additional lanes in the future at relatively low cost and the fact that a raised median currently exists at the end of the project.

EXAMPLE #2

A half mile section of roadway in Shan City is being analyzed for reconstruction. The roadway is a 4-lane undivided facility with signals at both ends. The roadway is located in a suburban area and the land use is primarily business (stores and shopping malls). Existing right-of-way allows installation of an 8-ft raised median or a 10-ft TWLT. The remainder of the site data is contained on the worksheet of example 2.

A midblock segment study was conducted since signalized intersections are at both ends of the segment. The raised median will not extend into the intersections due to the need for left turn lanes. The results of the accident analysis indicate that both raised and TWLT medians result in lower accidents than an undivided cross-section. A further inspection of the accident predictions reveals that TWLT medians result in the greatest reduction of both vehicle and pedestrian accidents.

The results of vehicle delay estimates indicate that TWLT median design is the most efficient in reducing delay. Notice that raised medians actually cause more delay than an undivided cross-section during the initial year volume conditions. As the volumes increase to design year levels the raised median causes less delay than would be experienced by an undivided cross-section.

The design team decided to install a TWLT median due to the safety and delay benefits and the lower construction and maintenance costs associated with raised medians.

DESIGN OF URBAN ARTERIALS WORKSHEET

Analysis performed by: BLB

Date of Analysis: 07/08/93

Project Number: EXAMPLE #1

Median Arterial Identifier: TRUE LANE

City and County: TAN CITY / CAROL CNTY

Study Type (1=Median Arterial, 2=Midblock Segment): 1

Project Length (mile): 1

On street parking (0=No, 1=Yes):
(Required only if study type = 2)

Project Start: ROUTE 55

Project End: CNTY RD 26

Accident Reporting Threshold ($): 250

Speed Limit (mph): 45

Initial Year of Analysis: 2000

Design Year of Analysis: 2020

Initial Avg. Daily Traffic: 20000

Design Year Avg. Daily Traffic: 30000

Annual Percentage Growth:

Median Type: 1=Raised, 2=TWLT, 3=Undivided
Median Type Prior to Start (1,2,3): 3

Median Type After End (1,2,3): 1

Type of Area (1=CBD, 2=Suburban): 1

Type of Land use (1=Res, 2=Off, 3=Bus): 3

Number of Through Lanes: 6

Planned or Possible Median Width (ft):
RAISED: 24
TWLT: 12

Percentage of Left Turns (0-100)%*: 10

*If unknown, use the following number of left turns per hour:

(1) low level:	50 veh/hr
(2) medium level:	75 veh/hr
(3) high level:	100 veh/hr

$$\text{Percentage of left turns} = \frac{\textbf{number of left turns per hour}}{\textbf{directional peak hour traffic volume}} \times 100$$

Number of Minor Cross Road Approaches	Initial Year:	3	Design Year:	5
Number of Driveways -	Initial Year:	35	Design Year:	47
Number of Signalized Intersections - (Required only if study type = 1)	Initial Year:	3	Design Year:	3
Number of Planned/Possible Median Crossovers** -	Initial Year:	8	Design Year:	8

**If unknown, use the following number of crossovers per mile.

(1) low number	3 per mile
(2) medium number	8 per mile
(3) high number	11 per mile

Number of crossovers = number of vehicles per mile x project length:

*********** OUTPUT EXAMPLE #1 ***********

Analysis Performed by: BLB   Date of Analysis: 07/08/93

Project Number: EXAMPLE #1   Median Arterial Identifier: TRUE LANE

District: EX1   City and County TAN CITY/CAROL CNTY

Study Type (1=Median Arterial, 2=Midblock Segment): 1

Project Length: 1.00

Project Start: ROUTE 55   Project End: CNTY RD 26

Accident Reporting Threshold: 250.0   Speed Limit (mph): 45

Initial Year of Analysis: 2000   Design Year of Analysis: 2020

Initial Avg. Daily Traffic: 20000   Design Year Avg. Daily Traffic: 30000

Annual Percentage Growth : 2.05

Median Type: 1=Raised, 2=TWLT, 3=Undivided
Median Type Prior to Start (1,2,3): 3   Median Type After End (1,2,3): 1

Type of Area (1=CBD, 2=Suburban): 1   Type of Land use (1=Res, 2=Off, 3=Bus):3

Number of Through Lanes: 6   Planned or Possible Median Width -
RAISED: 24
Percentage of Left Turns (0-100)%: 10.0   TWLT : 12

Number of Minor Cross Road Approaches Initial Year: 3.0   Design Year: 5.0

Number of Driveways - Initial Year: 35.0   Design Year: 47.0

Number of Signilized Inersections - Initial Year: 3   Design Year: 3

Number of Planned/Possible Median Crossovers -

Initial Year: 8.0   Design Year: 8.0

Analysis For Entire Median Project

	Annual Estimates by Median Type		
Time Period	Raised	TWLT	Undivided
Initial Year			
Vehicle accidents	65.37	64.70	108.93
Pedestrian accidents	0.47	2.83	5.15
Design Year			
Vehicle accidents	98.06	100.41	191.53
Pedestrian accidents	0.91	4.24	7.72
Estimated Total for Year Design Period 20			
Vehicle accidents	1692.55	1733.14	3305.82
Pedestrian accidents	15.78	73.25	133.29

Estimated Delay Savings For Entire Median Project

	Estimated Delay Savings During the Peak Hour by Median Type	
	Raised	TWLT
Initial Year		
Delay Per Vehicle (sec per veh)	-38.37	5.08
Total Delay (Vehicle hours)	-13.86	1.83
Design Year		
Delay Per Vehicle (sec per veh)	21.88	53.44
Total Delay (Vehicle hours)	11.85	28.95

Analysis Results for Entire Median Arterial

The estimated accident occurrence indicates that a RAISED median installation will have 2.35 less vehicle and 3.33 less pedestrian accidents in the design year than a TWLTL median installation. The RAISED median installation will have 93.47 less vehicle and 6.81 less pedestrian accidents in the design year than a UNDIVIDED median installation.

The TWLT median will provide 28.95 less vehicle hours of delay than an undivided median and 17.10 less vehicle hours of delay than a raised median during the peak hour of the design year.

DESIGN OF URBAN ARTERIALS WORKSHEET

Analysis performed by: JM

Date of Analysis: 09/23/93

Project Number: EXAMPLE #2

Median Arterial Identifier: GENE AVE

City and County: SHAN CITY/LEE CNTY

Study Type (1=Median Arterial, 2=Midblock Segment): 2

Project Length (mile): 0.5

On street parking (0=No, 1=Yes): 0
(Required only if study type = 2)

Project Start: GLENN AVE

Project End: CNTY RD 196

Accident Reporting Threshold ($): 500

Speed Limit (mph): 35

Initial Year of Analysis: 1995

Design Year of Analysis: 2015

Initial Avg. Daily Traffic: 19000

Design Year Avg. Daily Traffic:

Annual Percentage Growth: 1.2

Median Type: 1=Raised, 2=TWLT, 3=Undivided
Median Type Prior to Start (1,2,3): 3

Median Type After End (1,2,3): 1

Type of Area (1=CBD, 2=Suburban): 2

Type of Land use (1=Res, 2=Off, 3=Bus): 3

Number of Through Lanes:

Planned or Possible Median Width (ft):
RAISED: 8
TWLT: 10

Percentage of Left Turns (0-100)%*:

*If unknown, use the following number of left turns per hour:

(1) low level:	50 veh/hr
(2) medium level:	75 veh/hr
(3) high level:	100 veh/hr

$$\text{Percentage of left turns} = \frac{\text{number of left turns per hour}}{\text{directional peak hour traffic volume}} \times 100$$

Number of Minor Cross Road Approaches	Initial Year:	4	Design Year:	4
Number of Driveways -	Initial Year:	25	Design Year:	40
Number of Signalized Intersections - (Required only if study type = 1)	Initial Year:		Design Year:	
Number of Planned/Possible Median Crossovers** -	Initial Year:	4	Design Year:	4

**If unknown, use the following number of crossovers per mile.

(1) low number	3 per mile
(2) medium number	8 per mile
(3) high number	11 per mile

Number of crossovers = number of vehicles per mile x project length:

************ OUTPUT OF EXAMPLE #2 ************

Analysis Performed by: JM Date of Analysis: 09/23/93

Project Number: EXAMPLE #2 Median Arterial Identifier: GENE AVE

District: EX2 City and County SHAN CITY/LEE CNTY

Study Type (1=Median Arterial, 2=Midblock Segment): 2

Project Length: 0.50 On Street Parking: 0

Project Start: GLENN AVE Project End: CNTY RD 198

Accident Reporting Threshold: 500.0 Speed Limit (mph): 35

Initial Year of Analysis: 1995 Design Year of Analysis: 2015

Initial Avg. Daily Traffic: 19000 Design Year Avg. Daily Traffic: 24119

Annual Percentage Growth : 1.20

Median Type: 1=Raised, 2=TWLT, 3=Undivided
Median Type Prior to Start (1,2,3): 3 Median Type After End (1,2,3): 1

Type of Area (1=CBD, 2=Suburban): 2 Type of Land use (1=Res, 2=Off, 3=Bus):3

Number of Through Lanes: 4 Planned or Possible Median Width -
RAISED: 8
Percentage of Left Turns (0-100)%: 10.0 TWLT : 10

Number of Minor Cross Road Approaches Initial Year: 4.0 Design Year: 4.0

Number of Driveways - Initial Year: 25.0 Design Year: 40.0

Number of Planned/Possible Median Crossovers -

Initial Year: 4.0 Design Year: 4.0

Analysis For Midblock Segment

Time Period	Annual Estimates by Median Type Raised	TWLT	Undivided
Initial Year			
Vehicle accidents	7.48	7.02	9.48
Pedestrian accidents	0.21	0.21	0.55
Design Year			
Vehicle accidents	11.02	8.91	12.03
Pedestrian accidents	0.40	0.27	1.02
Estimated Total for Year Design Period	20		
Vehicle accidents	205.97	166.57	224.80
Pedestrian accidents	7.52	5.01	19.04

Estimated Delay Savings For Midblock Segment

Estimated Delay Savings During the Peak Hour by Median Type

	Raised	TWLT
Initial Year		
Delay Per Vehicle (sec per veh)	-4.41	21.45
Total Delay (Vehicle hours)	-2.33	11.32
Design Year		
Delay Per Vehicle (sec per veh)	158.11	256.27
Total Delay (Vehicle hours)	105.93	171.69

Analysis Results for Midblock Segment

The estimated accident occurrence indicates that a TWLTL median installation will have 2.11 less vehicle and 0.13 less pedestrian accidents in the design year than a RAISED median installation. The TWLTL median installation will have 3.12 less vehicle and 0.75 less pedestrian accidents in the design year than a UNDIVIDED median installation.

The TWLT median will provide 171.69 less vehicle hours of delay than an undivided median and 65.76 less vehicle hours of delay than a raised median during the peak hour of the design year.