CHAPTER 3

NEED FOR TRAFFIC SIGNALS

3.0 Highway Traffic Signals – The MUTCD defines a "highway traffic signal" a power-operated traffic control device by which traffic is warned or directed to take some specific action. These devices do not include power-operated signs, illuminated pavement markers, barricade warning lights, or steady-burning electric lamps.

The term "traffic signal" has been associated with an intersection stop-and-go signal. However, "traffic signals" can apply to other types of power operated devices.

Listed below are the general types of traffic signals that are commonly used today:

A. Traffic Control Signals (Traffic Signals) – any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed. *This is what is normally referred to as a" traffic signal"*. Chapter 4 goes into detail on traffic control signals.

- **Pedestrian Signals –** a part of a traffic control signal to direct pedestrians when to cross a street.

B. Other Highway Traffic Signals (See Chapter 5):

- **Emergency Vehicle Traffic Control Signals –** a special traffic control signal that assigns the right-of-way to an authorized emergency vehicle.
- **Lane-Use Control Signals –** a signal face displaying signal indications to permit or prohibit the use of specific lanes of a roadway or to indicate the impending prohibition of such use.
- **Ramp Control Signal –** a highway traffic signal installed to control the flow of traffic onto a freeway at an entrance ramp or at a freeway-to-freeway ramp connection.
- **Flashing Beacons –** a highway traffic signal with one or more signal sections that operates in a flashing mode.

In this Manual, the term "traffic signals" will assume to apply to intersection stop-and-go signals unless otherwise noted.

3.1 Cooperation with Local Agencies – The Tennessee Department of Transportation (TDOT) does not typically own, operate or maintain traffic signal devices or street lighting installed under Departmental projects or located along state highways. Ownership, along with responsibility for operation and maintenance, reverts to the local governing agency executing either the Right-of-Way agreement or other funding contracts as provided by the Department.

It is TDOT's goal to provide a safe, reliable and economically sound traffic control or street lighting installation that is best suited to the maintenance capabilities of the local agency. In this regard and in limited cases, TDOT has prepared Special Provisions for inclusion in contract documents that address the specific requirements of several local government agencies. TDOT also provides special notes and details on certain projects to conform to other agency practices. However, the specification of proprietary items will not be allowed except in special pre-approved cases.

3.1.1 Authorization of Installation of Traffic Signals:

A. Authorization of Installation of Signals on TDOT Projects (state or local routes): It shall be the responsibility of the Civil Engineering Manager 1 in charge of the Traffic Design Section, a Regional Traffic Engineer, and/or the State Traffic Engineer to review, comment and/or approve the installation or upgrade of any traffic signals installed as part of a TDOT managed project.

Recommendations for new signal installations as part of a Final Scoping Report (FSR), Advance Planning Report (APR) or Safety Project report shall be reviewed and approved by the Traffic Design Office before the final report is issued to avoid problems in the Design phase of the project.

Proposed signal operation should safely, economically and efficiently accommodate current and near future traffic and safety needs. Although some local governmental agencies may request certain aesthetic features, enhancement of signal systems with materials or equipment that does not meet basic operational needs should generally be avoided unless the local agency is willing to cover the additional costs with local funds.

Before installations of traffic control devices are approved, an engineering study shall be performed and sealed by a licensed Engineer and approved, in writing, by appropriate TDOT officials as stated above. As required by the Manual on Uniform Traffic Control Devices (MUTCD), an engineering study shall be performed and should indicate "that installing a traffic control signal will improve the overall safety and/or operation of the intersection."[1] If not, a traffic signal should neither be put into operation nor continued in operation.

B. Authorization of Installation of Signals on Non-TDOT Projects (on state routes): All locally initiated signal design projects shall follow procedures and conform to guidelines given in this Manual.

C. Authorization of Installation of Signals on Non-TDOT Projects: (non-state routes): For locally initiated signal designs affecting the

[1] MUTCD, FHWA, 2003, p. 4C-1

intersection of two or more local routes, procedures and guidelines in this Manual are recommended as they represent current best practices.

3.1.2 Environmental Requirements – Basic signal installation projects usually require little in the way of environmental permits due to the minimal impact of locating poles, pull boxes, and conduit. However, larger projects involving installation of turn lanes or widening of the road may require various permits.

Permit needs are assessed and applications are processed and acquired by TDOT's Environmental Planning Division. The Environmental Planning Division may require some special maps, forms, and plan sheets as prepared by the design engineer.

Hydrological permits may include:

A. Tennessee Department of Environment and Conservation (TDEC)

- Notice of Intent (NOI)
- Aquatic Resource Alteration Permit (ARAP)
- Class V Injection Well Permit

B. Corps of Engineers: Section 404 of the Clean Water Act requires permit applications for any stream, spring, wetland, or sinkhole impact or total project impact of ½ acre or more.

C. TVA: Section 26a is required when any project impacts any water resource in the Tennessee River Valley or on TVA lands. If the impact is low, TVA may issue a letter of no objection.

D. Tennessee Wildlife Resources Agency (TWRA): Any impact on the Reelfoot Lake Basin will require a TWRA permit.

The design engineer shall consult with the Environmental Planning Division for the latest requirements and guidelines for any environmental permits.

3.1.3 Erosion Control – Most simple traffic signal projects require minimal erosion control as the impact is usually limited to pole foundations and trenching for conduit. A short list of items (hay bales, etc.) and standard drawings is all that is usually required. No separate plan is required.

On larger projects, with grading and drainage, an erosion control plan will be required. Any project involving grading and drainage should also include a drainage map.

3.2 Justification for Traffic Signal Control – Generally, the installation of a traffic control signal is considered only after all of the following conditions are met:[2]

- One or more of the MUTCD traffic signal warrants are met.
- An engineering study shows that traffic signalization will improve the overall traffic operations and/or safety of an intersection.
- The resulting traffic signal will not disrupt the progressive traffic flow from adjacent traffic signals.

The MUTCD cautions that "the satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal."[3]

3.2.1 Traffic Signal Study Advance Engineering Data – The following engineering data should be included in a traffic signal study.[4]

A. Traffic Counts – Traffic counts should be made on a typical weekday for the location, which would normally be in the middle of the week (Tuesday thru Thursday). Additionally, if the location is affected by school traffic, then the count should be made when school is in session. Counts should be avoided on holidays, and during special events or inclement weather. Counts should include cyclists.

- **Machine Traffic Counts –** Twenty-four (24) hour directional machine counts should be conducted on each approach counting all vehicles entering the intersection.
- **Manual Traffic Counts –** Manual traffic counts should be conducted on each approach of the intersection showing all vehicular movements during each 15-minute interval for a minimum of 2 hours in the AM, midday, and PM peak periods. In any case, these hours should include the periods of greatest traffic volumes as revealed by the previously conducted machine traffic counts.
- **Pedestrian Traffic Counts –** If pedestrians are a concern, pedestrian volume counts should be conducted on each crosswalk for the same periods as the manual traffic counts and during the periods of peak pedestrian volumes. The presence of nearby facilities that could generate young, elderly, or disabled pedestrian traffic should be noted. The count data should be submitted in a format that shows hourly pedestrian volumes by approach.

[2] Traffic Engineering Handbook. 1999. p.460
[3] MUTCD, FHWA, 2003, p. 4C-1
[4] Ibid p. 4C-2.

B. Speed Data – a speed study showing the 85th percentile speeds on the approaches to the intersection.

C. Condition Diagram – a diagram of the intersection showing its geometry, channelization, pavement markings, signs (traffic, business marquees, and billboards) driveways, utility poles, parking conditions, transit stops, sidewalks and handicap ramps, vegetation (if over 3' in height), adjacent land use, nearby railroad crossings and the distance to the nearest traffic signal (if less than 1 mile). See Figure 3.1.

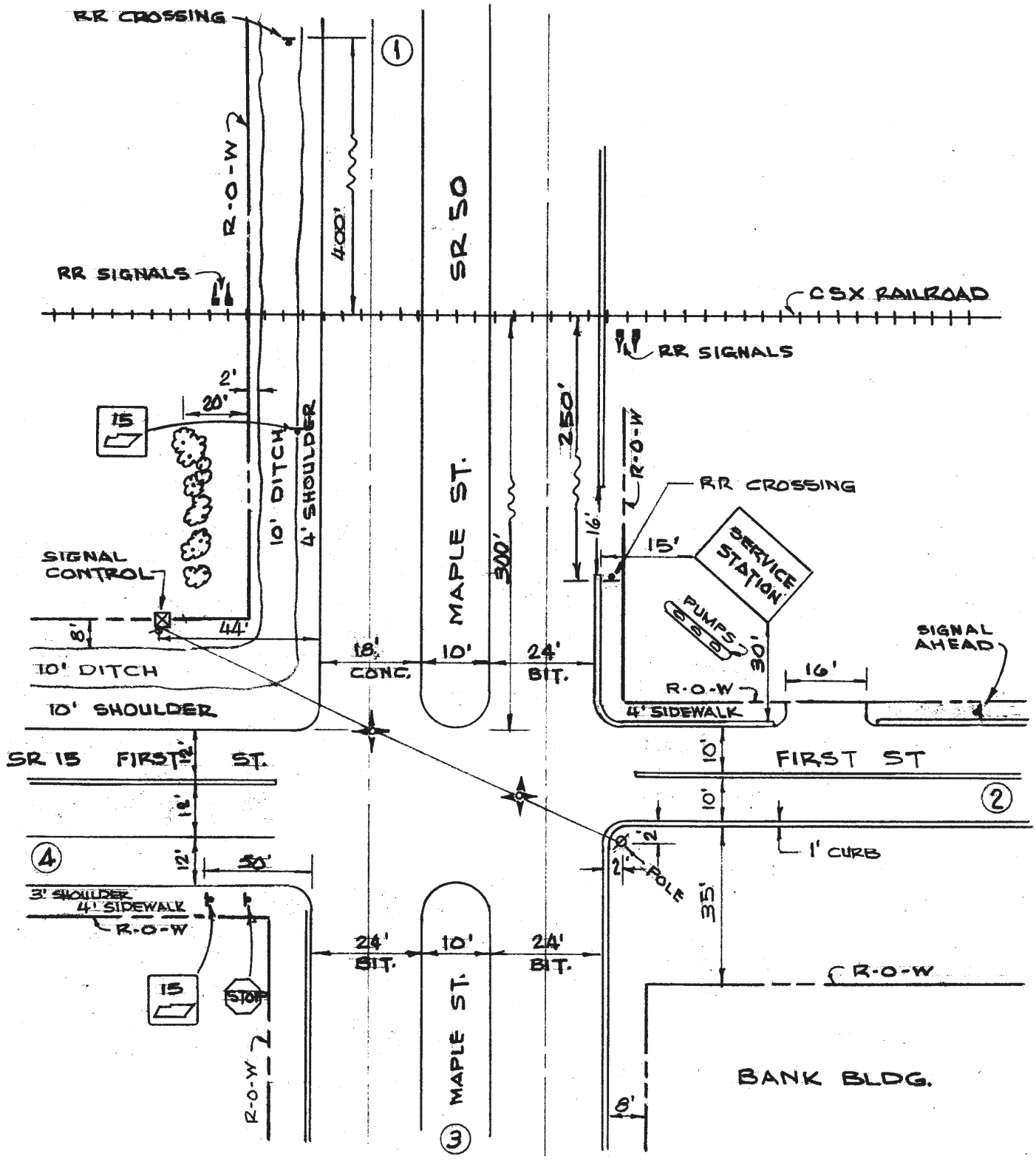
D. Collision Diagram – a diagram or listing showing the crash record for the intersection covering the most recent 12 months (as a minimum) for which records are available. Each crash symbol or record should show the crash type, the direction of travel of the vehicles, the severity (injuries/fatalities), time of day, date, pavement condition, weather, and lighting conditions. See Figure 3.2.

3.2.2 Traffic Signal Warrants

A. Signal Warrants – Traffic signal warrants define minimum threshold levels for a set of objective traffic and pedestrian operational conditions. If met, they become part of a total engineering study needed to justify signalization.[5] The MUTCD identifies eight traffic signal warrants as follows:

- Warrant 1 – Eight Hours 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

[5] Traffic Engineering Handbook. 1999. p. 460



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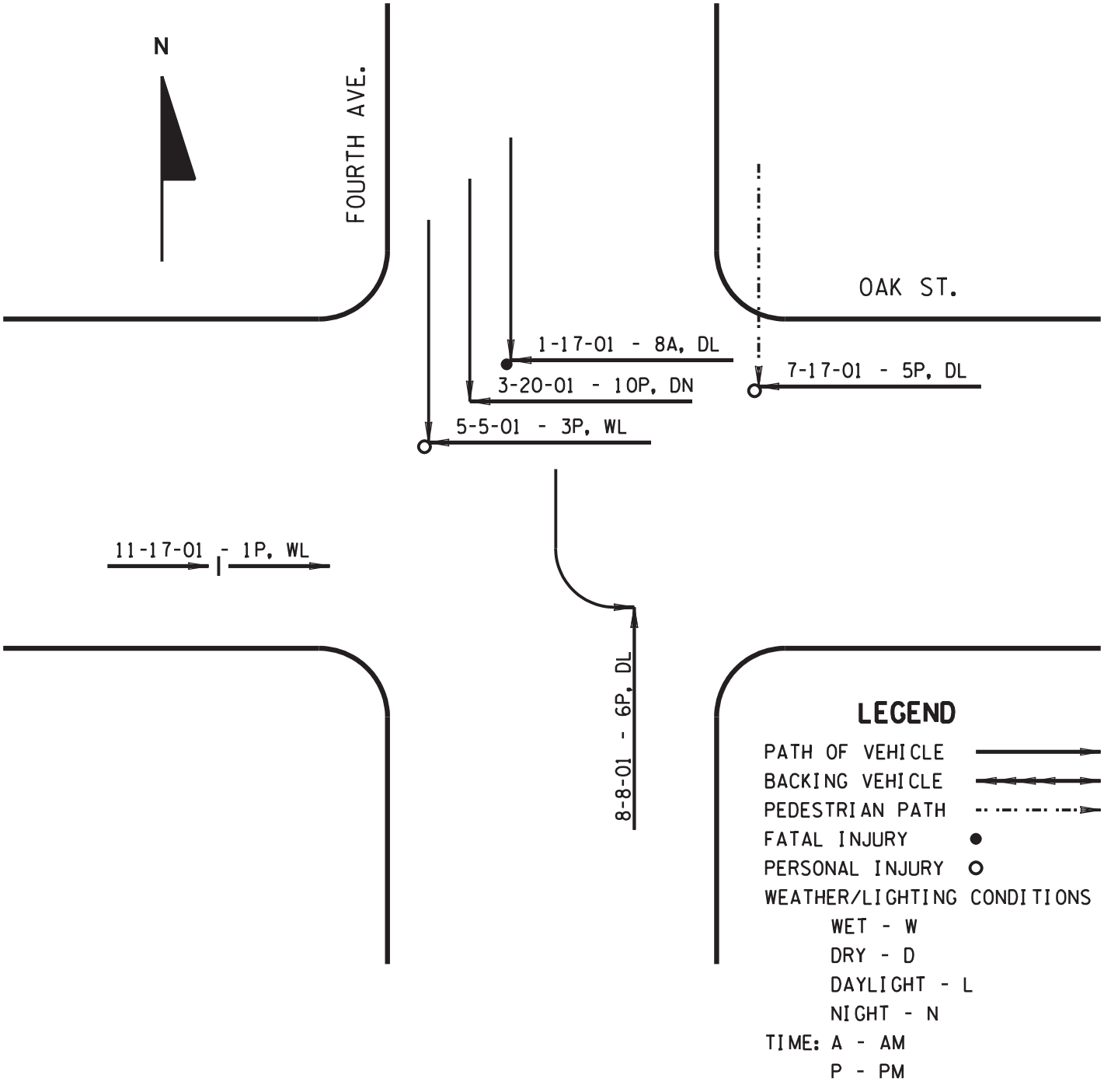
Condition Diagram

Figure 3.1



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Collision Diagram

Figure 3.2

3.2.3 Right Turn Volume Consideration[6] **–** Engineering judgment should be used as to whether all or part of right turning traffic volumes on the side street should be included when applying signal warrants. If right turns on an intersection approach are in a mixed lane containing through and right turning traffic, they should be included in the analysis. However, the percent of right turning traffic and its conflict with major street traffic must be considered. If the right turns are in their own lane and channelized away from the intersection, they should probably be excluded from the analysis. Engineering judgment should be applied in all cases.

- **Approach Lane Consideration –** Where there are separate turn lanes present on a single lane intersection approach, the question arises as to whether these lanes should be counted as an approach lane for warrant application. The following guidelines are provided:

- **Left Turn Lane –** If a separate left turn lane is present on an approach, it may be considered an approach lane if it carries approximately half the approach traffic volumes and it has sufficient storage capacity to store the left turning traffic.[7] Engineering judgment should be used.

- **Right Turn Lane –** If a separate right turn lane is present on an approach, it may be considered an approach lane if it has a significant volume of traffic, has sufficient storage capacity to store right turning traffic, and is not channelized away from the intersection. However, if right turns have been eliminated from the approach volumes for warrant analysis, then any separate right turn lane present should not be included in the number of approach lanes. If no separate right-turn lane exists, right-turning traffic should be included in analysis of the warrant. If a separate right-turn lane exists and delays to right-turning vehicles are significant, a capacity analysis may be conducted to determine the impact of the right-turn volume on operation. Engineering judgment should be used.

[6] Ibid p.461
[7] MUTCD, FHWA, 2003, p. 4C-1

3.2.4 TDOT Signal Justification Guidelines

A. Application of Signal Warrants – In investigation of warrants toward signal justification, Warrant 1 (Eight Hour Vehicular Volume) or Warrant 7 (Crash Experience) will be the primary warrants considered for signal approval. If geometric improvements are proposed as part of the project, Warrant 7 may not be applicable if the proposed improvements are expected to reduce crashes. Signal justification based on other warrants will be considered only when extenuating circumstances exist.

B. Access to Adjacent Signals – Before new signalization is justified, consideration is to be given as to whether the side street or driveway traffic being studied has access to an existing traffic signal. If access to an adjacent signal exists, a new signal might be denied based on the access to an existing signal. Such traffic diversions may not be practical, however, if the diversion takes place through residential areas or on substandard streets. Engineering judgment must be exercised.

C. Estimating Future Conditions – At a location where a signal study is requested, but the future development is not yet in place, the hourly generated traffic volumes must be estimated based on the portion of development to be completed at time of signal installation. The following procedures will be used:

- **Similar Developments –** Where similar developments (in both type and size) exist in the same or similar size community, actual hourly generated traffic volumes can be measured and applied to the new site. Signal warrants can then be applied using these volumes.

- **Estimating Procedure –** Where similar developments do not exist, peak hour trip generated volumes can be estimated using the Trip Generation Manual published by the Institute of Transportation Engineers.

Whether calculated based on an existing similar development or estimated using data from the Trip Generation Manual, all assumptions and trip estimates must be approved by the TDOT Mapping and Statistics Office.

D. Signal Operation – A capacity analysis may be required to determine the impacts of signalization at an intersection. If within an existing coordinated system or if progression of the corridor should be considered, a progression analysis should also be completed.

3.3 Removal of Traffic Signals – Although the original installation of a traffic signal may be based on the satisfaction of one or more warrants and other factors, changes in traffic flow over time may reduce the effectiveness of traffic signal control. When this occurs, it may be appropriate to remove a traffic signal. The MUTCD does not contain specific warrants for the removal of traffic signals[8].

A general rule of thumb is that if a traffic signal does not meet 60% of the values of any of the warrants, the signal should be analyzed for removal. Even though traffic volumes may have decreased, the removal of a traffic signal requires engineering judgement because removal of the traffic signal may or may not be appropriate.

If the engineering study indicates that the traffic control signal is no longer justified, removal should be accomplished using the following steps:

1. Determine the appropriate traffic control to be used after removal of the signal.

2. Remove any sight-distance restrictions as necessary.

3. Flash or cover the signal heads for a minimum of 90 days, and install the appropriate stop control or other traffic control devices.

4. Remove the signal if the engineering data collected during the removal study period confirms that the signal is no longer needed. Instead of total removal of the traffic control signal, the poles and cables may remain in place after removal of the signal heads for continued analysis.

5. Remove traffic signal equipment if the continued analysis finds the intersection

[8] MUTCD, FHWA, 2003, p. 4B-1.