Procedures for Conducting Traffic Impact Studies

TED 106-2

Introduction

- The purpose of TED 106-2 is to provide guidance on the expectations and contents of a completed traffic impact study (TIS). A TIS is intended to review the impacts of a proposed development on the surrounding roadway network. This impact is dependent upon the number of trips generated, the locations of any proposed access(es), as well as the roadways utilized to travel to/from the development
- A TIS involves the evaluation of the expected roadway conditions with and without the proposed development and what measures are necessary to offset the increases in future traffic volumes due to the development

When is a TIS required?

- A TIS is required under the following conditions:
  - When the proposed development is projected to generate 100 or more trips (total of entering and exiting) per hour during the peak generating time for the development (This could be a new development or redevelopment of an existing site)
  - For smaller developments under one of the following three conditions
    - When the proposed new approach is to an intersection already operating at level of service (LOS) “D” or worse
    - When the developer is requesting a new traffic signal
    - When modification of an existing traffic signal is being requested
  - An older TIS may need to be updated when the data is over two years old

Can the requirement for a TIS be forgone?

A TIS may not be required in situations where the project's impact on traffic is obvious and where the West Virginia Division of Highways (WVDOH) is agreeable to the proposed mitigation measures without conducting a TIS.

Typical examples would be the need for turn lanes at either a new or existing approach or intersection.

Certification by Professional Engineer

All traffic impact studies must be certified by the WV registered professional engineer (PE) who conducted and/or supervised the study. A WV PE must certify all studies by sealing and signing all copies of the study.

A current Certificate of Authorization (COA) from the WV PE Board is also required.

Scope of Work

Prior to beginning a TIS, the developer or their consultant shall contact the WVDOH to discuss the scope of the study. Consultant will provide the type of development being proposed, the expected build-out date, and a list of intersections to be studied.

Once the scope of work is approved, and prior to beginning full detailed analyses, a preliminary submission should be made to the Traffic Engineering Division.

Preliminary Submission

Typical preliminary submissions include the following:

- Locations of proposed access(es)
- Existing turning movement count data
- Trip distribution percentages
- Pass-by percentages (ITE) and Internal Capture Rates (NCHRP) if applicable

At this time, consultant would also request/obtain where applicable, any actual signal timings and plans for use within analyses as well as any applicable growth rate for developments that have a build-out date over one year.

Data Collection

Preparation of the TIS will require data collection, which will be the sole responsibility of the developer or their consultant. It may be permissible to utilize data from a previous study if said data is less than two years old and/or traffic volumes and/or patterns have not changed significantly

In addition to collecting traffic volumes, data collection shall also include the speed limits of any roadways within the study area, roadway grades, and roadway geometry (lane widths, shoulders, turn lane lengths, sight distances).

Data Collection

Traffic volumes shall be obtained at all locations and times agreed upon during scoping, generally as follows:

- ADT counts for all roadways within study area. These can be obtained via automatic traffic recorders (ATR) or through the WVDOH Planning and Programming Division (if available)
- Turning movements shall be obtained for appropriate peak hour (Friday 7-9 AM, Friday 3-6 PM, or Saturday Midday 11 AM to 2 PM)
- Counts shall be obtained while classes are underway in any study area near a Public K-12 or College/University
- Counts shall be obtained during favorable weather conditions
- Counts shall not be obtained during a holiday weekend, sporting or special event
- Volume collections should indicate the presence of any bike/peds, the volume/percentage of heavy vehicles, and if any transit exists in the study area
- A peak hour factor (PHF) shall be calculated for each peak hour for each intersection

Traffic Projections

Traffic projections should be made utilizing the latest edition of Trip Generation published by the Institute of Transportation Engineers (ITE). Additional studies and references can be provided as needed to supplement the information in Trip Generation. These projected trips for each entity of the development shall be displayed on a chart showing the entering and exiting volumes for each peak hour

Typical study peak hours are as follows:

- Residential – Friday AM and PM
- Industrial – Friday AM and PM
- Medical and General Office – Friday AM and PM
- Retail and Commercial Facilities – Friday PM (and AM if necessary) and Saturday Midday

Traffic Projections

Pass-by Trips – Pass-by trips are those motorists that are already traveling along the roadway when they decide to enter a development that was not their primary destination. These are trips that are shown entering and exiting the development and are subtracted from the existing mainline volumes. Pass-by trips only apply to retail and commercial developments.

Pass-by percentages should be obtained from the ITE Trip Generation Handbook and applied accordingly.

Traffic Projections

Internal Capture – trips between multiple land uses within a single development. These are trips whose origin and destination are within the development.

Internal capture rates should be obtained from the National Cooperative Highway Research Program (NCHRP) Report 684.

It is recommended that Internal Capture rates be discussed and pre-approved by the WVDOH prior to submitting final TIS

AM	Entering Trips				Exiting Trips			
Category	Internal	External	Total	Percent	Internal	External	Total	Percent
Cinema	0	0	0	0%	0	0	0	0%
Hotel	0	0	0	0%	0	0	0	0%
Office	2	10	12	17%	3	0	3	100%
Residential	0	0	0	0%	0	0	0	0%
Restaurant	7	371	378	2%	8	349	357	2%
Retail	7	62	69	10%	5	36	41	12%
All Other Land Uses	0	9	9	0%	0	4	4	0%
Totals	16	452	468	3%	16	389	405	4%

PM	Entering Trips				Exiting Trips			
Category	Internal	External	Total	Percent	Internal	External	Total	Percent
Cinema	0	0	0	0%	0	0	0	0%
Hotel	0	0	0	0%	0	0	0	0%
Office	4	3	7	57%	4	12	16	25%
Residential	0	0	0	0%	0	0	0	0%
Restaurant	48	201	249	19%	84	147	231	36%
Retail	85	79	164	52%	49	112	161	30%
All Other Land Uses	0	13	13	0%	0	12	12	0%
Totals	137	296	433	32%	137	283	420	33%

Table 1: Site Trip Generation

Land Use	Size	Units	FRI PM Peak Hour Total	FRI PM Peak Hour In	FRI PM Peak Hour Out	SAT Peak Hour Total	SAT Peak Hour In	SAT Peak Hour Out
Supermarket (LU 850) -- *Grocery*	28,709	SF	272	139	133	306	156	150
Internal Capture Reduction (32%)			*-87*	*-44*	*-43*	*-98*	*-49*	*-49*
Pass-By Trip Reduction (36% FRI / 36% SAT)			*-67*	*-34*	*-33*	*-75*	*-38*	*-37*
Fast-Food Restaurant with a Drive-thru (LU 934) -- *Chicken*	3,200	SF	104	54	50	189	96	93
Internal Capture Reduction (32%)			*-33*	*-17*	*-16*	*-60*	*-30*	*-30*
Pass-By Trip Reduction (42% PM / 42% SAT)			*-30*	*-15*	*-15*	*-54*	*-27*	*-27*
Fast-Food Restaurant with a Drive-thru (LU 934) -- *Pizza*	1,600	SF	52	27	25	94	48	46
Internal Capture Reduction (32%)			*-17*	*-9*	*-8*	*-30*	*-15*	*-15*
Pass-By Trip Reduction (42% PM / 42% SAT)			*-15*	*-8*	*-7*	*-27*	*-14*	*-13*
Fast-Food Restaurant with a Drive-thru (LU 934) -- *Restaurant 1*	2,800	SF	91	47	44	165	84	81
Internal Capture Reduction (32%)			*-29*	*-15*	*-14*	*-53*	*-27*	*-26*
Pass-By Trip Reduction (42% PM / 42% SAT)			*-26*	*-13*	*-13*	*-47*	*-24*	*-23*
Fast-Food Restaurant with a Drive-thru (LU 934) -- *Restaurant 2*	2,200	SF	72	37	35	130	66	64
Internal Capture Reduction (32%)			*-23*	*-12*	*-11*	*-42*	*-21*	*-21*
Pass-By Trip Reduction (42% PM / 42% SAT)			*-21*	*-11*	*-10*	*-37*	*-19*	*-18*
Shopping Center (LU 820) -- *Available*	11,600	SF	43	21	22	56	29	27
Internal Capture Reduction (32%)			*-14*	*-7*	*-7*	*-18*	*-9*	*-9*
Pass-By Trip Reduction (0% PM / 0% SAT)			*0*	*0*	*0*	*0*	*0*	*0*

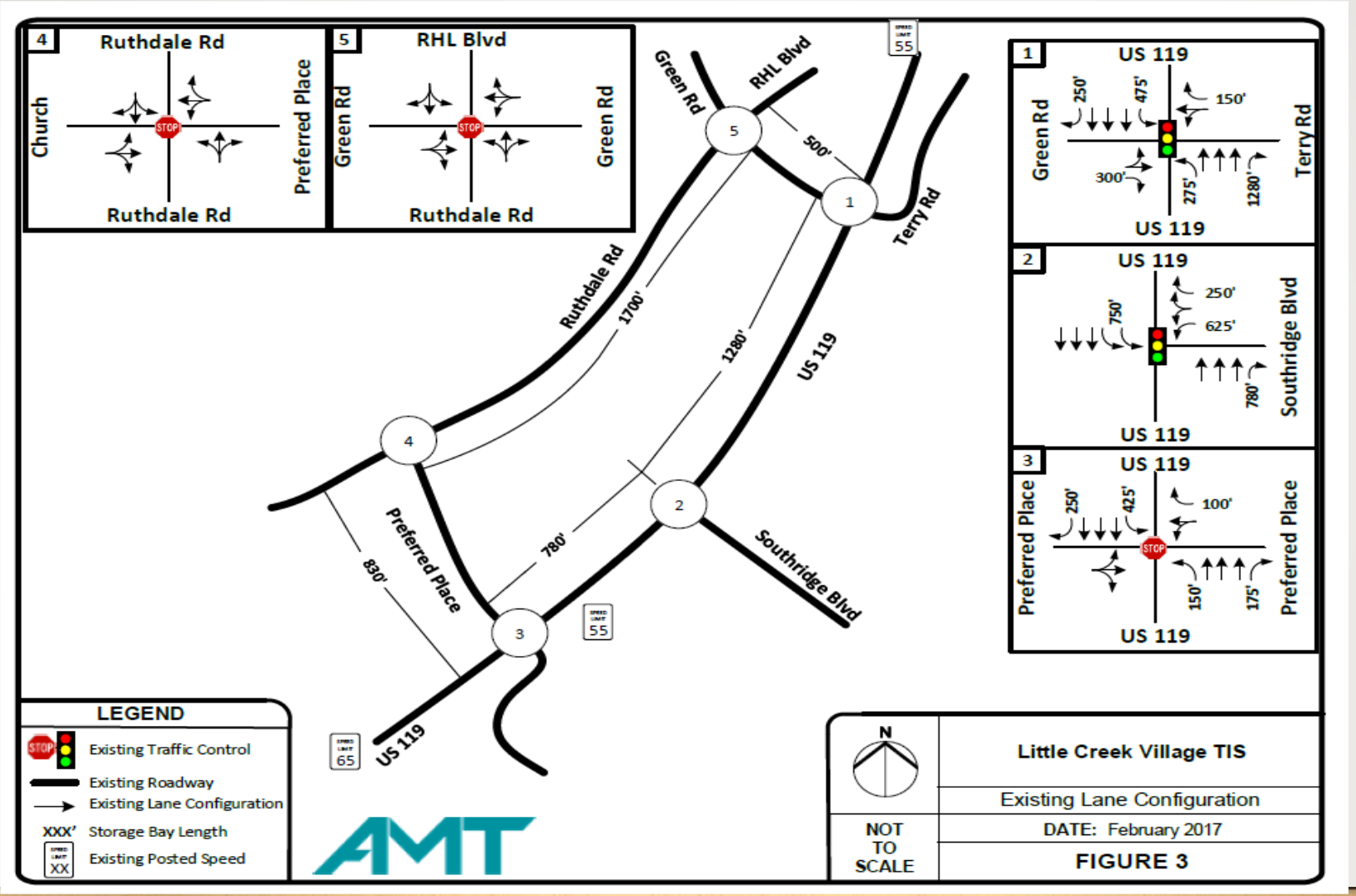
Data Displays

TIS shall provide separate diagrams containing the following information:

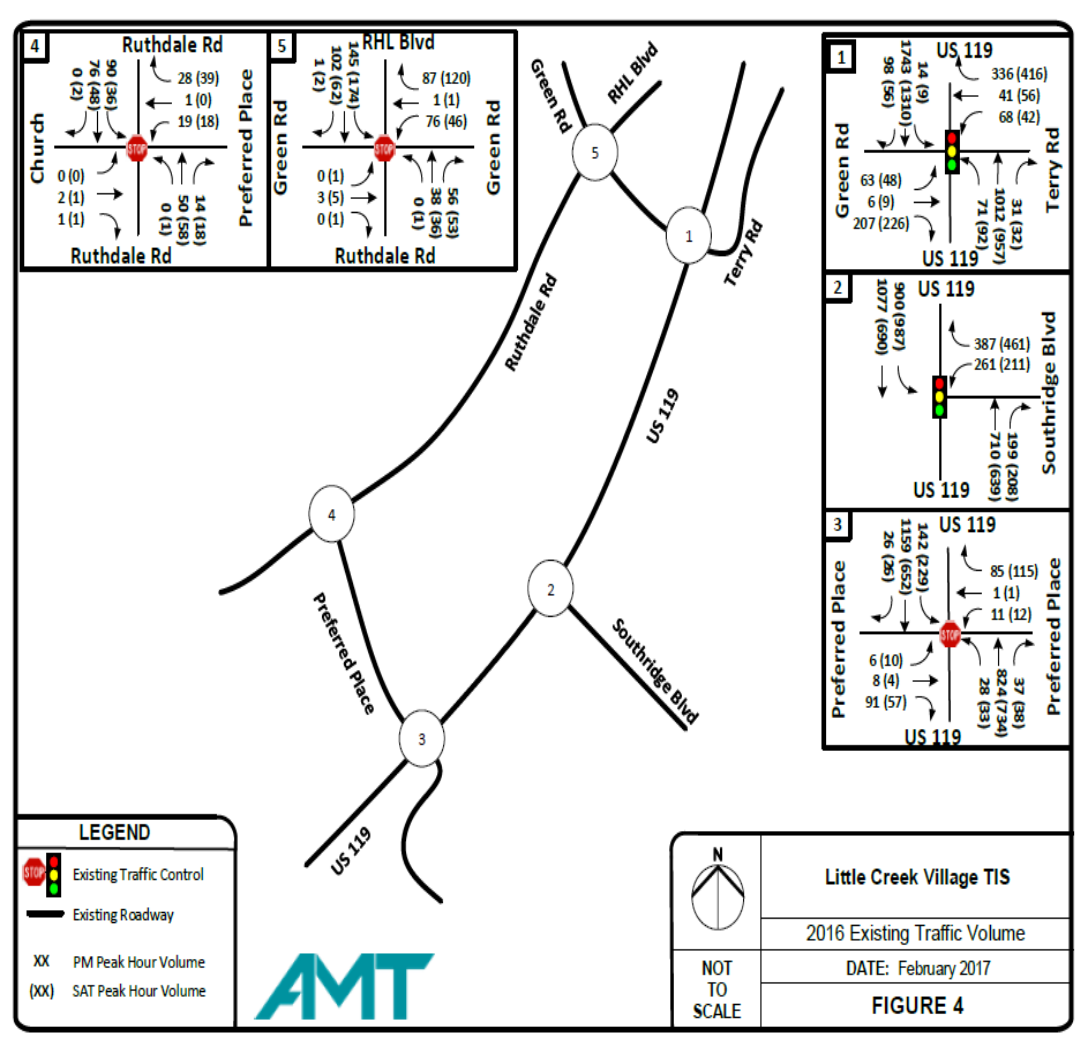
- Existing turning movement data
- Background turning movement data
- Projected new trips and pass-by trips
- Future combined turning movement data

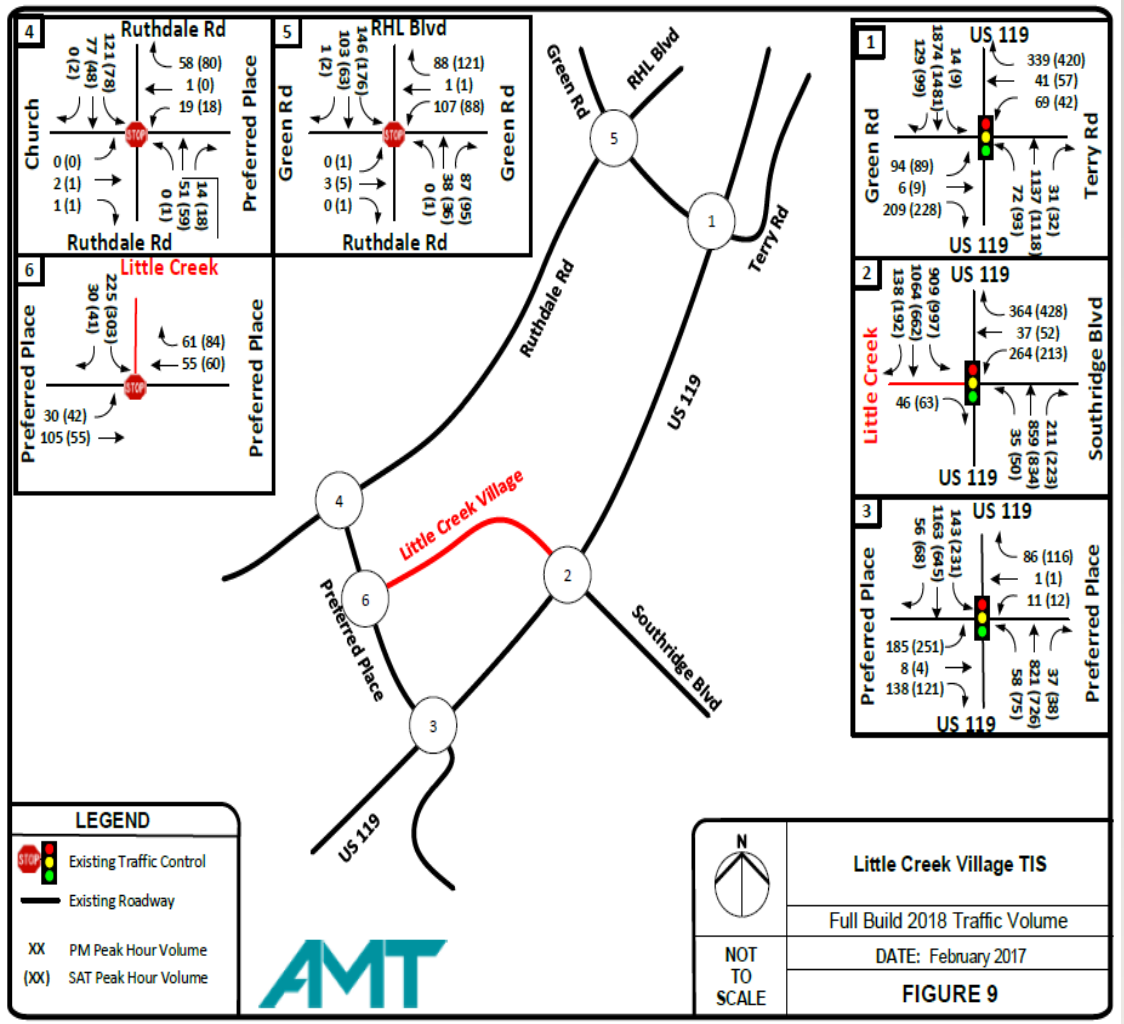
There should also be a diagram(s) included in the TIS that shows the distance between study intersections, and the existing and proposed lane configuration (with turn lane lengths)

Data Display Example



Data Display Example





Capacity Analyses

Capacity analyses should be conducted utilizing the latest edition of the Highway Capacity Manual (HCM) published by TRB. Highway capacity analyses softwares which are capable of using the procedures of the HCM may be utilized. Currently the DOH allows the use of the following software for TIS analyses:

- HCS
- SYNCHRO
- SIDRA

Other software, such as VISSIM or TransModeler may be utilized if prior approval is obtained from the DOH Traffic Engineering Division. Whichever software is proposed, it should be the latest version available and analyses shall be "operations analyses" rather than "planning analyses."

Capacity Analyses

The Level of Service (LOS) of all intersections affected by the proposed development should be no worse than the LOS before the new facility opens. If it is determined that the LOS of an intersection is adversely affected as a result of the proposed development, the TIS shall recommend all reasonable improvements (turn lanes, additional thru lanes, signalization, etc.) to alleviate projected problems.

It may be necessary to worsen the LOS and increase queuing inside the development to ensure that the state highway continues to operate at an acceptable LOS.

Capacity Analyses

Capacity analyses shall be conducted for all applicable peak hours for all study intersections. Any internal intersection that could potentially affect the state highway system shall also be analyzed. Analyses worksheets showing inputs, LOS, delays, and queuing shall be included within the TIS.

Level of Service Criteria

Level of Service	SIGNALIZED Intersection Control Delay (sec/veh)	UNSIGNALIZED Intersection Control Delay (sec/veh)	Intersection LOS Description
A	≤ 10.0	≤ 10.0	Free flow, insignificant delays.
B	10.1-20.0	10.1-15.0	Stable operation, minimal delays.
C	20.1-35.0	15.1-25.0	Stable operation, acceptable delays.
D	35.1-55.0	25.1-35.0	Restricted flow, common delays.
E	55.1-80.0	35.1-50.0	Maximum capacity, extended delays. Volumes at or near capacity. Long queues form upstream from intersection.
F	> 80.0	> 50.0	Forced flow, excessive delays. Represents jammed conditions. Intersection operates below capacity with low volumes. Queues may block upstream intersections.

Queuing Analyses

Queuing analyses shall be conducted and included within the report to determine the length of any proposed/recommended auxiliary turn lanes, or if there is a need to extend any existing turn lanes. These analyses will also determine if there are overlapping queues for adjacent intersections. These analyses should be conducted utilizing the previously discussed software packages.

Geometric Improvements

The latest edition of A Policy on Geometric Design of Highways and Streets (Green Book) published by AASHTO shall be utilized in conjunction with WVDOH Design Directives to design any necessary geometric improvements.

Procedures recommended in the Green Book and HCM will be utilized when designing auxiliary turn lanes.

If the construction of a development changes the classification of a roadway or section of roadway (refer to DD-601), then the developer may be required to provide mitigation (such as widening) to allow for safe and efficient traffic flow along the roadway.

Geometric Improvements

Improvements may be recommended with or without the proposed development. For improvements recommended based on existing conditions, they should be included within the recommendations section of the TIS and listed separately from any improvements recommended as a result of the development.

Any improvement shown as an existing need (non developer responsibility) prior to development must be clearly corroborated with engineering data.

Traffic Signals

The need for any traffic signals shall be adequately justified utilizing one or more warrants of the Manual on Uniform Traffic Control Devices (MUTCD). For an existing intersection, this requires collection of 12 hours of traffic data.

The method for warranting traffic signals based on ADT contained in the ITE Manual on Traffic Signal Design can also be considered.

Traffic Signals

- The actual design of any traffic signals will be performed by the Traffic Engineering Division of the WVDOH.
- Any recommendations for signal timings or timing changes shall be jusitified using highway capacity software and should account for any interconnection of nearby signals
- Final timings will be determined by the Traffic Engineering Division

MUTCD Warrants

There are currently nine warrants contained within the MUTCD pertaining to traffic signalization:

- 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
- Warrant 9, Intersection Near a Grade Crossing

The satisfaction of a traffic signal warrant(s) shall not in itself require the installation of a traffic control signal.

Warrant 1, Eight-Hour Vehicular Volume

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

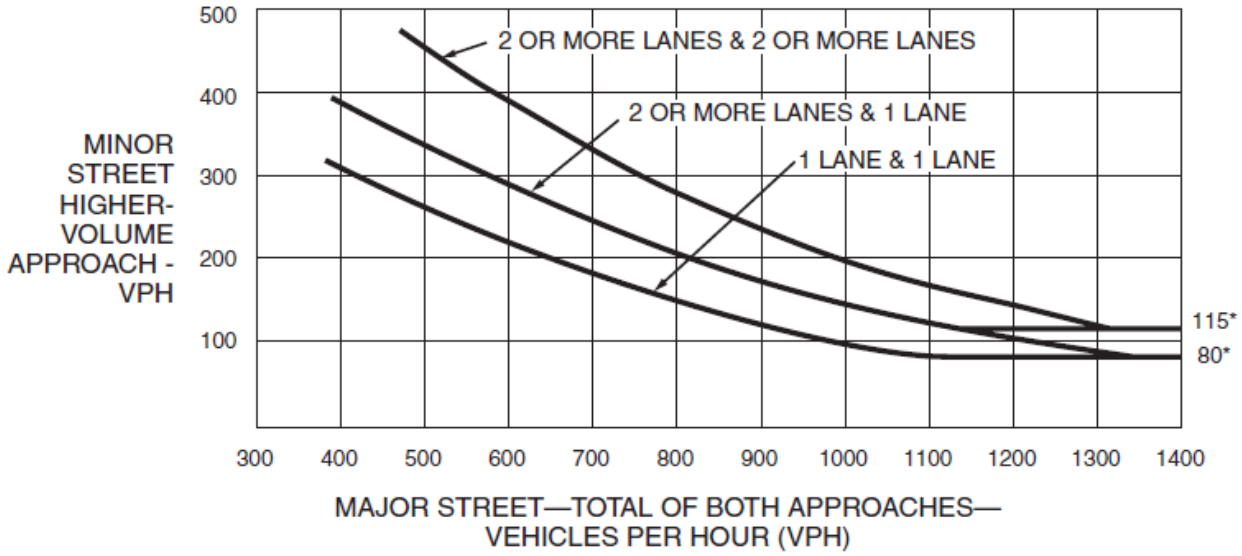
[b] Used for combination of Conditions A and B after adequate trial of other remedial measures

[c] May be used when the major-street speed exceeds 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 40 mph or in an isolated community with a population of less than 10,000

Warrant 2, Four-Hour Vehicular Volume

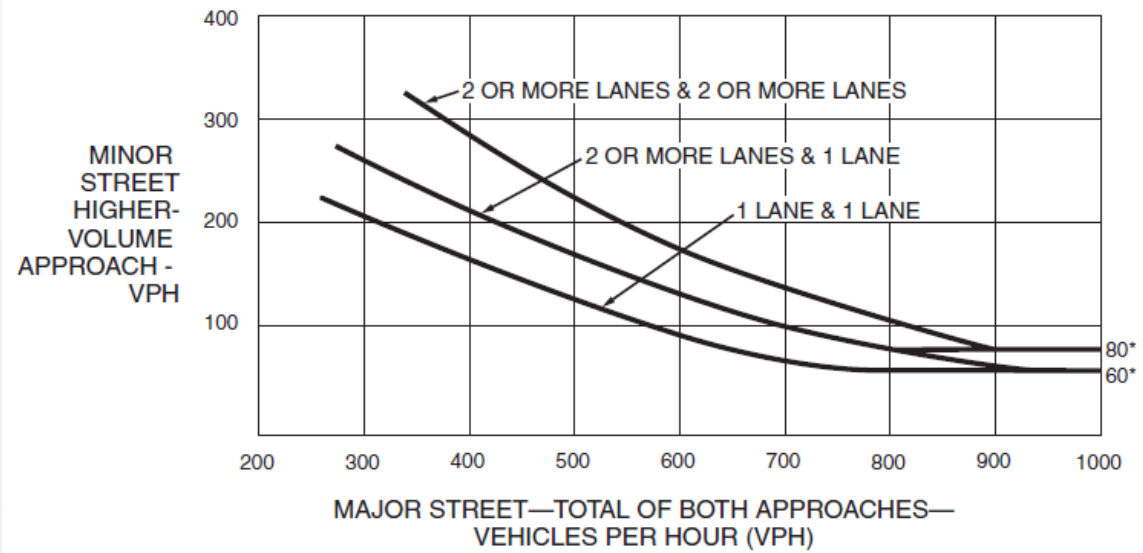
Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



*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-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)

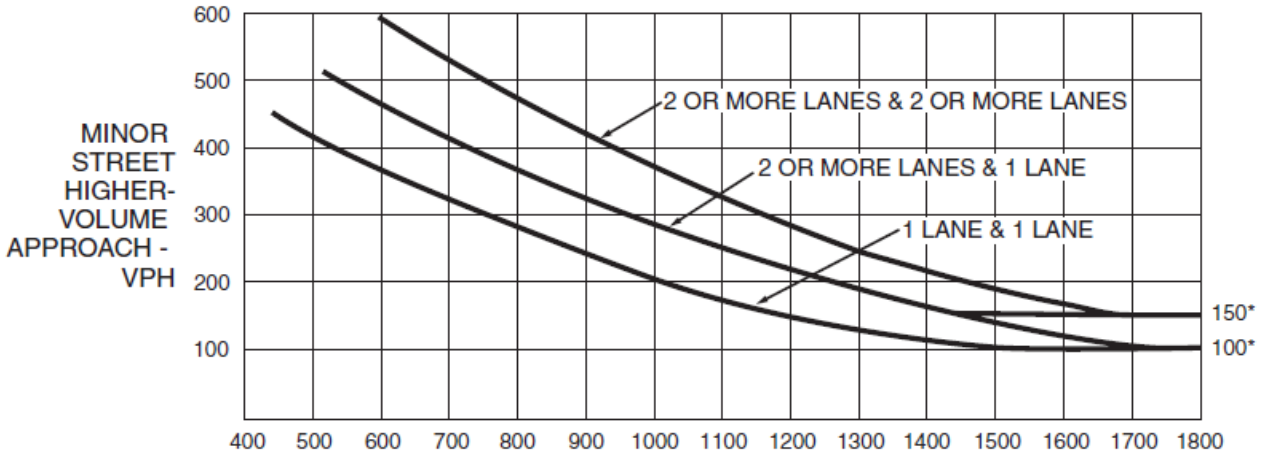
(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



*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.

Warrant 3, Peak Hour

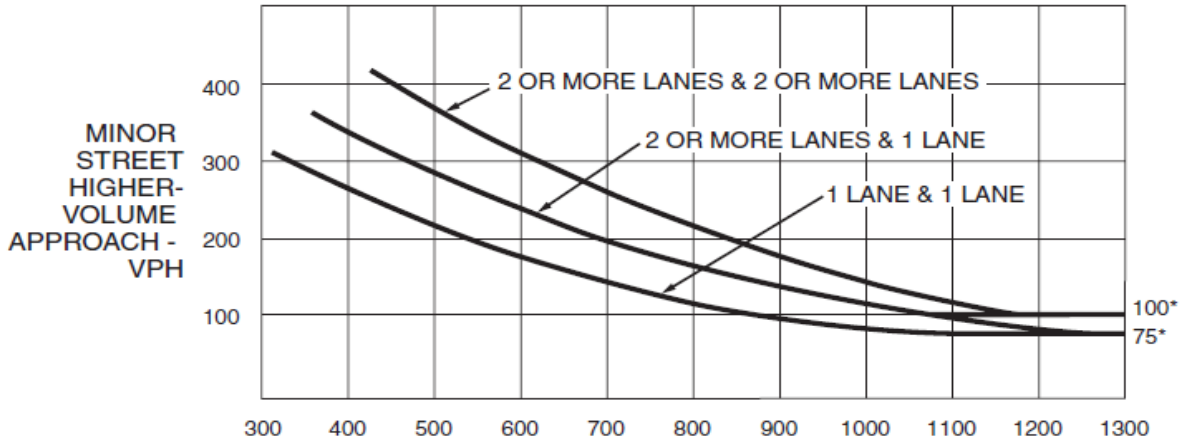
Figure 4C-3. Warrant 3, Peak Hour



*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.

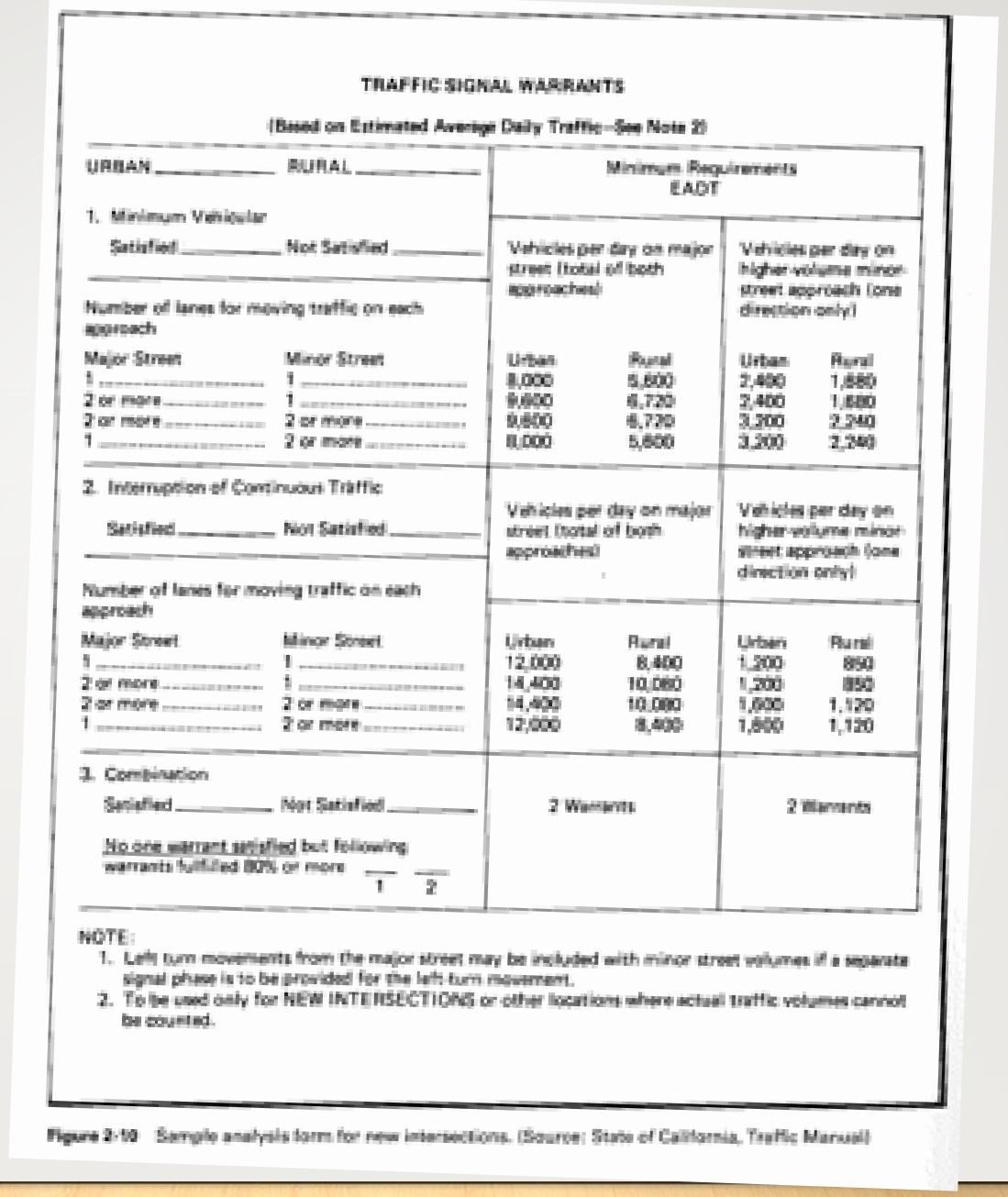
Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



*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.

ITE ADT Signal Warrant



TRAFFIC SIGNAL WARRANTS

(Based on Estimated Average Daily Traffic—See Note 2)

URBAN _____ RURAL _____

	Minimum Requirements EADT			
1. Minimum Vehicular	Vehicles per day on major street (total of both approaches)		Vehicles per day on higher-volume minor-street approach (one direction only)	
Satisfied _____ Not Satisfied _____				
Number of lanes for moving traffic on each approach				
Major Street / Minor Street	Urban	Rural	Urban	Rural
1 / 1	8,000	5,600	2,400	1,680
2 or more / 1	9,600	6,720	2,400	1,680
2 or more / 2 or more	9,600	6,720	3,200	2,240
1 / 2 or more	8,000	5,600	3,200	2,240
2. Interruption of Continuous Traffic	Vehicles per day on major street (total of both approaches)		Vehicles per day on higher-volume minor-street approach (one direction only)	
Satisfied _____ Not Satisfied _____				
Number of lanes for moving traffic on each approach				
Major Street / Minor Street	Urban	Rural	Urban	Rural
1 / 1	12,000	8,400	1,200	850
2 or more / 1	14,400	10,080	1,200	850
2 or more / 2 or more	14,400	10,080	1,600	1,120
1 / 2 or more	12,000	8,400	1,600	1,120
3. Combination				
Satisfied _____ Not Satisfied _____	2 Warrants		2 Warrants	
No one warrant satisfied but following warrants fulfilled 80% or more ___ (1) ___ (2)				

NOTE:
1. Left turn movements from the major street may be included with minor street volumes if a separate signal phase is to be provided for the left-turn movement.
2. To be used only for NEW INTERSECTIONS or other locations where actual traffic volumes cannot be counted.

Figure 2-10 Sample analysis form for new intersections. (Source: State of California, Traffic Manual)

Pagone's Theorem

Figure 1. Pagones Theorem* provided by IDOT District 1—used with a 12-hour manual traffic count.[26]

First, determine which lane configuration represents the leg that is being studied. Then, based on the movements for each hour, find the percent reduction for each hour with Pagones Theorem.

Pagones Theorem

Situation	Approach configuration	Condition	Reduction of right turns
1	Shared Left/ Through/Right	$R > 0.7A$ $0.7A \geq R > 0.35A$ $R \leq 0.35A$	Reduce R by 60 percent Reduce R by 40 percent Reduce R by 20 percent
2	Exclusive Left, Shared Through/ Right	$R > 3T$ $3T \geq R > T/3$ $R \leq T/3$	Reduce R by 60 percent Reduce R by 40 percent Reduce R by 20 percent
3	Any configuration with an exclusive right turn lane (usually ≥ 600 feet long)		Reduce R by 75 percent in all cases
4	Shared Left/Through and Shared Through/Right	$R > (T + L)$ $L > (T + R)$ $L = T = R$ (±10 vehicles) $L = T > 3R$ $R = T > 3L$ All other cases	Reduce R by 65 percent Use Situation 2 Reduce R by 40 percent Reduce R by 20 percent Reduce R by 50 percent Reduce R by 30 percent
5	Exclusive Left, Exclusive Through and Shared Through/Right	$R > T$ $T \geq R > T/2$ $T/2 \geq R > T/4$ $R \leq T/4$	Reduce R by 75 percent Reduce R by 50 percent Reduce R by 30 percent Reduce R by 15 percent

Where: L = number of left turning vehicles in approach;
T = number of through vehicles in approach;
R = number of right turning vehicles in approach; and
$A = (L + T + R)$.

Crash Modification Factors

14.4.2.6. Convert Stop Control to Signal Control

Prior to installing a traffic signal, an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location is typically performed to determine whether installing a traffic signal is warranted at a particular location as outlined in the MUTCD. The satisfaction of a traffic signal warrant or warrants does not in itself require installing a traffic signal.

Urban and rural minor-road stop-controlled intersections

Table 14-7 summarizes the CMFs related to converting a stop-controlled intersection to a signalized intersection. The CMF presented for urban intersections applies only to intersections with a major road speed limit at least 40 mph.

The base condition for the CMFs summarized in Table 14-7 (i.e., the condition in which the CMF = 1.00) is a minor-road, stop-controlled intersection in an urban or rural area.

Table 14-7. Potential Crash Effects of Converting from Stop Control to Signal Control (8,15)

Treatment	Setting (Intersection Type)	Traffic Volume AADT (veh/day)	Crash Type (Severity)	CMF	Std. Error
Install a traffic signal	Urban (major road speed limit at least 40 mph; four leg (8))	Unspecified	All types (All severities)	**0.95***	**0.09**
			Right-angle (All severities)	**0.33**	**0.06**
			Rear-end (All severities)	*2.43*	*0.4*
	Rural (three leg and four leg (15))	Major road 3,261 to 29,926; Minor road 101 to 10,300	All types (All severities)	**0.56**	**0.03**
			Right-angle (All severities)	**0.23**	**0.02**
			Left-turn (All severities)	**0.40**	**0.06**
			Rear-end (All severities)	*1.58*	*0.2*

Base Condition: Minor-road, stop-controlled intersection.

NOTE: **Bold** text is used for the most reliable CMFs. These CMFs have a standard error of 0.1 or less.
Italic text is used for less reliable CMFs. These CMFs have standard errors 0.2 or higher.
* Observed variability suggests that this treatment could result in an increase, decrease, or no change in crashes. See Part D— Introduction and Applications Guidance.

Source: 2010 Highway Safety Manual by AASHTO

Other Traffic Control

The need for other traffic control devices such as STOP and YIELD signing, markings, and intersection channelization shall be indicated in the report with appropriate reference to the MUTCD, HCM, WVDOH Design Directives, WVDOH Standard Details (Vol. 2), and/or AASHTO Green Book.

The traffic control scheme for internal intersections may need to be designed in a manner that allows inbound traffic to have the right of way.

No internal intersections, driveways, or parking aisles should be shown to be within 100 feet of the state highway.

Typical Organization of a TIS

- Introduction and Summary
- Background Information
- Analysis of Existing Conditions
- Analysis of Future Conditions without Development
- Trip Generation, Site traffic distribution and assignment
- Analysis of Future Conditions with Development
- Recommendations and Conclusions
- Appendices – Scope Notes, Photos, Data Collection, Analyses, Calculations, etc.

Submission/Review Process

Once developer/consultant is ready to submit a TIS, we request digital copies be submitted to the WVDOH Commissioner's Office of Economic Development. In addition to copies submitted to DOH, copies shall also be provided to any applicable Municipality, County Commission/Council, or MPO.

While the DOH is the approval authority, any comments received from above entities shall be addressed appropriately.

Questions?????????????

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