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Traffic impacts and their potential need for mitigation are important for any community to consider when a significant development is proposed. Public policy makers, citizens and developers all have a stake in understanding and responding to additional demands on the transportation system. All share the common interest of a safe and efficient transportation network. A properly developed traffic impact analysis can provide the factual basis for good decision-making and facilitate the timely implementation of effective mitigation measures.

A traffic impact analysis (TIA) is a specialized engineering study that determines the potential traffic impacts of a proposed traffic generator. A TIA should answer the following fundamental questions:

- What are the existing traffic conditions, the expected future traffic conditions without the development, and the expected future traffic conditions with the development in place for all roadway users?
- Can the existing and planned multimodal transportation system accommodate the additional traffic generated by the planned development?
- Are there additional transportation needs, beyond those already programmed or included in the local transportation plan, in order to maintain a desirable level of service (LOS)?
- What are the recommended roadway improvements that may be necessary to accommodate the expected development traffic?

The TIA preparer shall complete the TIA prior to finalizing the development design, while there is still flexibility in the development’s site design. Prior to obtaining any permits, the developer shall receive WisDOT’s acceptance of the completed TIA.

The purpose of this document is to establish uniform guidelines for conducting TIA’s for proposed new developments, the expansion of existing developments and requests for new or modified access to the State Trunk Network (STN). The guidelines aim to ensure all studies contain the necessary information in a uniform format, providing the opportunity for an efficient review of the proposal’s effect on the state highway.

WisDOT is accountable for operating a safe and efficient state highway system. Proactive access management is vital in maintaining the overall safety and efficiency of this system. WisDOT manages access to the state highway system through statutes 84.09, 84.25 and 86.07 and Administrative Rules Trans. 231 and Trans. 233.

As part of the Wisconsin Department of Transportation’s Access Permitting Procedure or the Trans. 233 review process, the regional office may require a TIA for proposed access requests. Facilities Development Manual (FDM) procedure 7-35-10.2 states, “A TIA should be considered whenever traffic generated by the proposed development is expected to exceed 100 vehicles in the peak hour. Greater consideration should be given to requiring a TIA on an already congested or unsafe highway than on one with lower
traffic volumes and crash rates. Whenever WisDOT determines a TIA is necessary, the developer is required to provide it.”

Note that the acceptance of the TIA is not an approval of proposed recommendations outlined in the study, but an acknowledgment that the format of the TIA is acceptable for the department to review. Typically, the regional traffic contact will provide a summary of the department’s position and issues on the proposed recommendations outlined in the submitted TIA. The developer needs to address the region’s issues prior to moving forward with the permitting process.

TIA STUDY TIMEFRAME

If a development will generate between 100 and 500 driveway trips in the peak hour, WisDOT has the option to require an abbreviated TIA instead of a full TIA. An abbreviated TIA focuses only on the base year traffic conditions with and without the development, whereas a full TIA analyzes both base and horizon year traffic conditions with and without the development. A full TIA is generally more suitable for larger developments (greater than 500 peak hour vehicles), and requires involvement from the WisDOT forecasting team (the Southeast Region has their own forecasting unit, while all other regional offices must go through central office forecasting) for horizon year traffic projections. The regional traffic contact will send a letter that identifies the need for an abbreviated or full TIA, defines the parameters of the study and outlines the proposed study years.

INITIAL REVIEW

Prior to the submission of a full or abbreviated TIA, WisDOT may require preliminary traffic information for their use in developing the TIA parameters as part of the initial review process. Typically, WisDOT will inform the preparer of the need to complete an initial review during or shortly after preliminary development review meetings with WisDOT’s planning and operations staff. The initial review document shall, at a minimum, provide an overview of the proposed development plan, outline the existing transportation system and highlight existing ADT volumes and expected trip generation of the proposed development. For additional information on the initial review process, please contact the appropriate WisDOT regional TIA representative.

IMPLEMENTATION OF TIA-REQUIRED IMPROVEMENTS

Improvements that are required to mitigate traffic impacts caused by development are based on, but not limited to, the recommendations section of a TIA. In response to the findings of the TIA, WisDOT will send a letter, memorandum or email correspondence to identify the required development-driven improvements. These requirements are subject to WisDOT’s authority and jurisdiction over any given highway. The mechanism for requiring TIA-related improvements is generally the permitting process (e.g., work on highway right-of-way, access, utility, etc.) overseen by the regional maintenance or planning units. Cited improvements and the methods for implementing them will become a condition of the permit. All improvements shall comply with current FDM standards.
Design plan sets of required improvements based on a TIA should typically include:

- Project overview
- Typical sections
- Construction details
- Right-of-way plats
- Erosion control plans
- Pavement details
- Structural details
- Intersection layouts
- Storm sewer details
- Plan/profile views
- Traffic control designs (e.g., traffic signal plans)
- Lighting designs
- Signing & marking plans
- Work zone traffic control plans
- Standard detail drawings
- Standard sign plates
- Cross-sections
- Specifications and
- Project cost estimates

The TIA preparer shall make this information available in hardcopy and AutoCAD format (e.g., .dwg). Coordination and plan review meetings between the developer, developer’s agents, and the appropriate municipal and WisDOT staff are encouraged.

QUALIFICATIONS OF THE PREPARER

A transportation professional with training and experience in traffic engineering and transportation planning should prepare the TIA. The TIA shall be prepared by, or under the supervision of, a professional engineer (PE) who has a valid Wisconsin PE license/registration and experience in traffic engineering operations. The responsible PE shall include their signature, PE seal and the following statement of certification at the beginning of the TIA:
"I certify that this Traffic Impact Analysis has been prepared by me or under my immediate supervision and that I have experience and training in the field of traffic and transportation engineering."

(Signature)
John Q. Smith, P.E.
Wisconsin Registration #12345
Consulting Firm, Inc.

QUALIFICATIONS OF THE REVIEWER

One or more of WisDOT’s professional staff, along with staff from any other participating agency (regional planning agency, county, city, village or town), who collectively have training and experience in traffic-impact-study methodology, land use planning and traffic engineering, shall review the TIA including traffic safety and operations.

ETHICS AND OBJECTIVITY

Although TIA preparers and reviewers might have different objectives and perspectives, they should adhere to the established engineering and planning ethics (similar to the Canon of Engineering Ethics) and should conduct all analyses and reviews objectively and professionally.

ORGANIZATION/FORMAT

The WisDOT Traffic Impact Analysis Guidelines highlight the information to be included within the TIA and the format for presenting the study findings in a manner consistent with the reviewer’s expectation. The TIA report organizational structure shall follow the format outlined in this guideline. All TIA’s are to include:

- Formatting that matches the order, labeling, and numbering system presented in the attached outline
- Pages that are dated with the current document submittal date
- Table of contents
- Tabs or dividers to assist in identifying each chapter and appendices of the TIA

The TIA preparer shall submit at least one ring-bound hard copy of the full TIA report and analysis output as well as one copy of the electronic files used in the study (compact disc or other media storage). The regional office may request additional hard copies of the TIA report, thus the TIA preparer should coordinate with the regional office to verify the number of hard copies to submit. Electronic files shall include, but are not limited to, a portable document format (PDF) of the report and appendices along with the capacity analysis files in their software file format (e.g., .syn).

TIA SCOPING CHECKLIST

The following checklist may serve as a guide for TIA preparers and reviewers to aid them in appropriately determining the scope of a development-related traffic study. This list is not all-inclusive and thus may not cover all aspects that a specific TIA may need to
address. Therefore, the TIA preparer and reviewer should carefully consider the issues that may be unique to a specific study and should reasonably adjust the scope as necessary.

- Determine study objectives and purpose
- Verify development land use and, if specific land use is unknown, make reasonable development assumptions
- Identify off-site development(s)
- If available, review site plan
- Verify development staging
- Determine build-out, interim, and study horizon year(s)
- Based on land use trip generation, identify peak periods for analysis
- Determine area of significant traffic impact and identify specific study area intersections
- Determine appropriate site access
- Determine target LOS
- Identify any alternative analyses that need to be considered within the study such as those needed to address various geometric conditions/configurations
- Identify planning studies or programmed roadway improvement projects that may require coordination
- Check to see if recent field data is available for: intersection turning movement counts, spot-speeds or specialized studies (saturation flow, delay, etc.) and make arrangements to collect additional field data as necessary
- Consider the impacts to and needs of other transportation modes (e.g., pedestrian, bicycle, public transit, etc.) within the study area
- Determine the appropriate source for trip generation information - typically the most current version of the Institute of Transportation Engineers (ITE) Trip Generation Manual
- Estimate pass-by and linked-trips
- Determine development trip distribution
- Arrange for a WisDOT traffic forecast based on the analysis years
- Identify traffic analysis software that will be used to evaluate each alternative
- Determine the specific analysis requirements including, but not limited to, the analysis software inputs such as peak hour factor (PHF), saturation flow rate, right-turn-on red (RTOR) volumes, pedestrian/truck volume considerations, etc.
- Identify any special considerations that will need to be addressed within the study
Prior to preparing a TIA, please contact the WisDOT regional office and request an initial review of your proposed development. The following map provides the contact information for each regional office.

**Superior Office**
1701 N. 4th St.
Superior, WI 54880
(715) 392-7925
FAX (715) 392-7863
nwr.dtsd@dot.wi.gov

**La Crosse Office**
3550 Mormon Coulee Rd.
La Crosse, WI 54601
(608) 785-9022
FAX (608) 785-9969
swr.dtsd@dot.wi.gov

**Green Bay Office**
944 Vanderperren Way
Green Bay, WI 54304
(920) 492-5643
FAX (920) 492-5640
ner.dtsd@dot.wi.gov

**Eau Claire Office**
718 W. Clairemont Ave.
Eau Claire, WI 54701
(715) 836-2891
FAX (715) 836-2807
nwr.dtsd@dot.wi.gov

**Rhinelander Office**
510 N. Hanson Lake Rd.
Rhinelander, WI 54501
(715) 365-3490
FAX (715) 365-5780
ncr.dtsd@dot.wi.gov

**Wisconsin Rapids Office**
1681 2nd Ave South
Wisconsin Rapids, WI 54495
(715) 421-8302
FAX (715) 423-0334
ncr.dtsd@dot.wi.gov

**Madison Office**
2101 Wright St.
Madison, WI 53704
(608) 246-3800
FAX (608) 246-7996
swr.dtsd@dot.wi.gov

**Waukesha Office**
141 NW Barstow St.
Waukesha, WI 53187
(262) 548-5902
FAX (262) 548-5662
ser.dtsd@dot.wi.gov
TRAFFIC IMPACT ANALYSIS OUTLINE

Chapter 1  Introduction and Executive Summary
A. Purpose of Report and Study Objectives
B. Executive Summary
C. Chapter 1 Exhibits

Chapter 2  Proposed Development
A. On-Site Development
   1. Development Descriptions and Site Location
   2. Land Use and Intensity
   3. Site Plan
   4. Development Phasing and Timing
B. Study Area
   1. Influence Area
   2. Area of Significant Traffic Impact
C. Off-Site Land Use and Development
D. Site Accessibility
E. Chapter 2 Exhibits

Chapter 3  Analysis of Existing Conditions
A. Physical Characteristics
B. Traffic Volumes
C. Capacity/Level of Service
D. Sources of Data
E. Chapter 3 Exhibits

Chapter 4  Projected Traffic
A. Background Traffic Forecasting
B. On-Site and Off-Site Development Traffic Forecasting
   1. Trip Generation
   2. Mode Split
   4. Trip Distribution
   5. Trip Assignment
C. Build and Total Traffic
D. Chapter 4 Exhibits

Chapter 5  Traffic and Improvement Analysis
A. Site Access
B. Capacity/Level of Service Analysis
C. Queuing Analysis
D. Multimodal Considerations
E. Speed Considerations/Sight Distance
F. Traffic Control Needs
G. Traffic Signal Warrant Analysis

Chapter 6  Conclusions and Recommendations
A. Conclusions
B. Recommendations
C. Chapter 6 Exhibits

Chapter 7  Design Considerations

Glossary
# LIST OF REQUIRED EXHIBITS

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**Chapter 6**

**Intersection Conceptual Drawing**
- Alternative/Location 1 Conceptual Improvements ...................... 6-1A
- Alternative/Location 2 Conceptual Improvements ...................... 6-1B

**Notes:**
- Multiple interim years or alternatives **shall** be labeled sequentially (e.g., Exhibit 4-5E, Exhibit 6-1C)
- Exclude exhibits not required for the specific TIA, but maintain required numbering as shown above. It is not necessary to include a page in the TIA report indicating the exhibit is not attached or needed.
APPENDICES

Appendix A: Traffic

• Summary of PHF and Percent Heavy Vehicles
• Existing Traffic Counts
• Future Traffic Projections
• Intersection sight distances at intersection locations immediately adjacent to the proposed development
• Existing signal phasing and timing
• Roadway horizontal and vertical alignment (as-built plans)

Appendix B: Existing Transportation System with Background Traffic Operational Analysis

• Capacity Analysis Inputs/Outputs

Appendix C: Existing Transportation System with Build Traffic Operational Analysis

• Capacity Analysis Inputs/Outputs

Appendix D: Existing Transportation System with Total Traffic Operational Analysis

• Capacity Analysis Inputs/Outputs

Appendix E: Transportation System Improvements with Background Traffic Operational Analysis

• Capacity Analysis Input/Outputs for each Alternative (Label I, II, III, Etc.)

Appendix F: Transportation System Improvements with Build Traffic Operational Analysis

• Capacity Analysis Input/Outputs for each Alternative (Label I, II, III, Etc.)

Appendix G: Transportation System Improvements with Total Traffic Operational Analysis

• Capacity Analysis Input/Outputs for each Alternative (Label I, II, III, Etc.)

Appendix H: Justification for a Regulatory Speed Limit Change

• Speed Study

Appendix I: Warrant Analysis for Intersection Traffic Control

• Signal warrants
• Warrants for other types of control

Appendix J: Intersection Control Evaluation (ICE)

• Phase I: Scoping ICE for each Intersection
CHAPTER 1  INTRODUCTION & EXECUTIVE SUMMARY

The TIA preparer should briefly describe the development and provide a summary of its potential traffic impacts at the beginning of the TIA report. Chapter 1 of the TIA shall include the following exhibits, as applicable to the proposed development:

Exhibit 1-1................................................................................................................ Site Plan
Exhibit 1-2............................................Base Year Background Traffic Recommended Improvements
Exhibit 1-3............................................Base Year Build Traffic Recommended Improvements
Exhibit 1-4............................................Base Year Total Traffic Recommended Improvements
Exhibit 1-5........................ Interim Year Background Traffic Recommended Improvements
Exhibit 1-6....................................... Interim Year Build Traffic Recommended Improvements
Exhibit 1-7....................................... Interim Year Total Traffic Recommended Improvements
Exhibit 1-8........................ Horizon Year Background Traffic Recommended Improvements
Exhibit 1-9............................... Horizon Year Build Traffic Recommended Improvements
Exhibit 1-10............................... Horizon Year Total Traffic Recommended Improvements

PART A — PURPOSE OF REPORT AND STUDY OBJECTIVES

The purpose of the report, highlighting who conducted the analysis and why, shall be clearly identified. Discussion of the study objectives, focusing on the specific issues addressed, is also helpful in establishing the background for review of the report.

PART B — EXECUTIVE SUMMARY

The TIA preparer shall include an Executive Summary at the beginning of the report to provide a short synopsis of the important findings and conclusions. The summary would normally be a maximum of five pages in length and should be understandable as a stand-alone document. It shall contain, at a minimum, the following information:

- Location of the study site with respect to the area roadway network
- Description of the proposed development including the types and sizes of all land uses, construction phasing (if applicable), and proposed access scheme
- Discussion of the principal findings of the analysis including existing traffic conditions, programmed transportation improvements (if applicable), amount of site-generated traffic, and projected background traffic volumes
- Summary of the study conclusions including future levels of service with and without the proposed development
- Identification of all mitigation measures recommended to achieve an acceptable LOS on the area transportation network, including a discussion of when they should be implemented
CHAPTER 2  PROPOSED DEVELOPMENT

Narratives and exhibits provide the reviewer with a complete description of the proposed development. Descriptions must explain the time frame and stages/phases for the development, location of the site, planned land use, and intensity of the development. If the development will not take place at once, the site plan shall illustrate the development-staging plan to highlight the location where each phase of the development will occur in relationship to the full project buildout.

The description of the proposed development shall include the following:

- On-site development
- Study area
- Off-site land use and development
- Site accessibility

PART A — ON-SITE DEVELOPMENT

The description of the proposed development shall include the following exhibits:

1. Development Description and Site Location

Identify the name of the proposed development and describe its general intended use. The report shall provide a legible map showing the study site in relation to the surrounding roadway network in. The site map and/or the accompanying text shall note the size of the site in acres and the amount of frontage available on all adjacent streets. Exhibit 2-1 is a sample of a site location map.

2. Land Use and Intensity

The project description should provide as much detail as possible, including the local zoning designation, for all proposed land uses for the site. If specific tenants are known (e.g., Wal-Mart, Walgreens, Menards) or if the developer expects to attract certain types of uses (e.g., branch bank, medical offices, fast-food restaurant, convenience store, gas station), these should be noted. Avoid the use of generalized land use categories (e.g., commercial/retail) whenever possible.

The size of each land use component within the development shall be given in terms of square feet of gross building area (for retail, office, and industrial uses), dwelling units (for residential components), or other unit appropriate for that particular land use type in accordance with the latest version of the ITE Trip Generation Manual.
Exhibit 2-1

Site Location Map
3. Proposed Site Plan

The TIA shall include a scaled drawing of the proposed development plan. A brief narrative shall also be included in the report to help identify key features on the drawing. The site plan shall clearly identify the following information:

- North Arrow
- Dimensions of the site
- Site boundaries and adjacent streets
- Location of existing driveways and/or street intersections in close proximity to the site (scalable or include dimensions)
- Location and design of all proposed driveways and/or street intersections in close proximity to the site (scalable or include dimensions)
- Existing and proposed rights-of-way on all adjacent streets
- Location, configuration and dimensions of the following, demonstrate compliance with applicable WisDOT and the American with Disabilities Act (ADA) standards as appropriate:
  - Travel lanes, shoulders and bike accommodations
  - Pedestrian accommodations (e.g., sidewalks, curb ramps, etc.)
  - Shared-use paths
- Location and dimensions of transit stops (if applicable) indicating transit facilities are accessible and compliant with applicable WisDOT and ADA standards (e.g., show bus boarding alighting area dimensions are at least five feet by eight feet)
- Location and size of all land uses within the project
- Building configurations (if known) and pedestrian access including sidewalks
- Parking layout, internal circulation, and location of bike racks
- Any deed restrictions or access control
- Medians
- Median Openings

*Exhibit 2-2* illustrates an example site plan that shows the driveways and the relationship of the driveways to the street system.
Exhibit 2-2 Site Plan
4. Development Phasing and Timing

The TIA **shall** identify the anticipated opening date for the proposed development. If the developer plans to build a large project over a period of five years or more, the TIA **shall** provide the expected phasing schedule. The phasing schedule **should** indicate the specific construction (land-use, size and type) to be undertaken and the projected completion date for each phase of development. The TIA **should** supplement the phasing schedule with a drawing of the site that highlights each of the various stages of development. The phasing schedule and development plan may help illustrate whether the entire project requires any improvement needs that exceed what is necessary during the initial stage(s) of development.

*Exhibit 2-3* is an illustration of a development phasing detail.

**PART B — STUDY AREA**

The purpose of this section is to identify those areas that the traffic generated by the proposed development could potentially affect. This section **should** also describe the area that may influence how traffic travels to/from the development site. Typically, this area depends upon the prevailing traffic conditions of the surrounding roadway network and the type, size, and location of the proposed development.

The study area **should** be determined based on the project’s influence area and its area of significant traffic impact.

1. **Influence Area**

   The proposed development’s influence area is the geographical area surrounding the site from which the project is likely to draw a high percentage of its trips. The influence area is typically the starting point for estimating the distribution of vehicle trips to/from the site. Describe the influence area for this project and identify the method used to establish it.

2. **Area of Significant Traffic Impact**

   The area of significant traffic impact is the geographical area that includes the facilities significantly impacted by the site traffic. The traffic generated by larger developments, as compared to smaller projects, is likely to affect traffic conditions over a wider area. Therefore, it is appropriate to require a bigger study area for the analysis of larger projects. WisDOT’s regional office will confirm the study area during the initial review process. The TIA preparer **should** use this section to describe the anticipated roadway system to include in the analyses.
Exhibit 2-3 Development Phasing
PART C — OFF-SITE LAND USE AND DEVELOPMENT

Understanding the existing and future developments within the study area is essential to evaluating the impacts of the new site, determining the appropriate access points and selecting improvements. The TIA report should provide the reader a full understanding of the area, to allow the reader to recognize the potential conflicts, impacts and opportunities for incorporating improvements as part of the proposed development.

This section should provide a brief description of current land uses and anticipated future development near the proposed site. Note any available information on planned projects that, due to their size and/or location, would have a significant impact on future travel conditions in the study area.

The local entities within the study area should be consulted to determine what other developments are being proposed for the area. Discuss the latest land use and short term (within 5 years) plans for the area with the local metropolitan planning organization (MPO), regional planning commission (RPC) and/or local government agency. The following link provides the contact information for all MPOs and RPCs within Wisconsin: [http://wisconsindot.gov/Documents/doing-bus/local-gov/plning-orgs/contacts.pdf](http://wisconsindot.gov/Documents/doing-bus/local-gov/plning-orgs/contacts.pdf). A local entity’s master plan for the area shall be shown, if complete.

Exhibit 2-4 illustrates a map of a study area showing existing and proposed land uses.

PART D — SITE ACCESSIBILITY

The purpose of this section is to present the existing and future multimodal transportation system in the area servicing the proposed development. The TIA should present this information in both a narrative form and as an illustration in the site location map and/or site plan.

This section of the report should provide a description of the existing transportation system with particular emphasis on the major travel routes to and from the site. The narrative should include such items as existing roadways, adjacent driveways, frontage roads/interconnections, private roads, sidewalks, bike accommodations, and transit routes and facilities within the study area. The TIA preparer shall identify the existing traffic control at each intersection (e.g., signalized, all-way stop, roundabout) and shall discuss any travel restrictions (e.g., one-way streets, left-turn prohibitions) that are present in the study area.

The TIA preparer shall consult with the local entities including the maintaining authorities and transit operators to identify if there are any potential roadway improvement projects within the study area. These projects might include, but are not limited to, construction of new roadways, widening or extension of existing facilities, or installation of new traffic signals. The TIA should provide the schedule for the completion date for such improvements.

This section of the TIA shall include a discussion of all modes of transportation that may service the development. Modes of transportation include, but are not limited to, motor vehicles, transit, carpools, vanpools, bicycles and pedestrians. In addition, the TIA should discuss alternative work hours, future transit service and other considerations that effect travel to/from the site as appropriate. For further information, see Chapter 4 – Part B.
CHAPTER 3  ANALYSIS OF EXISTING CONDITIONS

The analysis of existing conditions provides a base against which to measure the incremental traffic impacts of the proposed development. This chapter of the TIA **shall** address the following topics:

- Physical characteristics
- Traffic volumes
- Capacity/Level of Service
- Sources of data

PART A — PHYSICAL CHARACTERISTICS

This section **shall** provide detailed information regarding the physical characteristics of the existing transportation system for the study area. Indicate any currently planned roadway or traffic control changes (identify the agency initiating the improvement and state the year they plan to complete the improvement). Discuss this topic in narrative form. The narrative *should* also include a discussion of existing multimodal facilities including bicycle, pedestrian and transit infrastructure as appropriate. When applicable, include a discussion of transit service frequency (e.g., headways). Contact WisDOT regional multimodal staff with any questions.

The report **shall** provide a general discussion and a detailed exhibit highlighting the characteristics of the existing transportation system. This section of the TIA **shall** include the following exhibits:

Exhibit 3-1A  Existing Transportation System
Exhibit 3-1B  Planned Transportation System (if known project in study area)

Exhibit 3-1A and Exhibit 3-1B **shall** include the following items:

a. North Arrow
b. Major highways and streets (include roadway names)
c. Roadway system characteristics including:
   » Roadway geometry
     ▪ Indicate if roadways are divided or undivided
     ▪ Identify median openings
   » Intersection geometry (e.g., medians and islands, curb ramps)
   » Distances between major roadways and proposed site
   » Location of driveways within the immediate area
   » Lane configuration at each intersection to be analyzed (can be shown as arrows)
   » Location and type of traffic control devices (e.g., stop signs, traffic signals, etc.)
   » Posted speed limits
   » Pedestrian, bicycle, and shared-use paths (as applicable)
   » Transit service and bus stop locations (as applicable)
   » Restrictions such as one-way streets or left-turn prohibitions
ANALYSIS OF EXISTING CONDITIONS

Note: A scaled exhibit is not required; however, the exhibits shall show the distances to major roadways, driveways, access points, median openings, etc., to allow for the easy identification of access spacing issues that may arise during the review.

Exhibit 3-1 is an example of how to illustrate the transportation system.

PART B — TRAFFIC VOLUMES

The report should contain information on existing 24-hour traffic volumes for the highways and streets in the study area. This section should also provide the existing peak-hour turning movement volumes for the major intersections to be included in the analysis.

At a minimum, the traffic volumes should identify the Average Annual Daily Traffic (AADT) or Average Annual Weekday Daily Traffic (AAWDT) volumes and should address the critical hours of ingress or egress of the proposed development. The critical hours shall be determined as any timeframe that will have the greatest impact to the highway system and will generate the highest volume of traffic to/from the development. Timeframes may vary depending on the type of development and the traffic volumes generated, but typically should be:

- Morning peak: 6 A.M. to 9 A.M.
- Afternoon peak: 3 P.M. to 6 P.M.
- Weekend peak: 11 A.M. to 2 P.M.

Under the following situations, it may be appropriate to specify other peak periods in addition to, or in place of, the typical morning and afternoon peak hours:

- Peak traffic in the study area is known to occur at a different time of day (e.g., noon or weekends only)
- The proposed project is expected to generate little or no traffic during the AM or PM peak periods
- The proposed land use has unusual peaking characteristics (e.g., a church or theater)

Show the current turning movement volumes at the intersections where the proposed development is anticipated to have an impact. The exhibit shall show both the AM and PM peak volumes for all major intersections. The highest traffic volumes for a given maneuver at a major intersection may be higher during a period that is not a critical time for the development. In this case, volumes not identified as the critical hours for development generated traffic would dictate storage lengths or lane needs. The TIA shall still provide an evaluation of the traffic volumes for the intersection’s peak hours to ensure the improvements are appropriate to handle the system’s traffic.

Improvements to meet the highest traffic volume shall be proposed and discussed in the conclusions and recommendations.

WisDOT collects mainline traffic volume data at just over 26,000 sites (26,000 short-term coverage count sites and 221 continuous count sites) on streets and highways around the state. These coverage and continuous count sites are located on freeways,
ANALYSIS OF EXISTING CONDITIONS

Exhibit 3-1
ANALYSIS OF EXISTING CONDITIONS

major and minor arterials, and collector streets in all 72 Wisconsin counties. The coverage count data includes AADT, raw data and hourly volumes. Summaries of the AADT are available at the following link: \[\text{http://wisconsindot.gov/Pages/projects/data-plan/traf-counts/default.aspx}\].

TIA preparers benefit from information about how traffic volumes vary at different times of the day (e.g., rush hour vs. off-peak) or by travel direction. The Wisconsin Traffic Operations and Safety (TOPS) Laboratory has created a website with the continuous and coverage count data collected by WisDOT to provide more convenient data access to hourly and directional traffic volume information. The TOPS Lab website is accessible via the following link: \[\text{http://transportal.cee.wisc.edu/products/hourly-traffic-data/}\].

Some regions also perform manual turning movement counts at certain intersections. With the exception of the Southeast Region, most regional offices only collect intersection turning movement counts as part of an improvement project. The Southeast region, however, has an established count program in which they collect intersection turning movement counts at key intersections in their region, typically on a three-year cycle. Traffic volume data (mainline and/or intersection counts) might also be available from the local municipality.

The TIA preparer should use the traffic data sources above as the primary basis of existing traffic volumes and should only conduct new traffic counts when valid traffic data does not already exist. WisDOT does not typically conduct counts for private entrances; thus, the TIA preparer will most likely need to collect the traffic data at these locations. The TIA shall clearly document the data sources and independent data collection methods.

Traffic volume data used shall be at most three years old. Traffic volume data for multiple intersections in the same corridor should be within the same year. Contact the WisDOT regional office with requests for existing traffic volume information that is not available in the links provided above.

The TIA preparer shall consult with the WisDOT regional office prior to conducting any traffic counts to help identify the time frames to cover with the counts.

If the completion date of the development is not within two years of the oldest count in the study area, the TIA preparer shall establish base year traffic. Base year traffic refers to the anticipated opening year of the development. If applicable, the TIA preparer shall submit a forecast request for the base year traffic to the WisDOT regional traffic forecasting contact.

This section of the TIA shall include the following exhibits:

Exhibit 3-2A .................................................................................... Existing Traffic Volumes
Exhibit 3-2B ................................................................................. Base Year Background Traffic Volumes

Exhibit 3-2A shall illustrate the existing AADT/AAWDT for all highway segments within the study area, and shall show all peak hour movements for the critical hours of ingress or egress. Exhibit 3-2B shall illustrate the base year AADT/AAWDT for all highway segments within the study area, and shall show all peak hour movements for the critical...
hours of ingress and egress. Exhibit 3-2B is necessary if the development is not building in the existing year.

Exhibits 3-2A and 3-2B shall include the following items:

- North Arrow
- All major highways, streets and access points (include roadway names)
- Legend indicating the peak hour movements by time. The following format should be used to differentiate between each hour:
  - AM
  - (PM)
  - [Other Critical Hours]

Exhibit 3-2 is an example of how to display the traffic volume data. Appendix A shall include any raw data used to create Exhibits 3-2A and 3-2B.

PART C — CAPACITY / LEVEL OF SERVICE

The purpose of the capacity/level of service (LOS) analysis is to show the relationship between traffic operations and roadway geometrics, assess needs, and identify alternatives for further consideration. The TIA preparer shall conduct analysis of traffic volumes, facility capacity and LOS for each intersection and driveway in the immediate area of the development within the study area.

Consider analysis of pedestrian, bicycle and/or transit facilities when such services are present or planned for the area, especially if the proposed development will generate bicycle, pedestrian and/or transit trips. Bicycle accommodations may include bike lanes, wide outside travel lanes, paved shoulders and shared-use paths. Where existing or proposed transit stops are located within 2,000 feet of the proposed development, it may be advantageous to include an analysis of transit service. Transit service analysis may be applicable if the proposed development is located in an area with frequent fixed transit service and/or where there is substantial transit ridership. Coordinate with regional multimodal planning staff and transit operators to determine when to conduct analysis of the pedestrian, bicycle and/or transit service.

The procedures, methods and techniques recommended in the Highway Capacity Manual (HCM) shall be the basis for the intersection capacity analysis. Currently, WisDOT is in the process of transitioning from use of the 2010 HCM methodologies to the HCM 6th Edition methodologies. As such, prior to initiating any traffic analysis, coordinate with the regional engineer and/or the Bureau of Traffic Operations (BTO), Traffic Analysis and Safety Unit (TASU) to confirm which HCM methodologies to apply.
ANALYSIS OF EXISTING CONDITIONS

Exhibit 3-2

Legend
- Traffic Signal
- Stop Sign
XX  Weekday AM Peak Hour Volume (7:30 - 8:30 AM)
CC  Weekday PM Peak Hour Volume (4:30 - 5:30 PM)
PDT  Saturday Midday Peak Hour Volume (12:00 - 1:00 PM)
2017  Annual Average Daily Traffic

EXHIBIT 3-2
YEAR 2017 BACKGROUND TRAFFIC VOLUMES MEADOWS ON THE RIVER DEVELOPMENT
ARTHUR, WI
FDM 11-5-3.7 provides a list of the WisDOT supported software packages that implement the HCM methodology for capacity analysis. The TIA preparer shall use the most current version/build of the WisDOT supported software packages to conduct the intersection capacity analysis. At the time of this publication, WisDOT does not have access to Synchro 10, thus, in order to ensure WisDOT staff can review the analyses the TIA preparer shall use the latest build of Synchro 9 until such time that WisDOT has access to Synchro 10. Bear in mind that Synchro 9 follows the HCM 2010 methodologies. WisDOT does have access to the Highway Capacity Software (HCS) 7 and Sidra Intersection 7 for any HCM 6th Edition compliant analyses.

Obtain approval from the WisDOT regional office prior to using Synchro 10 or other software programs not listed in FDM 11-5-3.7. For studies that require a traffic signal system analysis, the regional office will determine the appropriate software program. For all analyses, both the input and output data must be clearly labeled and included in Appendix B.

When using Synchro to perform the analysis, the appendix shall include the following reports:

Signalized Intersections:
- Intersection report with the following data:
  - Lane Inputs
  - Volume Inputs
  - Timing Inputs
  - Actuated Inputs
  - Queues
- HCM 2010/HCM 6th Signalized “Summary” report (with 95th percentile queue)*

Unsignalized Intersections (AWSC and TWSC):
- Intersection report with the following data:
  - Lane Inputs
  - Volume Inputs
- HCM 2010/HCM 6th AWSC or TWSC report

‘Skip Unused Items’ should not be selected when creating the reports.

* Obtain approval from the WisDOT regional office prior to using Synchro 10 to produce the HCM 6th reports.

* To present the 95th percentile queue within the HCM 2010/HCM 6th Signalized report, change the Queue Length Percentile to “95” under Synchro’s HCM 2010/HCM 6th tab.

When using HCS to perform the analysis, the appendix shall include the full formatted report for signalized intersections and the formatted summary report for unsignalized (AWSC, TWSC, and roundabout) intersections.
When using Sidra to perform the analysis (applicable only for roundabout analysis), make sure to select the appropriate roundabout model options (either US HCM 2010 or US HCM 6) that corresponds to the HCM methodologies as directed by the regional office. Provide the following Sidra output worksheets in the appendix:

- Site Layout
- Input Volumes
- Input Comparisons (“with Standard Model Defaults”)
- Movement Summary
- Lane Summary

The roadway system characteristics such as traffic volume, lane geometry, percentage of trucks, peak-hour factor, number of lanes, roadway grades, parking conditions and pedestrian flows are the basis for the intersection LOS analysis.

The analyst shall calculate the percent heavy vehicles for each approach based on the most recent manual vehicle classification/distribution count. They shall gather geometric information such as the number of lanes, lane widths, approach grades and lane usage from either as-built plans or field observations. Additionally, the TIA preparer shall obtain transit information including route locations, stop locations and frequency of buses from the appropriate transit agency.

The analyst shall calculate the peak hour factor (PHF) for each study intersection based on the most recent manual traffic count. In general, the analyst shall apply the total intersection PHF to all turning movements and approaches. In those cases where one approach to the intersection has significantly different peaking characteristics than the rest of the intersection (e.g., one approach provides direct access to a church, movie theater, factory, school), coordinate with the regional engineer to determine whether it is appropriate to use a different PHF for that one approach and/or movement.

For signalized intersections, additional features including saturation flow, signal progression and ratio of signal green time to cycle time, influence the LOS analysis. For the analysis of an existing signalized intersection, contact the regional office for the current signal timings and sequence of operations. This information will dictate the time for minimum green, maximum green, pedestrian walk, pedestrian clearance and vehicular clearance intervals. For signalized intersections within a system, the existing timing will also provide cycle lengths, splits and offsets. For an isolated actuated signalized intersection, the TIA preparer should conduct a field study to determine the average green time for each movement.

The intersection must have an exclusive right turn lane before the analyst can include right turn on red (RTOR) in the capacity analysis of a signalized intersection. As of the publication of this document, BTO is updating the department’s policy regarding the application of RTOR. Prior to release of the final RTOR policy, contact BTO and/or the regional engineer for guidance on the application of RTOR in the capacity analysis.

At unsignalized intersections LOS analysis for two-way stop controlled (TWSC), all-way stop control (AWSC) and roundabout controlled intersections depends upon a clear understanding of the interaction of drivers on the controlled approaches with drivers on
the uncontrolled approaches (if any). The current HCM methodologies use both gap acceptance and empirical models to describe this interaction. The TIA preparer may supplement the results from the HCM-based analysis with a gap study. There are two main issues related to gap studies, however, which preclude its use as a replacement of the HCM procedures.

1. The gap study only considers the existing available gaps; as such, a gap study does not allow the evaluation of the gap reduction due to increased traffic along the main highway.

2. The gap study must look at the total gaps available for all conflicting maneuvers within the intersection. A left turn exiting may turn directly after an entering left turn if no other vehicles are queued waiting to enter the side road or access point. However, the exiting vehicle may not proceed into the intersection if other main highway traffic is waiting to turn left. Since exiting traffic must yield to all other traffic maneuvers, it is important to ensure they can turn without excessive delay or blocking of a median opening to complete the turn.

The HCM procedure defines LOS for the overall intersection (applicable only for signalized and roundabout-controlled intersections), each intersection approach and each lane group. Control delay characterizes the LOS for the overall intersection or intersection approach, while the combinations of control delay and volume to capacity ratio (v/c) characterize the LOS for a lane group at an intersection. A lane group can have a delay less than the threshold for LOS D, E or F when the v/c ratio exceeds 1.0. A v/c ratio of 1.0 or more indicates full utilization of the cycle capacity at a signalized intersection or the presence of inadequate gaps for the minor street demand volume (i.e., gap sizes are too small to allow vehicles to safely cross/enter the intersection) at a stop controlled intersection. A v/c equal to or greater than 1.0 represents failure from a capacity perspective just as LOS F represents significant failure from a delay perspective. A critical v/c greater than 1.0 indicates that the overall signal, stop control and or lane configuration provides inadequate capacity for the given flows.

Using the information provided in Parts A and B above, conduct the analysis for the existing (i.e., base) roadway and traffic conditions with non-site traffic (i.e., without the proposed development). Base roadway conditions include the existing roadway and intersection conditions plus any programmed improvements that will be in place prior to completion of the development. This serves as the baseline for determining the current operation or LOS of the existing transportation system. Identify the existing capacity, delay, LOS, geometric and operational deficiencies and the methods used to calculate them.

This section of the TIA shall include the following exhibit:

Exhibit 3-3............. Base Year Background Traffic Capacity/LOS Analysis, Existing/Planned Transportation System

Exhibit 3-3 shall illustrate in a table and/or graphic format the LOS and 95th percentile queues for each movement. Delay and v/c shall be included for any movement with a less than desirable level of service (i.e., LOS E or LOS F). Consult with the regional office for their format preference. The TIA submittal shall include an electronic copy of the
analysis files, clearly labeled as a digital submission (e.g., .syn). The electronic files are necessary to allow the WisDOT regional office to conduct a peer review of the traffic analysis in accordance with the WisDOT Traffic Guidelines Manual (TGM) 16-25.

PART D — SOURCES OF DATA

In this section, list the type, year and source of all traffic data including but not limited to: turning movement counts, average daily traffic, traffic forecasts, existing signal timings, crash data and programmed improvement plans/analysis files (if available). WisDOT provides data on the state trunk highway and connecting highway systems.

Additional sources of data include:

- Regional Planning Commissions (RPCs)
- Metropolitan Planning Organizations (MPOs)
- Municipal Traffic Departments
- County Traffic Departments
- Other recent traffic studies
- Highway design data for recent projects
- Traffic Operations and Safety (TOPS) Laboratory
CHAPTER 4  PROJECTED TRAFFIC

Future traffic volumes in the study area shall consist of background traffic plus development traffic plus the additional off-site development traffic generated. Because the accuracy of the traffic analysis is dependent upon the accuracy of the traffic projections, it is very important to document all assumptions and methodologies used in the preparation of future traffic such that the regional engineer can judge them for reasonableness and completeness.

A description of the projected traffic shall include:

- Background traffic forecasting
- Development traffic and off-site forecasting
- Total traffic (i.e., background plus development plus off-site development traffic)

PART A — BACKGROUND TRAFFIC FORECASTING

Background traffic volumes represent the amount of traffic that will be on the area roadway network without any proposed development. The analyst shall complete a traffic projection of this background volume to an appropriate horizon (future) year. Regional staff shall establish the horizon year prior to proceeding with the study. There may be more than one horizon year (i.e., interim years) required for phased development. Generally, the horizon year shall represent 10 years after the opening of the proposed development or five years after build out, whichever is greater.

The WisDOT regional traffic forecasting contact will generally provide traffic volume forecasts for the state trunk highways and connecting highways involved. After obtaining the traffic forecasts, the TIA preparer, in coordination with the regional traffic engineer, should review them against the latest coverage counts and consider them for use in the analysis. The WisDOT forecasting unit shall review and approve any forecasts not developed by WisDOT forecasting staff.

Potential sources of background traffic projections are:

- WisDOT regional traffic forecasting contact
- Local or regional planning commissions or MPOs
- Trends and growth rates used in projects within the study area
- Area or sub-area transportation models

Prior to making traffic forecasts, the preparer shall discuss with the regional traffic forecasting contact the availability of non-site traffic projections and the method to be used in developing such estimates when none are available.

This section of the TIA shall include the following exhibits:

Exhibit 4-1 Interim Year Background Traffic Volumes
Exhibit 4-2 Horizon Year Background Traffic Volumes

Exhibit 4-1 and Exhibit 4-2 shall illustrate the anticipated interim and horizon-year traffic volumes respectively for each time frame chosen for analysis. Exhibit 4-1 and 4-2 shall have a similar structure as Exhibit 3-2A and Exhibit 3-2B.
PART B — ON-SITE AND OFF-SITE DEVELOPMENT TRAFFIC FORECASTING

To determine the impact, if any, the proposed development will have on future conditions, it is necessary to estimate the trip generation potential of the development and identify how to distribute this additional traffic to the area roadway network. This requires the following five steps:

1. Trip generation
2. Mode split
3. Pass-by and linked trip traffic estimation (if applicable)
4. Trip distribution
5. Trip assignment

The TIA preparer shall estimate the trip generation and trip distribution potential associated with the on-site and off-site developments for each horizon year to be included in the analysis. Phased developments may have more than one horizon year. It may be appropriate to use different traffic assignments for the same development when:

- There is a multi-phased project, in which case, each phase may require a different traffic assignment
- There is significant traffic growth expected between horizon years
- There are major roadway, bicycle, pedestrian or transit improvements which result in a significant change in travel patterns between horizon years

This section of the TIA shall include the following exhibits:

Exhibit 4-3 .......................................................... Trip Generation Table
Exhibit 4-4 .......................................................... Trip Distribution

1. Trip Generation

The major factors that influence the amount of traffic a development will generate include the development’s size and land use types. In particular, the type of land use (e.g., residential, retail, industrial, office, etc.) will significantly impact not only the volume of new traffic the development will add to the area roadway network but also the time of day in which the new traffic will be added.

The most commonly accepted source for trip generation data for land use developments is the current version of the ITE Trip Generation Manual. ITE Trip generation provides data in terms of trip rates (average, maximum and minimum), fitted curve equations (i.e., regression equations) and data plots. The ITE Trip Generation Handbook provides guidelines for when to use each source of data for estimating the trip generation characteristics of a land use. (As of the date of this publication, the most current version of these documents is the ITE Trip Generation Manual, 9th Edition and the ITE Trip Generation Handbook, 3rd Edition.)

The ITE Trip Generation Handbook, 3rd Edition recommends using the following guidelines to determine whether to use the fitted curve equations, the weighted average rates or whether it is best to collect local data in order to estimate the trip
Evaluate whether the trip generation data is applicable to the specific site.

generation potential of a development. The following page provides a flow chart that outlines the process for selecting the average rate or fitted curve equation.

I. **Use fitted curve equation when:**
   - A fitted curve equation is provided and the data plot has at least 20 data points OR
   - A fitted curve equation is provided, there are between 3 (preferably 6 or more) and 20 data points, the curve has an $R^2$ of at least 0.75, the fitted curve falls within the data cluster, and the weighted standard deviation is greater than 55 percent of the weighted average rate

II. **Use weighted average rate when:**
   - The data plot has between 3 (preferably 6 or more) and 20 data points; the $R^2$ value for the fitted curve is less than 0.75 or no fitted curve equation is provided;
   - The weighted standard deviation for the average rate is less than or equal to 55 percent of the weighted average rate;
     AND
   - The weighted average rate falls within the data cluster

III. **Choose either the fitted curve or weighted average rate (whichever line best fits the data cluster for the size of the development) when:**
   - The data plot has between 3 (preferably 6 or more) and 20 data points; the fitted curve equation is provided, the curve has an $R^2$ of at least 0.75, the fitted curve falls within the data cluster;
     AND
   - The weighted standard deviation for the average rate is less than or equal to 55 percent of the weighted average rate and the weighted average rate falls within the data cluster

IV. **Collect local data when any of the following exist:**
   - Study site is not compatible with ITE land use code definition;
   - The Independent variable does not fall within the range of data;
   - Data plot has only one or two data points (and preferably, when five or fewer);
   - The data plot has between 3 (preferably 6 or more) and 20 data points; the $R^2$ value for the fitted curve is less than 0.75 or no fitted curve equation is provided; and the weighted standard deviation for the average rate is greater than 55 percent of the weighted average rate;
     OR
   - Neither the weighted average rate line nor the fitted curve fall within the data cluster for the size of the development
ITE Trip Generation Handbook Process for Selecting Fitted Curve Equation, Weighted Average Rate or Local Data Collection

Compatible with ITE Land Use Code, size within data extremes, AND at least 3 (preferably 6 or more) data points?

Fitted Curve Equation Provided?

NO

Standard Deviation ≤ 55% of weighted average

NO

Data cluster ok?

YES

R² ≥ 0.75 AND within data cluster?

YES

Use Weighted Average Rate

NO

Choose the line (fitted curve or weighted average) that best fits the data cluster for size of development

YES

Use Fitted Curve Equation

YES

20 or more data points?

NO

Standard Deviation ≤ 55% of weighted average AND within data cluster?

YES

Use Fitted Curve Equation

NO

Collect Local Data (Refer to Chapter 9 of ITE Trip Generation Handbook)

Source: Figure 4.2, ITE Trip Generation Handbook, 3rd Edition
Typically, the analyst should use the trip generation rates or regression equations published in the latest edition of ITE Trip Generation Manual to estimate site traffic. Exceptions to this include times when an individual trip generation study for the proposed development exists or when there is trip generation data available for an individual company/entity within the proposed development. In cases where ITE Trip generation data is very limited or unavailable, it may be appropriate to use trip generation rates available via one or more of the following sources:

- Local data for comparable developments
- Other published references such as the ITE Journal
- The open source trip generation data available from Spack Consulting which is accessible via the following link: http://www.tripgeneration.org/
- Trip generation studies conducted at sites similar to the proposed development
- The April 7, 2017 Mixed-Use Development (MXD) Trip Generation Study prepared for WisDOT by TADI which is available via the following link: http://wisconsindot.gov/dtsdManuals/traffic-ops/manuals-and-standards/mxd-study.pdf

The TIA shall document all sources used to determine the trip generation for each land use. If the source is from something other than the ITE Trip Generation Manual, the TIA preparer shall provide, in writing, as to their suitability for this particular application. The outcome of the entire traffic analysis can often depend solely on the question of appropriate trip generation rates, thus any use of non-ITE rates shall be reasonable and defensible.

The TIA should present the trip generation information in Exhibit 4-3 in an organized manner that makes it easy for the reader to understand the exact process used to derive the trip generation estimates. Typically, the table would identify the following:

- Land use
- ITE code
- Land use size
- Daily and peak-hour trip rates (i.e., total two-way for daily and in, out and total for peak hours)
- Number of daily and peak-hour vehicle trips generated (i.e., total two-way for daily traffic and in, out, and total for peak hours)

2. Mode Split

The ITE Trip Generation Manual primarily uses data collected throughout the United States and Canada at low-density, single-use, homogeneous, general urban or suburban developments with little or no public transit service and little or no convenient pedestrian access as the basis for the trip generation rates. Thus, in almost all cases, the ITE trip rates represent 95 percent or more auto usage and in most cases represent 100 percent motor vehicle travel. This assumption may be appropriate for many of the developments that occur in Wisconsin; however, there will be occasions where the development trips will include pedestrian, bike, transit or other non-passenger vehicle
modal trips. These trips would normally occur in populated areas where transit services and/or bicycle/pedestrian facilities are available.

The ITE Trip Generation Handbook, 3rd Edition provides guidance on how to analyze trips in units of either person trips or vehicle trips. Where person trips consist of trips made to or from a site by each individual person using any mode of transportation including walk trips, bike trips, transit trips, truck trips and personal passenger-vehicle trips. Vehicle trips consist of trips made to or from a site by an automobile (e.g., personal passenger vehicle, bus, truck, etc.). Vehicle trips may consist of one or more person trips (e.g., an automobile with two people in it counts as one vehicle trip but two person trips). Using the information available in the ITE Trip Generation Handbook, 3rd Edition, the analyst, to the limits possible with available or readily collectible data, can estimate the inbound and outbound trips of a development by travel mode. Local data collection can also assist in determining the appropriate mode split percentages to use in calculating the developments trip generation potential. The TIA shall document the availability of transit service and/or pedestrian/bicycle facilities and shall summarize any surveys of current travel behaviors and/or other relevant data to support the mode split assumptions. The WisDOT regional office will review any assumptions regarding mode split, specifically the non-passenger vehicle trips, for reasonableness.

3. Pass-By and Linked Trip Traffic Estimation

New trips (or primary trips) are trips made for the specific purpose of visiting the trip generator. Therefore, these trips are new traffic on the area roadway network. Actual traffic counts conducted at the driveways of various developments are the primary source for trip generation rates. When dealing with non-commercial land uses such as residential projects, office buildings, hotels and industrial parks, these driveway volumes usually represent the amount of new traffic added to the area roadway network by those particular uses.

Pass-by trips are trips, currently on the roadway system, that make an intermediate stop at a generator (i.e., the development under study) with direct access to the roadway network that is adjacent to the original travel route between the origin and primary destination. Pass-by trips do not include trips that divert from their original travel path non-adjacent to the site (i.e., diverted trips). Pass-by trips are convenience-oriented, for example, stopping to refuel a vehicle during a commute from work. Pass-by trips are only applicable for retail-oriented land uses. Thus, the analyst should only consider the use of pass-by trips when the proposed development is a retail-oriented development that will attract existing traffic off an adjacent roadway or street.

The amount of pass-by traffic does not affect the number of trips that may enter and exit a proposed development (i.e., driveway volumes). However, it does reduce the amount of traffic added to the adjacent street system by the proposed development (i.e., new trips). Depending on the type of development and adjacent street traffic volumes, predicted pass-by trips can vary significantly, so the analyst shall apply these adjustments carefully. The number of pass-by trips is calculated after accounting for internal trips (Total Site Trip Generation – Internally-Linked Trips = External Trips; apply pass-by reduction to External Trips).
Generally, pass-by traffic should not exceed 5 to 10 percent of the traffic volumes on the adjacent roadways and it should have equal ingress and egress volumes. WisDOT shall approve the use of any pass-by trip estimates greater than 10 percent of the adjacent roadway traffic volumes. Refer to the Pass-By Trips table (http://wisconsindot.gov/dtsdManuals/traffic-ops/manuals-and-standards/pass-by-trips.pdf) for the acceptable ranges of pass-by rates developed for use in Wisconsin. The ITE Trip Generation Handbook, 3rd Edition provides additional guidance on the use of pass-by trip reductions.

The TIA shall clearly define the pass-by percentages assumed in the analysis and shall provide documentation supporting the pass-by percentages used in Appendix A. This is especially important when the pass-by percentage exceeds 10 percent of the adjacent roadway traffic volumes.

Linked trips are trips with one common point of origin and multiple destinations points. In essence, chaining (or linking) multiple stops together in a single trip. Trips can be linked between different land uses along the travel route (i.e., the trips use the major roadway system to get from one land use to another) or they can be linked between different land uses within the same development (i.e., the trips are captured internally on-site and do not use the off-site roadway system).

When trips between multiple land uses make use of the major roadway network (also known as multi-linked or externally-linked trips), there may be an increase in the number of trips entering/exiting a specific driveway as one driveway may serve two or more separate trips. When the multiple land uses are part of the same development, the analyst should adjust the trip generation estimates of the development as appropriate. When the multiple land uses are associated with different developments; however, the analyst should generally treat each development separately when estimating the trip generation potential, depending on access locations and connectivity among developments.

When trips occur between multiple land uses within the same mixed-use or multi-use development (MXD) without use of the adjacent roadway network (also known as internally-linked or internally-captured trips), there is typically a reduction in the number of trips entering/exiting the proposed MXD as one driveway trip can result in multiple trips between land uses within the development itself. Since trips between two or more land uses within the MXD can occur without use of the external street system, internally linked trips also reduce the amount of traffic the new development will add to the adjacent roadway.

Internal capture rates vary by the mix of land uses, the size of the land uses, the amount of potential interaction between complementary land uses and the availability of convenient internal on or off street facilities and connections. Typically, MXD sites need to contain the necessary facilities and land uses to support a significant amount of interaction in order to justify that the development will capture some of the generated trips internally and thus allow the analyst to apply internal capture rates when estimating the development’s trip generation potential.
In evaluating a proposed internal capture rate, the analyst should consider the following general guidance:

- Sites having a mix of residential and nonresidential components have the highest potential for internal capture trips. Mixes of nonresidential land uses are less likely to have a significant internal capture rate unless a hotel or motel is contained within the site.

- Residential and employment centers at the mixed-use development should be income compatible so residents have ample employment opportunities in the community.

- The design of the internal roadway system of the development as well as the pedestrian/bicycle facilities may affect the internal capture rate. A well-designed development with good internal connectivity can make it more convenient for trips to stay on the site.

- If there are nearby competing destinations, the analyst may need to adjust the internal capture rate.

- Internal capture rates are not applicable for the ITE land use code 820 (shopping centers) as the ITE trip rates for this land use already reflect the mixed-use nature of the shopping center. Therefore, the analyst should not use internal capture rates to forecast trips for this land use.

- Use the ITE land use code 750 (office park); rather than a MXD with internal capture rates, to estimate the trip generation potential for developments consisting of general office buildings and support services (e.g., banks, restaurants, gas stations) arranged in a park-or campus-like setting. Likewise, use ITE land use code 710 (general office building) for office buildings with support retail and/or restaurant facilities contained within the same building.

- The analyst should not apply internal capture rates to hotels with an on-site restaurant and/or small retail, as the trip rates for ITE land use code 310 (hotel) already reflects the interaction of these land uses.

- The TIA preparer should calculate internal trip capture rates for each phase of a multi-use development. If, during the review process, the development plans change, the analyst should update all internal capture calculations and submit the TIA for additional review.

Results of a study to evaluate the trip generation and internal trip capture rates for various mixed-use developments located across Wisconsin can be found at the following link: http://wisconsindot.gov/dtsdManuals/traffic-ops/manuals-and-standards/mxd-study.pdf. Contact the WisDOT regional traffic engineer and/or BTO-TASU for additional details and guidance on if/how to use the findings from this study when estimating the trip generation potential of proposed MXD sites.

In absence of Wisconsin-specific data, use the methodology outlined in Chapter 6 of the ITE Trip Generation Handbook, 3rd Edition to estimate internal trip capture and trip generation for mixed-use developments. A spreadsheet tool, which automates several of the calculations, is available for download from the ITE website (http://www.ite.org/tripgeneration/otherresources.asp). The analyst can also reference the National...
Cooperative Highway Research Program (NCHRP) Report 684: Enhancing Internal Trip Capture Estimation for Mixed-Use Developments, which is the source for much of the ITE methodology, for additional details on the process for estimating the internal trip capture and trip generation of MXD sites.

The ITE process and spreadsheet tool described above enables the analyst to evaluate the morning and afternoon peak period internal capture rates at a MXD site with any combination of the following six land use categories:

- Office
- Restaurant
- Cinema/Entertainment
- Retail
- Residential
- Hotel

Refer to Chapter 6 of the ITE Trip Generation Handbook, 3rd Edition for suggested internal trip capture rates for each of the above land use pairs. Data on internal capture rates is currently only available for the six land use categories listed above for the morning and afternoon peak, thus the analyst should not apply the ITE internal capture rates and methodology to other land uses or time frames (e.g., weekend peak period, weekday midday peak period, daily period).

The analyst is encouraged to make logical and supportable assumptions in the use of the ITE internal trip capture and mixed-use trip generation methodology described above. After checking the results for reasonableness, the analyst should generally use the total estimated internal trip capture from the ITE spreadsheet estimation tool when estimating the trip generation potential of a proposed MXD site. Consult with your regional contact to determine a maximum acceptable value for internal capture rates. WisDOT shall approve the use of all the internal trip capture rates greater than 10 percent of the total new trip generation for the development.

Both TIA preparers and reviewers should familiarize themselves with the ITE internal capture methodologies and underlying assumptions. It is critical that both the TIA preparer and reviewer have a clear understanding as to when the methodology is or is not appropriate for the proposed MXD.

Use the procedures described above only at those MXD sites that have characteristics that resemble the sites used to derive the internal capture rates. Per the ITE Trip Generation Handbook, 3rd Edition, the TIA preparer and reviewer should consider the following factors when assessing the appropriateness of the procedure for a particular mixed-use development.

- “Development Type: The mixed-use development should be a single, physically and functionally integrated development on a single block or a group of contiguous blocks with two or more uses, with internal pedestrian and vehicular connectivity, and with shared parking among some or all uses. The site should have sufficient parking supply to meet demand although the most convenient parking may sometimes fill during peak demand periods.

- Development Location: The mixed-use development should be downtown fringe, general urban, or suburban. It should not be located either within or adjacent to a central business district ([CBD]). Trip Generation for a study site in a CBD setting is addressed in Chapter 7 [of the ITE Trip Generation Handbook, 3rd Edition].
• **Development Size:** The mixed-use development *should* have between 100,000 and 2 million sq. ft. of building space within an overall acreage of up to roughly 300 acres. The mixed-use development can be a single site, a block, or a district or neighborhood (with multiple interconnected or interactive blocks within a defined boundary); however, this procedure *should* not be used for a development composed of different adjacent, but not directly connected, land uses. Adjacent blocks can be considered to be directly connected if there is an internal street, driveway, alley system, and/or pedestrian way by which person trips can be made to travel from one block to another. If the development site has multiple land uses but blocks are configured in such a way that these trips must use an external street system, then the site is not a mixed-use development.

• **Land Use Mix:** The mixed-use development *should* consist of a combination of at least two of the following uses: retail, restaurant, office, residential, hotel, and cinema/entertainment. Internal capture for land uses beyond these six *should* be considered to be zero (unless comparable survey data for other land uses are provided) because there are no supporting data from which to derive an appropriate percentage. In addition, if a substantial portion of the land use at a mixed-use site is outside these six land uses, the [ITE Trip Generation] Handbook internal capture rates might not be appropriate. Alternatively, the analyst can collect internal capture data at proxy sites in the same area with similar land use and setting characteristics.

• **ITE Trip Generation Manual Database:** The mixed-use development *should* not already be covered in the ITE trip generation database as reported in the latest edition of [the] *Trip Generation Manual*. Current ITE land use types that already account for internal trip-making include shopping center, office park with retail, office building with ground floor retail or on-site cafeteria, and hotel with limited retail and restaurant space.

• **Time Period for Analysis:** The internal capture rates contained in [the ITE Trip Generation Handbook methodology] cover the weekday AM and PM peak periods for adjacent street traffic. Internal capture rates for weekend peak periods, for weekday midday peak periods, or for a daily period *should* not be assumed to be the same as or even a simple, direct function of the weekday AM and PM peak period rates. For an application that requires internal capture information outside the weekday AM and PM peak periods, the analyst *should* collect additional data.”

All linked trip assumptions are subject to WisDOT approval and *should* be determined during the initial review process. It is important to note that linked trips refer to the internal capture of trips within a multi-use development site and *should* not be confused with diverted linked trips. Diverted linked trips refer to the number of trips attracted from the existing traffic on roadways within the vicinity of the generator but require a diversion from that roadway to another roadway to gain access to the site.

The TIA *shall* clearly identify and display pass-by and linked trip adjustments. Please see Chapter D for the appropriate exhibit numbering.
4. Trip Distribution

The major factors to be considered in estimating the orientation of the on-site and off-site development generated traffic include the distribution of potential trip origins and destinations within the proposed development’s influence area and the relative efficiencies (in terms of travel times) on the various approach routes to the site. Drivers normally choose the fastest, not necessarily the most direct, route to and from a traffic generator. This is particularly true when drivers are very familiar with likely travel conditions (as project residents or employees commuting to the site every day would be) and when alternative routes are available.

Common methods for estimating trip distribution are:

1. Analogy Method
   This method derives the trip distribution of a proposed development based on existing data at sites that are similar to the subject development. Typically, the analogy method uses existing segment and turning-movement count data.

2. Gravity Model Method
   Trip distribution models estimate trip distribution based on characteristics of the land-use pattern within the influence area and the transportation system. The most common model used for trip distribution is the gravity model.

3. Surrogate Data
   This method is useful if an extensive socioeconomic or demographic database exists for the influence area. For example, the analyst can use population data as a surrogate for retail trips. Employment is a reasonable surrogate for residential trips.

4. Market Area Analysis Method
   This method uses the influence area of the proposed development, which corresponds to the area that generates or attracts 90 percent or more of the trip ends to/from the site. A market study, if available, and a delineated influence area, typically a circle with a radius corresponding to a travel time appropriate for the type of development, are two options available for determining the boundaries of the study area for trip distribution.

5. Origin-Destination Method
   This method makes use of origin-destination (O-D) data that is available from WisDOT travel demand models (TDMs), regional transportation plans and/or local plans. The WisDOT Traffic Forecasting Section (TFS) develops and maintains a statewide TDM as well as TDMs for each of the MPOs within the state. For developments located within one of the TDM areas, the TFS may be able to provide O-D tables and/or select zone information, which the TIA preparer can use to help develop the trip distribution for the proposed development. Refer to Chapter 9 of the WisDOT Transportation Planning Manual for additional information regarding the travel demand models.

In areas where TDMs are unavailable, the analyst can reference regional and/or local transportation plans to identify the location and type of land uses that...
would either generate (point of origin) or attract (point of destination) trips to/from the proposed development. Two examples of major local and regional transportation plans available are:

» Madison Area Transportation Planning Board: www.madisonareampo.org/planning/regionalplan.cfm


The trip distribution method used and the source of data shall be documented in the report. The analyst should estimate the directional distribution for each land use component of the proposed project and for each horizon year included in the analysis. In some cases, inbound and outbound trips may have different distributions depending upon applicable operating conditions (e.g., one-way streets, medians, difficulty in making left turns, etc.). The analyst should provide an explanation of any such differences within the TIA.

Depict on-site and off-site development traffic distributions as percentages for each direction of travel. Displaying this information on a map provides the best method of showing the directional distribution of traffic for the development. Exhibit 4-4 provides an example of a trip distribution graphic.

5. Trip Assignment

Trip assignment involves assigning the projected on-site and off-site development traffic (peak hour and daily) to specific access points and travel routes along the roadway network. To do this, the analyst needs to multiply the projected on-site and off-site development traffic volumes by the percentage of traffic arriving/departing via a particular route after accounting for any reduction for less than 100 percent auto usage, pass-by traffic and/or linked-trip traffic.

The trip assignment process establishes the directional project-related traffic volumes (i.e., turning and through movements) at each access point, intersection and roadway segment within the study area. The product of this step of the process is traffic volumes appropriate for use in assessing the project-related impacts as detailed in Chapter 5.

The analyst should begin the trip assignment process by identifying all possible paths between origins and destinations. They should then evaluate the potential for the development traffic to use these paths on a comparative basis taking into consideration the following:

- Driver tendencies and characteristics
  - Drivers will often use the first convenient driveway they reach to access a site with multiple driveways
  - Local drivers tend to use back roads/local connections where drivers who are new to the area tend towards major travel routes
• Internal circulation design
  » The design of the internal circulation may determine what driveway the drivers will use
  » The internal circulation design can influence whether the driver decides to stay on-site or use the external roadway network to travel between land uses

• Available roadway capacities
  » Known capacity constraints may impact the route selection, especially if alternate routes are available
  » Turn restrictions; particularly left-turn restrictions may force a driver to take a non-direct route to access the site

• Analysis year travel conditions
  » Assuming the travel conditions (including level of congestion, roadway geometrics and roadway network) are comparable, the interim and horizon year traffic assignment will generally be the same as the existing/current year traffic assignment

• Planned roadway improvements or network changes could result in modifications to the horizon year trip assignment

  Proposed land use characteristics
  » Employment land uses primarily attract commuter trips which generally travel during the weekday morning and afternoon peak periods
  » Destination and/or entertainment land uses typically generate more recreational or event-based trips which tend to travel outside of the typical weekday peak periods
  » Commuter trips and recreational trips may use different travel routes

• Trip distribution percentages and traffic assignment typically apply to two-way trips
  » Turn movements will likely be different or reversed between an entering and exiting trip
  » One-way streets may influence assignment patterns

• The presence of nearby on/off ramps at interchanges
  » Developments located near interchanges tend to attract a high volume of regional trips
  » Developments without direct/convenient access to an interchange tend to attract a high volume of local trips
  » The presence of nearby on/off ramps at an interchange enables drivers to easily divert from their primary route to make an interim stop at the development site, thus potentially increasing the number of diverted trips

The above considerations are adapted from the Transportation Impact Analyses for Site Development: An ITE Recommended Practice, ITE 2010
The analyst shall make manual assignments for each analysis period for each base, interim and horizon year. To achieve realistic estimates, they should assign multiple paths between origin and destinations as deemed appropriate based on experience and professional judgment.

The exhibit order for illustrating the trip assignment shall be:

**Exhibit 4-5** ........................................... Base Year On-Site Development Traffic Assignment  
**Exhibit 4-6** ........................................... Interim Year On-Site Development Traffic Assignment  
**Exhibit 4-7** ........................................... Horizon Year On-Site Development Traffic Assignment  
**Exhibit 4-8** ........................................... Base Year Off-Site Development Traffic Assignment  
**Exhibit 4-9** ........................................... Interim Year Off-Site Development Traffic Assignment  
**Exhibit 4-10** ........................................... Horizon Year Off-Site Development Traffic Assignment

The following illustrates a sample exhibit order:

**Base Year On-Site Development Traffic**

**Exhibit 4-5A** .......................................................................................................... New Trips  
**Exhibit 4-5B** ....................................................................................................... Linked Trips  
**Exhibit 4-5C** ....................................................................................................... Pass-by Trips  
**Exhibit 4-5D** ................................................................................................... Driveway Trips

**Note:** In the case of multiple interim years, the lettering shall continue with E for new trips, and so on.

**Exhibit 4-5** provides an example of a trip assignment graphic.
Exhibit 4-5

Legend
- Traffic Signal
- Stop Sign
XX Weekday AM Peak Hour Volume (7:30—8:30 AM)
XX Weekday PM Peak Hour Volume (4:30—5:30 PM)
[XX] Saturday/Midday Peak Hour Volume (12:00—1:00 PM)
[XX] Weekday Daily Volume (50% IN, 50% OUT)

EXHIBIT 4-5A
NEW DEVELOPMENT TRIPS
MEADOWS ON THE RIVER DEVELOPMENT
ARTHUR, WI
PART C — BUILD AND TOTAL TRAFFIC

The TIA preparer **shall** develop build and total traffic volume assignments for each time period and horizon year chosen for analysis.

**Build traffic** is defined as the background/base traffic plus the on-site development or off-site development (new) traffic that is expected to be using the roadway network first (whichever development that occurs first is to be included in the build traffic).

The analyst **should** confirm the use of on-site or off-site development traffic for this analysis with the regional traffic contact. The purpose of the build traffic analysis is to determine any capacity concerns that may require improvements due to the expected development that is to occur first whether it is on-site or off-site.

**Note:** If off-site development(s) do not exist and/or will not occur prior to the on-site development, then a total traffic analysis scenario does not apply and is thus not necessary.

**Total traffic** volume consists of the summation of the background/base traffic plus the on-site development traffic and the off-site development traffic. These may be a combination of the following:

Exhibit 3-2A/B ................................................................. Existing/Base year traffic volumes
Exhibit 4-1 & 4-2 ................................................................. Background traffic forecasts
Exhibit 4-5 to 4-7 ..... Base/Interim/Horizon Year On-site Development Traffic Assignment
Exhibit 4-8 to 4-10 ...Base/Interim/Horizon Year Off-site Development Traffic Assignment

The following three exhibits **shall** illustrate the base, interim and horizon year build traffic respectively:

Exhibit 4-11 .................................................. Base Year Build Development Traffic Volumes
Exhibit 4-12 .............................................. Interim Year Build Development Traffic Volumes
Exhibit 4-13 ............................................. Horizon Year Build Development Traffic Volumes

The following three exhibits **shall** illustrate the base, interim and horizon year total traffic respectively:

Exhibit 4-14 .................................................. Base Year Total Development Traffic Volumes
Exhibit 4-15 .............................................. Interim Year Total Development Traffic Volumes
Exhibit 4-16 ............................................. Horizon Year Total Development Traffic Volumes

**Appendix A Traffic – Future Traffic Projections** **shall** include any raw data, supporting information, and calculations used to develop the traffic forecasts including:

- Base Forecasts
- Trip Generation
- Mode Split
- Pass-By Trips
- Linked Trips
- Trip Distribution
- Trip Assignment, etc.
CHAPTER 5  TRAFFIC AND IMPROVEMENT ANALYSIS

Given total projected traffic for each horizon year, the next step in the process is to analyze the future traffic conditions, identify needs (if any) and analyze alternative improvements. The TIA shall provide an analysis of all state highway intersections and select driveways within the defined study.

The analysis of the roadway and intersections should include the following elements:

- Site access
- Capacity/level of service analysis
- Queuing analysis
- Traffic safety
- Pedestrian, bicycle, and shared-use path needs
- Speed considerations/sight distance
- Traffic control needs
- Traffic signal warrant analysis

PART A — SITE ACCESS

Describe all proposed access driveways anticipated to serve the development site. An access driveway to a state highway is an intersection and thus, the TIA preparer should analyze it with respect to capacity, traffic operations and safety. Review the location of the access points on the site plan in relation to existing nearby access points and intersections. In some cases, the relocation of an access point may be necessary to improve safety and traffic operations. The TIA preparer and reviewer should also review the site plan to ensure that the design of the external access points account for pedestrian and bicycle safety. As part of the site plan review, the analyst should also include a review/assessment of the transit stop locations.

The application of sound access management principles can often minimize any potential adverse impacts to roadways adjacent to the site. The location and design of the site access should be in accordance with the following guidelines:

- The number of access points should be limited to minimize traffic conflicts.
- Access points should intercept traffic approaching the site in an efficient and safe manner. The location should minimize impacts to traffic operations on the adjacent highway. The site plan should align opposing access points where possible.
- The site plan should provide/maintain adequate spacing between adjacent streets and driveway intersections. Factors to consider when evaluating intersection spacing include, but are not limited to, the following:
  » Intersection spacing should be such that driveway blockage is minimized
  » Intersection spacing requirements depend on roadway classification, posted speed and influence of adjacent intersections.
TRAFFIC AND IMPROVEMENT ANALYSIS

» All access locations, whether or not they meet spacing requirements, are subject to WisDOT approval.
» Median openings shall conform to the requirements of the WisDOT FDM 11-25

• The department will encourage joint and/or cross access between adjacent properties.
• The on-site circulation pattern shall integrate the access point locations to allow for efficient ingress and egress, and to avoid queuing on the adjacent highway.
• Turning lanes shall provide adequate storage lengths. Provide acceleration and deceleration lanes as necessary.
• The design of the access points shall ensure adequate sight distance.
• The design of the width and radii of an access point should accommodate entering and exiting vehicles efficiently and safely.
• Access points should generally intersect the adjacent roadways at a 90-degree angle.
• Where applicable, the site plan should provide for multimodal access between the right-of-way and the development (multimodal facilities shall consider pedestrians, bicycles and transit).

PART B — CAPACITY/LEVEL OF SERVICE ANALYSIS

Similar to the capacity/level of service analysis conducted for the existing conditions (Chapter 3, Part C); conduct additional analysis for the following conditions:

Existing conditions with:

1. Background traffic (without the proposed development or off-site development) for the base year (if not the existing year) and each horizon year identified
2. Build traffic for the base year and each horizon year identified
3. Total traffic for the base year and each horizon year identified

The existing conditions for this section of the analysis include the existing transportation and intersection conditions plus any programmed improvements, expected to be complete by the end of the respective horizon year.

Proposed Improvements with:

1. Background traffic for the base year and each horizon year identified
2. Build traffic for the base year and each horizon year identified
3. Total traffic for the base year and each horizon year identified

The purpose of the future conditions analysis is to determine if the transportation system will operate acceptably with the additional site-generated trips. If not, one must determine what mitigation may be required. Consider analysis of pedestrian, bicycle and/or transit facilities when such services are present or planned for the area, especially if the proposed development will generate bicycle, pedestrian and/or transit trips. Bicycle accommodations may include bike lanes, wide outside travel lanes, paved...
shoulders and shared-use paths. Transit service analysis may be applicable if the proposed development is located in an area with frequent fixed transit service and/or where there is substantial transit ridership. Coordinate with regional multimodal planning staff and transit operators to determine when to conduct analysis of the pedestrian, bicycle and/or transit service.

The regional traffic engineer may require modification and/or expansion of the above-specified analysis.

There is a need to provide detailed information regarding the physical characteristics of the existing conditions as well as the planned transportation system improvements proposed.

Exhibit 3-1B should have identified any currently programmed roadway or traffic control modifications to include in this analysis. Exhibits 1-4, 1-7 and 1-10 should have identified any additional improvements for the proposed development that were included in the analysis.

Exhibits 3-3, 5-1 and 5-2 shall show, in tabular format, the capacity/LOS analysis for the existing transportation system with background traffic for the base year, interim year, and horizon years, respectively. Both the input and output data must be clearly labeled and included in Appendix B.

Exhibits 5-3 through 5-5 shall show, in tabular format, the capacity/LOS analysis for the existing transportation system with build development traffic for the base year, interim year, and horizon years, respectively. Both the input and output data must be clearly labeled and included in Appendix C.

Exhibits 5-6 through 5-8 shall show, in tabular format, the capacity/LOS analysis for the existing transportation system with total development traffic for the base year, interim year, and horizon years, respectively. Both the input and output data must be clearly labeled and included in Appendix D.

Exhibits 5-9 through 5-11 shall show, in tabular format, the capacity/LOS analysis for the transportation system improvements with background traffic for the base year, interim year, and horizon years, respectively, for each alternative. Both the input and output data must clearly be labeled and included in Appendix E.

Exhibits 5-12 through 5-14 shall show, in tabular format, the capacity/LOS analysis for the transportation system improvements with build development traffic for the base year, interim year, and horizon years, respectively, for each alternative. Both the input and output data must clearly be labeled and included in Appendix F.

Exhibits 5-15 through 5-17 shall show, in tabular format, the capacity/LOS analysis for the transportation system improvements with total development traffic for the base year, interim year, and horizon years, respectively, for each alternative. Both the input and output data must clearly be labeled and included in Appendix G.
Refer back to Chapter 3, Part C for appropriate procedures, methods, techniques and software to utilize in the analysis. If any of the following improvements are proposed, discuss their implications with the regional traffic contact prior to completing the study:

- A proposed traffic signal that will create a signal system, or
- A modification to an existing signal system

Recalculate the pedestrian and vehicular clearances and verify their appropriate usage for all modifications that increase the distance a vehicle must travel to clear the intersection. In addition, except in rare instances, changing the cycle length for a signal within an existing signal system would require a traffic signal system analysis to document the proposed change.

NOTES REGARDING IMPROVEMENTS

The TIA should evaluate various access locations and configurations to determine how they could handle the proposed traffic. The HCM procedure cannot identify all potential problems with ingress and egress; thus, the TIA preparer shall review merging conflicts, roadway and/or intersection control improvements, and driver behavior and expectations. The TIA shall identify appropriate mitigation measures as necessary. The various evaluations conducted should comply with WisDOT’s FDM.

Note that the acceptance of the TIA is not an approval of proposed recommendations outlined in the TIA but an acknowledgment that the format of the submitted TIA was acceptable for WisDOT to review. Typically, the regional traffic contact will provide a summary of the department’s position and identify any issues regarding the proposed recommendations outlined in the submitted TIA. The TIA preparer and developer will need to address any of the department’s outstanding issues prior to moving forward with the permitting process.

FDM 11-5-3 states, “... designers should strive to achieve the best intersection level of service (LOS) that is practical given the local land use, economic, social and environmental characteristics. The designer should aim to balance the level of service for all users of the intersection (e.g., vehicles, pedestrian, bicycles, etc.).” In general, the desirable level of service is LOS D for all turning movements (left, through and right) during the peak hours of travel.

In accordance with the FDM, the TIA shall propose improvements under the following conditions:

1. Case 1 exists when specific movements at the roadway intersection will operate at or above the desirable level of service (typically LOS D) in the horizon year(s) without the development but operate at a less than desirable level of service (typically LOS E or worse) with the development. In this case, the TIA shall propose improvements to bring the LOS back to the desirable level.
2. Case 2 exists when specific movements at the roadway intersection will operate at a less than desirable level of service (typically LOS E or worse) in the horizon year(s) without the development, but will operate at an even lower LOS with the development. In this case, the TIA shall propose improvements to maintain the amount of delay (in seconds per vehicle) expected to occur without the development using HCM methodology.

Mitigation to a less than desirable level of service may be acceptable at certain locations, specifically where it is not practical to provide the desirable level of service, at the discretion and approval of the regional traffic engineer. WisDOT will consider reduced LOS operations for specific intersection movements on a case-by-case basis to determine the most practical level of service.

Possible improvements to increase the level of service could include the following:

- Additional/modified left or right turn lanes
- Additional intersection through lanes
- Additional highway lanes
- Access modifications/alternative access means
- Construction of a median/two way left-turn lane (TWLTL)
- Expansion of an existing median
- Change in traffic control
- Addition of a traffic signal, roundabout, or other type of traffic control alternative
- Change in signal operation including re-phasing and/or re-timing of the existing signal
- Redesigning/relocating bus stops
- Introduction of grade separation
- Restriction of particular turning movements
- Providing for two-stage left-turn/crossing movements

The TIA should provide a comprehensive review of the proposed roadway with respect to the following:

- Right of way
- Intersection spacing
- Relationship of highway with site access
- Design criteria
- Practical feasibility
PART C — QUEUING ANALYSIS

The analyst shall perform a queuing analysis for all intersections, access points and ramp termini within the study area that are controlled by stop signs, traffic signals or roundabouts. The primary purpose of this analysis is to estimate the queue lengths and associated storage requirements that the intersection design should accommodate. The TIA shall evaluate queue lengths for left-turn and right-turn lanes to ensure that queues do not overflow into adjacent through lanes. The analyst should also evaluate the queues for through lanes to confirm that they do not obstruct turn lane entrances or extend back into neighboring intersections. Refer to the WisDOT FDM 11-25-2 for additional details on the queue storage requirements for intersections.

The HCM has a procedure for estimating the intersection queue lengths. FDM 11-5-3.7 provides a summary of the traffic analysis tools that WisDOT supports for implementing the HCM procedures. The analyst shall use the HCM procedures, or other preapproved methodologies such as microscopic simulation, and the WisDOT supported software to estimate the storage lane requirements. Use professional judgement in conjunction with the results of the queuing and operational analysis to verify the final storage lengths to use for design.

Identify the expected queue storage lengths that may be required with the proposed improvements in each peak period analyzed. The TIA shall utilize the following order for exhibits to summarize the queue lengths for the improved transportation system:

Exhibit 5-18 ................................................................. Base Year Background Traffic
Exhibit 5-19 ................................................................. Interim Year Background Traffic
Exhibit 5-20 ................................................................. Horizon Year Background Traffic
Exhibit 5-21 ................................................................. Base Year Build Development
Exhibit 5-22 ................................................................. Interim Year Build Development
Exhibit 5-23 ................................................................. Horizon Year Build Development
Exhibit 5-24 ................................................................. Base Year Total Traffic
Exhibit 5-25 ................................................................. Interim Year Total Traffic
Exhibit 5-26 ................................................................. Horizon Year Total Traffic

PART D — MULTI-MODAL CONSIDERATIONS

The TIA preparer and reviewer shall evaluate the site plan and recommend improvements to ensure that, where needed and feasible, it can accommodate pedestrian, bicycle and transit users safely and efficiently. Reference FDM 11-46 and consult with WisDOT regional multimodal staff for guidance regarding need and feasibility. Additional guidance on multimodal accommodations is available through the following:

• AASHTO Guide for Geometric Design of Transit Facilities on Highway and Streets

• The following guides from the National Association of City Transportation Officials (NACTO):


Pedestrian facilities, including shared-use paths, are required to be accessible to people with disabilities. Newly constructed and altered facilities shall comply with ADA requirements.

PART E — SPEED CONSIDERATIONS/SIGHT DISTANCE

This section of the TIA shall include the following exhibit:

Exhibit 5-27 .................................................... Intersection Sight Distance Photos/Drawings

Vehicle speed is a key element for estimating safe stopping, intersection and corner sight distances. In general, the posted speed limit is representative of the 85th percentile speed on the highway. A speed of 5 mph greater than the posted speed (i.e., design speed) or a measured 85th percentile speed shall be the basis for estimating safe stopping, intersection and corner sight distances for highways. The TIA shall base all analyses and improvement recommendations on a design speed derived from the existing posted speed limit. Recommendations for modifications to existing speed limits/design speeds fall outside the scope of a TIA. However, the TIA preparer may coordinate with the regional traffic engineer to make requests/recommendations to reduce the existing posted speed limit separately from the TIA process.

Discuss the design speed used to estimate safe stopping, intersection and corner sight distances as part of the safety review, and recommend improvements to address any deficiencies. The calculations for intersection sight distance at new driveways shall include adjustments for proposed geometry, including turn lanes and medians along the highway. For all intersections, including off-ramps, the analyst should evaluate sight distance to ensure that there is sufficient stopping sight distance to allow drivers to stop their vehicles completely prior to reaching the back of queue waiting at the intersection. To document the minimum and desirable sight distance requirements in relation to the field conditions, the TIA shall include photos and/or drawings as part of Exhibit 5-27.
The design vehicle to use in assessing intersection sight distance is dependent upon the land uses the access point will be serving. However, for most intersections, the analyst should evaluate sight distance based on a single-unit truck (SU) design vehicle. Due to the height difference of a passenger vehicle compared to a single-unit truck, the analyst should also evaluate intersection sight distance based on a passenger vehicle. Design vehicle decisions may require engineering judgment and/or discussions with WisDOT staff for further clarification. WisDOT may request adjustments to the calculated safe stopping, intersection and/or corner sight distances. The WisDOT regional traffic engineer shall approve the safe stopping, intersection and corner sight distances.

For additional information regarding intersection sight distance, refer to FDM 11-10-5.1 and AASHTO’s A Policy on Geometric Design of Highways and Streets, 6th Edition (i.e., AASHTO 2011 Green Book).

PART F — TRAFFIC CONTROL NEEDS

The TIA should identify, discuss and describe the need for the recommended traffic control treatments as they relate to the proposed development. This includes identifying the appropriate type and location of the required traffic control (e.g., no-control, yield-control, stop-control or signal-control) and/or recommended intersection/interchange type (e.g., roundabout, reduced conflict intersection, diamond interchange, etc.). Refer to FDM 11-25-3.1.3 for descriptions of the various traffic control and/or intersection/interchange types and guidance on when or when not to consider them. The TIA preparer should consult with the WisDOT regional office when considering traffic control and/or intersection type. It may be possible to address some of the requirements within the TIA scoping process.

The TIA shall identify and discuss the recommended traffic control treatments for the proposed development and describe their need. If the TIA considers an alternative form of traffic control or type of intersection/interchange as part of its recommended improvements and the subject intersection is on the STN and/or will receive funding through state or federal dollars, the analyst shall perform an Intersection Control Evaluation (ICE) study for that intersection. The TIA preparer shall include the ICE study as part of Appendix I of the TIA submittal to the WisDOT regional office.

Situations that generally trigger the need for an ICE study include:

- New traffic control
- Change in traffic control
- New or alternative type of intersection or interchange
- Introduction of access/median restrictions
- Off-setting intersections

The WisDOT regional traffic engineer shall approve the safe stopping, intersection and corner sight distances.
As detailed in FDM 11-25-3, the ICE process consists of the following two phases: 1) Phase I: Scoping ICE and 2) Phase II: Alternative Selection ICE. For purposes of the TIA report, the analyst shall provide a Phase I: Scoping ICE analysis for all study intersections as deemed appropriate by the WisDOT regional office.

The analyst shall complete the Phase I: Scoping ICE in accordance with FDM 11-25-3. The Phase I: Scoping ICE typically consists of a short memorandum (may be as short as one page) which documents all possible intersection types and/or traffic control alternatives considered. The specific content of the Phase I: ICE memorandum will vary depending on the project’s location, scope and the available data. However, the Phase I: Scoping ICE shall provide the following information:

- Project Description
- Description of Alternatives
- Safety Considerations
- Operational Considerations
- Other Considerations
- Feasibility of Alternatives
- Conclusions/Recommendations

Most of the information needed in the Phase I: Scoping ICE is already included in the TIA. A safety analysis that evaluates the crash data (same five years of crash data used for the project) is the only additional information required for the analysis. See FDM 11-25-3 for instructions on how to obtain and illustrate the crash data. The safety analysis shall identify existing crash patterns that may be of concern, emphasizing movements potentially impacted by the proposed development. As indicated in FDM 11-25-3, preparers are not required to include a crash diagram as part of the crash analysis in the Phase I: Scoping ICE but are encouraged to do so when evaluating a complex intersection to better identify crash patterns.

The ICE analysis and all supporting information that is not already part of the TIA shall be included in Chapter 6 of the TIA. The engineer reviewing the TIA will share the Phase I: Scoping ICE with the regional traffic operations staff and BTO for comment with a goal of establishing consensus on the recommended traffic control and intersection improvements.

PART G — TRAFFIC SIGNAL WARRANT ANALYSIS

Traffic signal warrants are the guiding principle for when to consider the installation of a traffic signal. See the Manual on Uniform Traffic Control Devices (MUTCD) - Section 4C and the Traffic Signal Design Manual (TSDM) Chapter 2 for traffic signal warrants (TSDM 2-3). Also, see the TSDM for design, capacity and operational guidance for signal control. A Traffic Signal Warrant Analysis shall be included for all proposed traffic signals.

In order for WisDOT to consider signalization of an intersection, the proposed signal location must meet at least one of the signal warrants. However, the analyst should conduct a complete engineering study (i.e., ICE) to assist with the decision to install a
traffic signal at a particular intersection. At a minimum, the analyst should evaluate MUTCD warrants 1, 2 and 3 for each proposed signal location. Depending on the specifics of the intersection, WisDOT may deem it necessary for the analyst to evaluate additional warrants. At least one of the warrants (generally warrants 1 or 2) must be satisfied before the State Traffic Signal Systems Engineer will consider the approval for the installation of a traffic signal. Satisfaction of Warrant 3 alone is not sufficient justification for the installation of the traffic signal.

The TIA preparer should view the warrants as guidelines and a decision-aid, not a legal requirement for the installation of a traffic signal. The satisfaction of warrants should not be the sole factor in determining the need to install a traffic signal. Rather, the primary justification for the installation of a traffic signal should be the intersection’s safety and/or operation improvement needs.

Please refer to the WisDOT TSDM for additional information on typical procedures used in conducting a signal warrant study. The TIA preparer should discuss region-specific procedures and methodologies with the regional traffic engineer prior to submittal of the TIA.

If proposing a signalized intersection, the analyst shall conduct a 12-hour intersection traffic count. WisDOT has developed hourly trip distribution percentages for specific land uses (e.g., shopping center, office, residential) that the analyst may apply to existing or new intersections when determining 12-hour volumes that include proposed development traffic. A spreadsheet showing the hourly trip distribution percentages available for use in Wisconsin can be accessed at the following link: http://wisconsindot.gov/dtsdManuals/traffic-ops/manuals-and-standards/12hour-traffic-dist.xlsx.

It is important to note that showing an unsignalized intersection operating at LOS F is not an acceptable justification for requiring traffic signal control. The analyst shall evaluate the need for traffic signals from a system standpoint, showing that the installation has positive benefits with minimal impact on progressive traffic flow.

If a signal installation is warranted, agreeable and subsequently approved by WisDOT, it should be located to facilitate signal coordination and traffic progression. WisDOT prefers a minimum spacing of 1200 feet between signalized intersections, but may require additional spacing on specific roadways. Consider traffic signal coordination at all signalized intersections within ½ mile (2,640 feet) of each other. Preserving the quality of flow and safety along public streets is contingent on the following factors:

- Relatively uniform spacing of traffic signals
- An ideal spacing between traffic signals for a given operating speed (optimum spacing being a function of progression speed and signal cycle length)
- An efficient through roadway bandwidth

Appendix I shall include any supporting documentation and calculations used to complete a warrant analysis for any recommended type of intersection control.
CHAPTER 6  CONCLUSIONS AND RECOMMENDATIONS

This chapter shall discuss conclusions about the analysis of existing and future conditions. Based on the conclusions of the analysis, the TIA shall make recommendations to mitigate identified deficiencies. A preferred improvement alternative should at a minimum, identify the following:

- Any required phased improvements
- Location and design of site access driveways
- Internal circulation plan
- Additional through and turning lanes
- Required turn lane extensions
- Any horizontal and/or vertical realignment
- Required traffic control devices
- Transportation demand management strategies which may be applicable to the particular development

FEASIBILITY OF IMPROVEMENTS

The TIA preparer and reviewer shall review all proposals to mitigate identified deficiencies to determine if they are feasible. For all feasible mitigation measures, identify the consequences, if any, of each measure (e.g., median closure, additional right-of-way needed, etc.). If it is uncertain, as to whether a mitigation measure is feasible, contact the regional traffic engineer for further guidance.

See FDM 11-25-3 and coordinate with your regional contact to determine if/when to complete the Phase I: Scoping ICE analysis. If applicable, include the ICE analysis with the submittal of the TIA to assist the region in selecting the appropriate traffic control, lane configuration and intersection type for an intersection.

Prior to the list of recommended improvements, the TIA preparer shall insert the following language in the TIA:

“Note that improvements are recommended to WisDOT for consideration and are not legally binding. WisDOT reserves the right to determine alternative solutions.”

In addition to the development-driven improvements identified within the TIA, the developer/municipality shall be responsible for all utility coordination and relocation costs on the existing and proposed roadway network. Utility companies shall only be responsible for utility coordination and relocation on standard WisDOT improvement projects involving improvements unrelated to the development.

CONCEPTUAL DRAWINGS

The TIA shall provide conceptual drawings for any alternative that has proposed changes to intersection geometry, including turn lane extensions. For improvements that do not result in a change in intersection geometry, the TIA preparer shall provide a
list of potential issues or conflicts as applicable (e.g., right-of-way, signal equipment locations, etc.). The conceptual drawing shall be to scale and superimposed on an aerial photo or topographic map.

Conceptual drawings for a roundabout shall include the outer diameter of the roundabout and the approximate approach geometry. Conceptual drawings for all-way stop control, signal control or any non-traditional intersection type shall include the proposed lane configurations, median width (if any), turn lane storage lengths, and transitions to match the existing roadway. The conceptual drawings shall show the existing right-of-way limits. Do not include pavement marking, signing, stationing, profiles or turning radii. The intent of the conceptual drawings is to show the approximate impacts of each intersection control alternative to assist in the determination of the appropriate alternative(s). Exhibit 6-1A and Exhibit 6-1B illustrate examples of acceptable conceptual drawings.

This chapter shall also include documentation on how the developer will notify others, if applicable, of the potential impacts associated with the proposed mitigation measures.
CONCLUSIONS AND RECOMMENDATIONS

Exhibit 6-1B

Willow Creek Development Traffic Study

Roundabout Alternative Intersection Conceptual Drawing

Exhibit 6-1B
CHAPTER 7  DESIGN CONSIDERATIONS

Consider the following guidance in the decision making process when evaluating the design of access points, intersection traffic controls, lane additions, medians, bridges or ramps. Please note that these design considerations may not reflect the most recent updates made to the WisDOT FDM, and thus, the WisDOT FDM standards supersede the guidance provided below. See noted reference for additional information.

The following design considerations are for guidance only. The TIA preparer shall not include this chapter in the official TIA report.

NEW ACCESS LOCATIONS

- Coordinate with the region to determine the proper spacing requirements between access points and adjacent intersections.
  - Spacing between rural access points shall be in accordance with FDM 11-5-5 Attachment 5.1
- Where possible, avoid locating the proposed access within the functional area of an existing intersection. The functional area includes (FDM 11-25-2.2):
  - Queue storage area
  - Turn lane tapers
  - Perception-reaction distance
- The following guidance detailed in FDM 11-10-5 shall be used to establish the proposed geometric design:
  - Provide adequate sight distance for all vehicles exiting from the minor street
  - Provide adequate stopping sight distance for major street volumes approaching the minor street
  - Provide adequate vision corners and intersection sight distance
  - Provide adequate storage for minor street exiting vehicles and major street entering volumes
  - Provide adequate decision sight distance on all approaches to intersections, specifically where traffic signals or roundabouts are proposed

NEW LANES

- Consider the following:
  - Are recommended lane widths appropriate? Are multimodal considerations included?
  - Are recommended lane widths consistent with existing widths?
  - Is there adequate space to accommodate additional lanes, especially if space is restricted?
  - Is there an adequate number of receiving lanes for right and left-turn lanes?
- Note: The analysis should reflect the recommended lane widths. WisDOT, or other appropriate maintaining authority, will ultimately have the final say in determining the appropriate lane widths. New turn lanes and/or extended existing turn lanes should not block adjacent streets or median openings.
necessary, access restrictions may be required.

- If there is sufficient median width at an access, the design should provide for the construction of a left-turn lane in accordance with FDM 11-25-5. If there is insufficient width or it is infeasible to expand the median to include a left-turn lane, the design should restrict inbound left-turn movements at the access point.

- For safety reasons, at locations where there is no median and left turn movements are present, unless volumes are very low, the design should provide for the installation of a left-turn lane or bypass lane (FDM 11-25-5).

- As detailed in FDM 11-25-10, the design should consider providing for right-turn lanes at the following locations:
  » At intersections on urban roadways posted 40 mph or lower that have significant right turn volumes
  » At all rural 2-lane public road intersections
  » At signalized intersections
  » Coordinate with the region for other situations that might warrant the consideration of right-turn lanes

- In accordance with FDM 11-25-5.5, the design should consider a left-turn by-pass lane (i.e. tee intersection bypass lane) at tee intersections along rural 2-lane non-community roads. Do not use left-turn by-pass lanes on 2-lane community roads; rather use exclusive left turn lanes with positive offsets.

**RIGHT OF WAY**

- Consider whether there is adequate right of way (ROW) available for the suggested improvements.

- Consider whether is there the ability to purchase additional ROW if necessary.

- Consider whether the ROW needs will affect an adjacent building’s parking lot, drive through or other critical facility.

- Consider impacts to multimodal transportation.

**TURN LANE LENGTH**

- Design the storage and taper lengths for turn lanes in accordance with the guidance provided in FDM 11-25-2.3

- Contact the regional traffic engineer for specific guidance regarding storage lengths and turn lane tapers

**QUEUE LENGTH CHECKS**

- Per FDM 11-25-2, the turn lane queue should fit within the existing/proposed storage at a minimum

- When evaluating the queues, consider whether the through queue blocks:
  » Turn lane storage openings
  » Median openings
  » Adjacent streets
**SIGNALS**

- Proposed signals should be a minimum distance of 1200 feet from adjacent signals (TSDM 3-3-3; FDM 11-5-5.3). Minimum spacing may be greater on certain roadways. Coordinate with the regional traffic engineer to determine proper spacing.

- Proposed signals should follow existing spacing patterns along the corridor

- Per TSDM 3-4-1, consider providing left turn phasing on an intersection approach when the product of the left turning volume and its opposing through ad right-turn volume meet or exceed the following requirements:
  - 50,000 for single left-turn lane crossing one through lane
  - 100,000 for single left-turn lane crossing two or more through lanes

- Per TSDM 3-3-5, the design should consider dual left turn lanes at locations where left turn volumes exceed 300 vehicles per hour (vph).

- If no signal exists and the TIA recommends the installation of a new signal, the analyst shall conduct a warrant analysis in accordance with FDM 11-50-50 and TSDM 2-3. As part of the signal warrant analysis, the analyst shall:
  - Locate the DOT 12-hour count for the intersection or nearest intersection for proposed new access if available. If a DOT 12-hour count is not available, the consultant should collect/develop one as part of a signal warrant analysis.
  - Determine timeframe when signal warrants are likely to be met (amount of development build-out).

- For the design and capacity analysis of a signalized intersection, the analyst should consider:
  - Whether the application of RTOR is appropriate. If so, they should coordinate with the regional traffic engineer for the appropriate reduction rates
  - Whether the traffic signal is (or will be) and isolated signal or whether it is (or will be) part of an existing or new signal system

**ROUNDBOAUTH CAPACITY ANALYSIS**

- Per FDM 11-25-3.1.3, when recommending new and/or modified traffic control at an intersection, consider the modern roundabout as a traffic control alternative when the minimum vehicular volume warrants for either all-way stop control or traffic signal control are met. There may also be situations where it is appropriate to consider a roundabout where an intersection has unique safety (e.g., significant right-angle crashes, limited intersection sight distance, etc.) or geometric concerns (e.g., skewed intersection, 5 plus approaches, etc.).
» Use the HCM methodology for the capacity analysis of a roundabout. As defined in FDM 11-5-3.7, the supported HCM-based traffic engineering software programs for roundabout analysis are:
   1. HCS
   2. SIDRA Intersection (HCM mode only)

• If access to either of the software packages listed above is not available, the analyst can program the HCM equations into a spreadsheet to conduct the roundabout capacity analysis.

• The table below shows the Wisconsin-specific minimum headway and follow-up headway values the analyst should use for the roundabout analysis.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Multi-Lane</th>
<th>Single-Lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Headway (aka Minimum Gap)</td>
<td>$t_c$</td>
<td>4.0 sec</td>
<td>4.2 sec</td>
</tr>
<tr>
<td>Follow-up Headway</td>
<td>$t_f$</td>
<td>2.8 sec</td>
<td>2.8 sec</td>
</tr>
</tbody>
</table>

**MEDIANS**

• Minimum width for a median is 6 feet curb face to curb face (FDM 11-25-5).
• Minimum width for a median with pedestrian storage is 8 feet curb face to curb face (FDM 11-25-5).
• Minimum width for a median with a left-turn lane is curb pan plus 6 feet curb face to curb face plus curb pan plus left-turn lane width (times number of lanes) plus median separation between the through lane and turn lane (if required) (FDM 11-25-5).
• A minimum 24-foot wide median is required to consider two-stage turning and crossing movements.

**BRIDGES**

• Consider whether the structure can accommodate the proposed improvements.
• When considering improvements to a structure, note that a raised median on a structure is extremely difficult to remove. Thus, the analyst should consider potential improvements that avoid median removal.
• Assess whether it is feasible to widen the existing structure to accommodate the proposed improvements.
• Verify that the bridge clearance heights to the underpass roadway meet FDM requirements (FDM 11-35-1).
• When proposing improvements underneath a bridge structure, the analyst should review the width available under the structure to verify that it is sufficient to accommodate the proposed improvements (lanes and shoulders).
RAMP STORAGE

- The proposed design shall provide sufficient stopping sight distance (SSD) for vehicles exiting the mainline to stop safely before reaching the back of queue for the upstream intersection. AASHTO’s requirements for SSD on ramps, as specified in Chapter 10 of the AASHTO 2011 Green Book, are as follows:
  » The ramp storage distance, or the distance from the point on the ramp where the traveled width is 12’ to the back of queue, shall be at least as great as the distance needed to allow appropriate deceleration from the design speed on the mainline to a stop condition.
  » The analyst should use an iterative process to determine the design speed for loop/curved ramps.

- Contact the regional traffic engineer for additional details on calculating the appropriate ramp storage distance

BICYCLE AND PEDESTRIAN ACCOMMODATIONS

- In accordance with FDM 11-46, follow design guidance and evaluation criteria for bikeways and pedestrian ways. Specific FDM sections to refer to include:
  » FDM 11-46-5 Pedestrian Facilities
  » FDM 11-46-10 Curb Ramps
  » FDM 11-46-15 Bicycle Facilities

- See the following additional references for guidance on bicycle and pedestrian facilities:
  » Wisconsin Bicycle Facility Design Handbook, Chapter 4, Shared-use Paths (http://wisconsindot.gov/Documents/projects/multimodal/bike/facility.pdf)

- Per FDM 11-46-5.1, pedestrian facilities are required to be accessible to people with disabilities. Newly constructed and altered facilities shall be ADA-compliant.

- Provide ADA-compliant curb ramps at intersections (including traffic islands and medians) and mid-block crossings where a sidewalk or other pedestrian walkway crosses the curb at locations where crosswalks (either marked or unmarked) are present on alteration improvement project types.

- Coordinate with the regional and statewide bicycle and pedestrian coordinators for additional guidance. Contact information is provided via the following link: http://wisconsindot.gov/Pages/projects/multimodal/bikeplan2020.aspx
**GLOSSARY**

Reference the following glossary for guidance only. The TIA preparer **shall** not include the glossary in the official TIA Report.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Average Daily Traffic (AADT)</td>
<td>The estimate of typical daily traffic on a road segment for all days of the week, Sunday through Saturday, over the period of one year.</td>
</tr>
<tr>
<td>Annual Average Weekday Traffic (AAWDT)</td>
<td>The estimate of typical traffic over the period of one year, for the days Monday through Thursday, calculated from permanent counter data as the sum of Monthly Average Weekday Traffic (MAWDTs) divided by the number of MAWDTs.</td>
</tr>
<tr>
<td>ADA</td>
<td>Americans with Disabilities Act of 1990</td>
</tr>
<tr>
<td>Area of significant traffic impact</td>
<td>The geographical area upon which the site traffic will have a significant impact on the transportation facilities</td>
</tr>
<tr>
<td>Background traffic</td>
<td>Traffic volumes that exist prior to the influence of the subject development or other identified off-site developments in the vicinity</td>
</tr>
<tr>
<td>Build traffic</td>
<td>The background/base traffic plus the on-site development or off-site development (new) traffic that is expected to be using the roadway network first (whichever development that occurs first is to be included in the build traffic)</td>
</tr>
<tr>
<td>Capacity</td>
<td>The maximum hourly rate at which vehicles can reasonably be expected to traverse a point or uniform section of a lane or roadway during a given time period under prevailing roadway, traffic, and control conditions</td>
</tr>
<tr>
<td>Design speed</td>
<td>Typically equal to the posted speed plus 5 mph</td>
</tr>
<tr>
<td>Development traffic</td>
<td>Estimated traffic volumes generated by a proposed development</td>
</tr>
<tr>
<td>Feasibility analysis</td>
<td>The determination of whether or not a mitigation measure can be accomplished without significant harm to other properties, and if it is possible within the confines of the highway corridor</td>
</tr>
<tr>
<td>G/C</td>
<td>The ratio of green time to total cycle time for a traffic signal.</td>
</tr>
<tr>
<td>Horizon year</td>
<td>The year in the future determined appropriate for the analysis. Generally, the horizon year is the greater of either 10 years after the opening of the proposed development or 5 years after build out of the project.</td>
</tr>
<tr>
<td>Influence area</td>
<td>The geographical area surrounding the site from which the development is likely to draw a high percentage of the total site traffic.</td>
</tr>
<tr>
<td>Internally linked trips</td>
<td>A trip where a user stops at multiple land uses within the development, but only makes one trip in and one trip out on the state highway network. This reduces the total trips entering the development study area, thus lowering driveway trips.</td>
</tr>
<tr>
<td>Level of service (LOS)</td>
<td>A quantitative stratification of a performance measure or measures that represent quality of service, measured on a scale of A to F, with LOS A representing the best and LOS F representing the worst operating conditions from the traveler’s perspective.</td>
</tr>
<tr>
<td>Mode split</td>
<td>The estimation of the number of trips made by each mode (automobile, pedestrian, transit, etc.) used by site-generated traffic</td>
</tr>
<tr>
<td>Off-site traffic</td>
<td>Traffic volumes generated by off-site developments within the study area</td>
</tr>
<tr>
<td>Glossary Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pass-by trips</td>
<td>Trips, currently on the roadway system, that make an intermediate stop at a generator (i.e., the development under study) with direct access to the roadway network that is adjacent to the original travel route between the origin and primary destination. Pass-by trips do not include trips that divert from their original travel path non-adjacent to the site (i.e., diverted trips).</td>
</tr>
<tr>
<td>Peak Hour Factor (PHF)</td>
<td>The ratio of total hourly volume to four times the maximum 15-minute volume within the analysis hour. A measure of traffic demand fluctuation within the analysis hour. The analyst shall calculate the peak hour factor by intersection.</td>
</tr>
<tr>
<td>Saturation flow rate</td>
<td>The equivalent hourly rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions; assuming that the green signal is available at all times and no lost times are experienced.</td>
</tr>
<tr>
<td>Stopped delay</td>
<td>The amount of time an individual vehicle spends stopped in a queue while waiting to enter an intersection.</td>
</tr>
<tr>
<td>Study area</td>
<td>The portion(s) of the transportation system directly affected by the planned development, to be included within the scope of the TIA analysis.</td>
</tr>
<tr>
<td>Total traffic</td>
<td>Background traffic plus the on-site development traffic and the off-site development traffic, if applicable.</td>
</tr>
<tr>
<td>Trip generation</td>
<td>The estimation of the number of trips generated to and from a site resulting from the land-use activity on that site.</td>
</tr>
<tr>
<td>Traffic generator</td>
<td>A designated land use (residential, commercial, office, industrial, etc.) that generates vehicular and/or pedestrian traffic to and from the site</td>
</tr>
<tr>
<td>Traffic impact</td>
<td>The effect of development traffic on highway operations and safety</td>
</tr>
<tr>
<td>Traffic impact analysis</td>
<td>An engineering study that determines the potential impacts the expected traffic of a proposed traffic generator will have on the surrounding roadway network. The study includes a recommendation of roadway improvements that may be necessary to accommodate the additional traffic. A complete analysis includes an estimation of future traffic with and without the proposed generator, analysis of traffic impacts, and recommended roadway improvements, which may be necessary to accommodate the expected traffic.</td>
</tr>
<tr>
<td>Traffic mitigation</td>
<td>The reduction of traffic impacts on roadways and/or intersections to provide an acceptable level of service</td>
</tr>
<tr>
<td>Trip assignment</td>
<td>Determines the amount of the proposed development traffic plus off-site traffic that will use each access point and route in the study area</td>
</tr>
<tr>
<td>Trip distribution</td>
<td>The allocation of the trips generated by the proposed development between all possible approach and departure routes.</td>
</tr>
</tbody>
</table>