
Transportation Impact Study Guidelines



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1 INTRODUCTION

The Transportation Impact Study Guidelines provide applicants with general direction for the level of detail to present in transportation impact studies. Following the guidelines when preparing a transportation impact study provides a standard process, set of assumptions, analytic techniques, and presentation format for preparing a Transportation Impact Study (TIS) and facilitates an efficient review process.

Section 2 of these guidelines discusses the requirements for transportation impact letters, detailed transportation impact studies(TIS) and master transportation impact studies (MTIS) as determined by the City of Littleton Transportation Group. Section 3 describes the Traffic Letter/TIS analysis requirements and methodologies, while Section 4 presents the required TIS report format. Sections 5 and 6 discuss submittal and revision requirements, respectively.

The City of Littleton (City) encourages developers to maintain contact with City personnel throughout the development process.

2 REQUIREMENTS FOR TRANSPORTATION IMPACT STUDY

The TIS evaluates the impact of site-generated traffic on the existing and future roadway & multimodal systems and recommends improvements necessary to maintain a safe and effective roadway system. The City Transportation Group reviews the TIS, which assists City staff, the Planning Commission, and the City Council in assessing a proposed development's effects. The subsections provided below outline TIS requirements and are not considered optional. Additional requirements are in the City of Littleton Engineering Design Standards (LEDS).

The site developer/owner is responsible for evaluating the traffic and multimodal impacts associated with an application for development approval. The evaluation of these impacts shall be contained within a TIS report. The report shall be prepared under the supervision of and sealed by a Licensed Professional Engineer in the State of Colorado with experience in traffic engineering and transportation planning/engineering.

Table 1 provides a general list of TIS requirements by type of development submittal. Since individual sites differ, the city Transportation Group will determine actual requirements on a case-by-case basis. The site developer/owner is responsible for confirming with the City Transportation

Group if a transportation impact letter, study, or master/detailed transportation impact study is required. In addition, City staff may require a scoping meeting before a formal submittal of a TIS.

Since the need for a TIS report depends on site-specific characteristics such as location, trip generation, existing road conditions, and type of development submittal, requirements may vary from site to site. Applicants are strongly required to attend a pre-application meeting with staff. At the pre-application meeting, site-specific traffic requirements and other areas can be discussed early in the development process. Pre-application meetings can be arranged through the City's Community Development Department.

Table 1 – Summary of When to Prepare a Transportation Impact Study

Application	Traffic Impact Study (TIS)			Explanation
	Traffic Letter	Detailed TIS	Master TIS	
Rezoning (Site > 5 acres)		√	√	Increased intensity will require a detailed or master TIS if the rezoned parcel is five acres or more. A rezoning analysis will include a comparison of the proposed site-generated traffic to the projected traffic from the existing zoning use.
Rezoning (Site < 5 acres)	√	√		Parcels less than five acres may require a detailed TIS or a transportation letter, depending on the specifics of the rezoning proposal.
Rezoning (reduction in trip intensity)	√			A detailed TIS typically will be required if the proposal is a downzoning not in use.
Master Plan			√	A master plan TIS is required, unless identified by City Transportation Group that it is not required.
Change in Access from Approved Master Plan		√		A detailed TIS is required, unless identified by City Transportation Group that it is not required.
Site Plan for New Development*	√	√		A transportation letter is required when a site is estimated to generate less than 50 trips per hour at any time of the day. A detailed TIS will be required in conjunction with a site plan where the site is estimated to generate 50 or more trips per hour at any time of the day or where an unusual condition exists which warrants study (such as existing high volumes, high accident incidence, commercial connection to residential area, etc.).
Amendment to Site Plan or Additional Facility to Already Existing Site*	√	√		A detailed TIS will be required if the surrounding environment has significantly changed since the plan was originally approved or trip generation exceeds 10% of existing use.
Approval for Conditional Use*	√			A detailed TIS will typically be required with a Conditional Use Approval when trip generation exceeds 10% of the existing use.

*** City Transportation may require a detailed TIS to varying degrees in the event that a site is in an area with ongoing safety performance concerns, is adjacent to a site with high vulnerable user activity (e.g., schools), or any other scenario determined at City Traffic's discretion.**

Notes:

1. If a site has been previously studied and the land use change results in a greater than 10% increase in daily trips, a detailed TIS will be required.
2. Pass-by and internal capture adjustments are not part of the trip generation exercise that determines the need for a detailed study.
3. City Transportation Group may require additional scope than what is indicated by this table.

2.1 Revisions and Updates

A revision or update to an approved TIS may be required if:

- It is more than two years old.
- Changes to the development proposal have been made that significantly affect trip generation or traffic patterns as indicated by a 10 percent or greater increase in average daily OR peak hour site-generated traffic volumes.
- There have been significant changes to the surrounding area that would affect background traffic conditions.
- Changes to the street network including site access or internal changes to traffic flow patterns.
- Background traffic conditions differ due to changes to the surrounding area.

If the currently approved study was prepared within the last two years, an amendment letter addressing the changes may be accepted and satisfy the requirements of this guideline. The letter must address a) an estimate of site trip generation, b) existing site trip generation, c) the differences between anticipated estimates and existing trip generation, and d) changes to the bicycle or pedestrian facilities. If the original study is older than two years, an entirely new study may be required by the City Transportation Group.

Updates may also be requested at the discretion of the City Transportation Group. Confirm with the City Transportation Group if an update will be required.

In any revisions prepared for a TIS that has already been accepted by the City, reference the date and title of the original document submitted. Provide a summary list indicating what parts of the original document were revised. Clearly present the new conclusions and specify which conclusions from the initial report remain valid.

2.2 Access to State Highways

Even if the City Transportation Group does not require a TIS report, the Colorado Department of Transportation (CDOT) may still require a study to support a state highway access request. Developers of any site that has or proposes access to a state highway must contact CDOT Region 1 for specific access and traffic analysis requirements.

Developers are encouraged to contact CDOT early in the review process to determine the feasibility of proposed access point(s) to the state highway. The City Transportation Group requires a letter from CDOT indicating they have reviewed the proposed access(es) and have given preliminary concurrence with the access(es). Actual approval and issuance of a CDOT access permit is completed by CDOT at the time of civil plans review. The letter's purpose is to show Planning Commission and City Council that the developer is working with CDOT and has access to the state highway. The letter must be received ten (10) days prior to the Planning Commission hearing for review and shall be considered expired after one year upon issuance.

3 ANALYSIS REQUIREMENTS AND METHODOLOGIES

This section describes the study parameters and various types of analyses that may be included within a TIS. In addition to following the requirements and methodologies outlined below, a discussion of the analysis process and results is also necessary. Refer to Section 4 for where each type of analysis is required.

3.1 Study Parameters

3.1.1 Analysis Horizons

Three study horizons are required for a Master or Detailed TIS analysis: the existing horizon (current), the site buildout/short range horizon (short range build-out), and the long-range horizon (20 year).

Existing Horizon

The intent of completing an analysis of the existing (current) study horizon is to establish a baseline of traffic conditions.

Site Buildout/Short-Range Horizon

The intent of the short-range planning horizon is to investigate the immediate impacts of the completed, proposed project on the existing and committed roadway network. If the project is proposed to occur over multiple phases, each phase shall be evaluated.

Long-Range Horizon

The third planning horizon is the long-range planning horizon. The long-range horizon year shall be based on the current Denver Regional Council of Governments (DRCOG) Transportation Plan 20-year planning horizon and approved by the City Transportation Group.

3.1.2 **Study Area**

The limits of the transportation network to be studied shall be defined for all levels of TIS analysis and are based on the size and extent of the application for development approval, the existing and future land uses, and traffic conditions on and near the site.

The TIS study area should encompass the roads adjacent to the site, up to the next major arterial intersection. This includes all access points, signalized and unsignalized arterial/collector and arterial/access drive intersections, in addition to internal intersections to site that are collector/collector and above.

3.2 Level of Service

One of the main goals of a TIS is to identify needed roadway and intersection improvements to mitigate site impacts. Level of service (LOS), as defined in the latest version of the Highway Capacity Manual (HCM), will serve as the means

for evaluating traffic operations. Explain any deviations from the analysis procedures or default variables presented in the HCM.

Present LOS values for peak hour periods for existing traffic, future background traffic, future total traffic, and any interim phase discussed in the study in a table. The recommended table format for presenting intersection LOS shall include the LOS and delay for the lane groups/turn movements and the overall intersection. Any LOS E or F operations shall be highlighted in the analysis discussion. Discuss all analysis findings and any changes to the intersection delay resulting from the proposed site. This discussion should also include any recommendations for improvements. As applicable, calculate the LOS/delay for the recommended improvements to demonstrate that the intersection will be improved, and an acceptable LOS/delay will be achieved. Clearly label and include any HCM input/output reports in an appendix. For LOS outputs at signalized intersections, include specific information regarding all signal timing assumptions and phasing and operational assumptions such as left turn type, etc.

Peak hour (typically AM and PM, however, can vary if the peak is different than typical rush hour periods) operations will need to operate at LOS D or better. If the existing LOS for an intersection is worse than LOS D, discuss potential alternatives to improve the intersection to achieve LOS D or maintain the existing critical lane volume with the addition of site-generated traffic.

Determine LOS for the study area intersections using HCM methodologies. Provide a description and brief justification for the input values used in the analyses. When analyzing City-owned signals for existing conditions, use the existing signal timing plans with information from the City Transportation Group.

LOS analysis shall be completed using the latest approved version of Synchro/HCS software. Coordination with City Transportation Group is required to use any other analysis software. All LOS reports must be the HCM methodology outputs.

Table 2 shows the thresholds for acceptable LOS for definition purposes. All intersection components shall meet the following requirements.

Table 2 – LOS Thresholds

	Overall	Any Approach Leg	Any Movement
Signalized	D	D	E ³
Unsignalized	-	-	E ^{1,2,3}
Roundabout	D	D	D

¹Mitigation may be required.

²May be appropriate for minor approaches turning onto an arterial.

³Movements that have lower traffic volumes and a viable travel alternative may be allowed to fall below LOS D.

3.2.1 **Roundabout Capacity Analysis**

If traffic signal warrant(s) or multiway stop warrant is met, a roundabout shall also be considered at the intersection, at the City's discretion. Use HCM methodology for the capacity analysis of a roundabout.

The latest approved version of Synchro/HCS software may be used to analyze single-lane circulating and single-lane approach roundabouts. All other roundabout types must be analyzed using the latest approved version of SIDRA software. All reports must be the HCM methodology outputs.

3.3 **Traffic Control Devices**

The appropriate type and location of required traffic control, such as stop signs, yield signs, traffic signals, or roundabouts, should be identified as part of the analysis.

3.3.1 **All-Way Stop Control**

The need for all-way stop control at an intersection shall be analyzed by applicable all-way stop control warrants presented in the Manual on Uniform Traffic Control Devices (MUTCD), latest edition.

3.3.2 **Signalization**

Signal warrant analysis for potential signal locations shall consist of a review of the applicable signal warrants contained in the MUTCD. A signal warrant study using actual traffic counts. 72-hour traffic counts are necessary for signal warrant analysis. For the analysis of future signals, volumes must also include site-generated traffic. Indicate which warrants are met. Traffic signals will only be considered for installation if at least one of the warrants is met, except for Warrant 3. Warrant 3 Peak Hour warrant is by itself not sufficient for consideration of signalization except under unusual circumstances at the discretion of the City Traffic Engineer. For warrant purposes, the minor street approach traffic shall typically be comprised of all through and left-turn movements and 50 percent of right-turn movements.

Signals shall be located and spaced according to the latest version of the Littleton Engineering Design Standards. If a new signal is proposed at a location other than what is described in the standards, prepare a progression analysis to ensure the new signal can be made to fit within established progression patterns. Cycle lengths between 90 and 150 seconds should be considered in five (5) second increments. In emerging areas, the proposed signal must meet a minimum of 35 percent bandwidth, while existing areas should meet a minimum of 30 percent bandwidth. If existing conditions are less than 30 percent along a road segment, the analysis must show that the new signal will not degrade progression beyond established conditions. Obtain base signal timing assumptions from the City Transportation Group to conduct the analysis. The timing assumptions used in the progression analysis must be consistent with those used in the LOS analysis.

While progression will be an important consideration in the approval of a new signal, another factor considered is the signal's position in relation to accesses on the opposite side of the street(s). The City Transportation Group may allow progression to suffer to a moderate extent in exchange for a location that serves the optimum number of users associated with the subject site and adjacent areas. Each proposal will be evaluated on a case-by-case basis.

3.3.3 **Roundabouts and Other Alternative Intersections**

The Federal Highway Administration's (FHWA) "Roundabouts: An Informational Guide," as well as other sources, identify numerous site-specific conditions that may favor or preclude the use of a roundabout for various situations. Other types of reduced-conflict intersection types, such as Continuous Flow intersections (CFI) and J-turn intersections, may be considered at the City's discretion or request and should be taken into consideration in an alternatives analysis, depending on the site-specific safety and operational concerns that are present.

Alternative intersection control types shall be determined using FHWA's intersection control evaluation (ICE). The objective of the alternate consideration is to document the decision-making process, which demonstrates that the recommended intersection type is (or is not) the most appropriate intersection control form. The scope of the feasibility study will vary depending on project conditions and the type and complexity of the intersection geometry.

3.4 **Queuing Analysis**

A queuing analysis shall be performed for all intersection approach lanes within the study area. An evaluation shall be made of queue lengths that should be accommodated at intersections in close proximity to each other, and the results should be discussed. Queue lengths shall be evaluated for left-turn and right-turn lanes to ensure the queues do not overflow into adjacent through lanes. For roundabouts, this requires the use of SIDRA or Synchro as defined in Section

3.2.1. Through movement queues should be evaluated to confirm they do not obstruct turn lane entrances or extend back into adjacent intersections. Queuing analyses should indicate the available vehicular storage will be adequate 95 percent of the time during peak hours. SIDRA or Synchro vehicle queuing information shall be provided in the Appendix.

3.4.1 **Auxiliary Lane Analysis**

If additional turn, acceleration, or deceleration lanes are recommended, include the bases for the recommended length of the auxiliary lanes and tapers and discuss the results in the body of the report.

The City may apply the State Highway Access Code (SHAC) to determine when an auxiliary lane is required for all roadways within Littleton. The City applies SHAC requirements on auxiliary lane taper and storage lengths to State Highway facilities. For auxiliary lane design on collector and local roadways, the City uses SHAC for taper lengths only. Storage length for auxiliary lanes on collector and local roadways is determined by the 95th percentile queueing analysis as prescribed by these Guidelines.

This information should be included in a figure within the study for larger projects. A summary of the auxiliary lane analysis shall be presented in a table, including the queue lengths and recommended storage and taper lengths. Any inputs, such as design or posted speed, used in the auxiliary lane analysis shall also be discussed and presented in the summary table.

4 TRANSPORTATION IMPACT STUDY REPORT FORMAT

In general, the TIS describes existing conditions, evaluates conditions at full build-out of the site, and evaluates future (20-year projection) conditions. Table 3 presents the transportation impact study outline requirements for each of the study types.

Table 3 – Transportation Impact Study Outline

Outline Requirements	Study Type	
	Traffic Letter	Detailed TIS / Master TIS
Executive Summary		✓
I. Introduction	✓	✓
<i>Applicable Figures: Vicinity Map, Site Plan</i>		
II. Existing Conditions	✓	✓
<i>Applicable Figures: Existing Volumes, Existing Geometry w/ Existing LOS</i>		
III. Future Background Conditions		✓
<i>Applicable Figures: Background Volumes, Existing Geometry w/ Background LOS</i>		
IV. Proposed Conditions	✓	✓
A. Site Trip Generation	✓	✓
<i>Applicable Tables: Site Generated Traffic</i>		
<i>Applicable Figures: Proposed Geometry & Intersection Control</i>		
B. Trip Distribution	✓	✓
<i>Applicable Figures: Proposed Geometry w/ Distributed Site Generated Volumes</i>		
V. Future Proposed Conditions		✓
<i>Applicable Figures: Background + Site Generated Volumes, Proposed Geometry w/ Corresponding Level of Service (LOS)</i>		
VI. Evaluation	✓	✓
A. Traffic Calming		✓
B. Pedestrian/Bicyclist Connectivity and Enhancements	✓	✓
C. Safety Evaluation		✓
<i>Applicable Tables: Queuing Summary, Auxiliary Lane Lengths Summary, Signal Warrant Summary</i>		
VII. Conclusions/Recommendations	✓	✓
<i>Applicable Tables: Proposed Improvements Summarized w/ Cost Responsibility</i>		
Appendices		✓
Traffic Count Data		✓
LOS Comparison Table		✓
Applicable Pages from Referenced Studies/Reports	✓	✓
Operational Analysis Output Reports		✓
<i>Applicable Reports: LOS Reports, Queue Reports, Signal Timing Reports, Roundabout Analysis Reports</i>		
Calculations		✓
Conceptual Drawings (if applicable)		✓
Traffic Signal Warrant Study		✓

Appendices to the study should include applicable traffic data and documentation for the technical analyses. The [City of Littleton Transportation Master Plan](#) should be reviewed to ensure roadway classifications and alignments presented are consistent with the City plans. Exceptions may be appropriate where significant changes in planning have occurred subsequent to the most recent plan.

4.1 Introduction

The transportation impact study's introduction section summarizes the study's purpose and provides site background information. This section includes a description of the proposed site development, current and proposed land use, site size, access locations, type and control, and the study area. Site access shall be provided in accordance with the Littleton Engineering Design Standards, latest edition. Describe any development phasing in this section. Information presented in this section and the remainder of the transportation impact study must be consistent with the site characteristics presented on the plans included with the development application. The introduction shall also include a vicinity map and site plan to visually depict the information.

When a Detailed TIS or MTIS is required, an executive summary of the study findings shall be included before the introduction.

4.2 Existing Conditions

Present descriptions of the existing site access points, surrounding developments, land uses and zoning, speed limits, and road classifications. Identify the existing lane geometry, posted speed, traffic control devices, and signal phasing of key intersections and nearby roadways. Also note any unusual terrain features (steep grades, limited sight distance, railroad crossings, etc.) in this section.

Graphically present existing traffic data for the site, including AM and PM peak hour volumes by movement and daily traffic volumes on roads in the vicinity of the site. Traffic volume data older than two years are not acceptable. Actual traffic count data is required where feasible since recently collected traffic counts can best represent actual conditions. The owner/developer is responsible for collecting the data. Traffic counting firms and traffic consultants can be contracted to perform data collection. Traffic volume data collection shall include a 24-hour traffic count, mid-block count, or other similar method for all site-adjacent streets. Along with traffic volume data, existing data regarding vehicle classification, including percentage of large trucks, shall also be provided and discussed.

This section shall also include a discussion of the analysis of the existing operational performance of the study intersections as outlined in Section 3.2. The existing LOS shall be depicted in a figure with the existing geometry. Intersection LOS shown on figures shall be the overall LOS, except for two-way stop-controlled intersections which shall display the critical movement LOS. A table presenting a more detailed look at LOS by movement shall be provided in accordance with Section 3.2.

4.2.1 Crash Analysis

Crash analysis is required for infill projects on existing arterial roadways and/or projects on the DRCOG High Injury Network. Additionally, the City Traffic Engineer can request a crash analysis for any location at any stage of the development review process.

Data Sources and Analysis Tools

The analysis shall utilize three (3) years of crash data. Crash data can be sourced from the CDOT website (CDOT Crash Data). Analytical software, like DiExSys, is recommended for comprehensive analysis.

Crash Data Summary and Analysis

Crash data must be systematically organized into tables to effectively identify and analyze safety issues. Each access point and intersection surrounding the property will have a dedicated table summarizing crash types by severity, highlighting disproportionately common crash types and their severity. Environmental factors such as lighting, roadway conditions, and the time of day should also be documented, potentially in graphical formats, to illustrate trends.

Site Specific Evaluation

This part of the review will assess site-specific aspects, such as:

- Movement restrictions (e.g., full movement, $\frac{3}{4}$ movement, right-in/right-out)
- Type of traffic control (e.g., Signal, all-way stop, two-way stop)
- Sight distances
- The condition and visibility of traffic control devices
- Access spacing
- Other site-specific factors

Mitigation Development

Findings from the Crash Data Summary and Analysis section and the Site Specific Evaluation shall be provided to the City Traffic Engineer. The City will evaluate the safety analysis and the associated proposed safety mitigation strategies to determine if those measures are appropriate. The development will be responsible for implementing the identified safety mitigation measures. Effective countermeasures can be referenced from the Federal Highway Administration's list (FHWA Safety Countermeasures), and their effectiveness is verified through the CMF Clearinghouse (CMF Clearinghouse). This section aims to guide the reduction of crash frequencies through proven data-driven safety measures.

4.3 Future Background Volumes

Future conditions should be evaluated for the short-range and long-range horizon years. The short-range horizon year is represented by the anticipated buildout year of the site, and the long-range horizon year shall be 20 years from the baseline year. Generally, the baseline year will be the year of the existing traffic conditions. Traffic volume data from developments adjacent to the proposed site are available from the City upon request. For some cases, it may be necessary to calculate future background traffic by applying an appropriate growth rate factor per year, compounded annually, to existing traffic. Growth rates may be determined using DRCOG or CDOT regional traffic count and forecast data. If a growth rate cannot be determined using published data, a 2 percent growth rate may be used. In either case, the estimates should account for future development adjacent to or near the proposed site based on the current zoning for undeveloped parcels within the study area. In addition, consideration and discussion of any transportation improvements occurring or planned for the surrounding area should also be provided. A discussion of how background traffic volumes were determined is required. If the distribution of future traffic volumes is different than that for existing traffic, provide an explanation of the variance with supporting data. Include figures illustrating the short-range and long-range projected background daily and peak hour traffic volumes.

This section shall also include a discussion of the analysis of the background operational performance of the study intersections as outlined in Section 3.2. The background LOS shall be depicted in a figure with the planned/expected geometry. Intersection LOS shown on figures shall be the overall LOS, except for two-way stop-controlled intersections which shall display the critical movement LOS. A table presenting a more detailed look at LOS by movement shall be provided in accordance with Section 3.2.

4.4 Proposed Conditions

Discuss the traffic impact created by the proposed site development, including trip generation, distribution and assignment. If the site is phased, prepare trip generation estimates for the interim time interval as appropriate and include the results in this section. Estimate the proposed conditions by determining site-generated trips and then assigning the trips to the road network as described in the following subsections.

This section should also include a discussion and figure of the site's proposed access, including spacing from other accesses and/or intersections, type, and control. Site access shall be provided in accordance with the Littleton Engineering Design Standards.

4.4.1 **Site Trip Generation**

The trip generation rates/equations from the most current *Trip Generation Manual* (and updates) published by the Institute of Transportation Engineers (ITE) shall be used to estimate the site trip generation. In specific instances where the *Trip Generation Manual* does not have a classification directly related to the proposed development, trip generation estimates can be based on the operational characteristics of the proposed use or collected data from similar sites in similar settings. If an alternative to the *Trip Generation Manual* is used, discuss the applicability and document the source(s) used.

Trip generation estimates shall be summarized in a table and thoroughly discussed in the report. In the table, trip generation shall be itemized by use or traffic analysis zone (if appropriate) and include:

- ITE trip generation category code
- Description
- Unit type
- Number of units

- Trip generation rates/equations
- Daily trips generated

Peak hour trips generated in and out and parameters used to determine the trips generated (i.e., average rate or equation, peak generator or peak of the adjacent street, etc.) shall be included in a footnote of the table. Further discussion of the method used is necessary when using a less conservative approach.

Trip Reductions

If applicable, introduce trip reductions in this section and provide supporting references. Trip reductions may be a result of pass-by or internal capture trips. Pass-by trips describe the number of trips that access the proposed site on their way to their intended destination. Internal capture trips represent the number of vehicles going to and from destinations within the same mixed-use development without accessing the external roadway network. In both cases, trips are considered existing rather than new. Justification must be provided for all trip reductions, and trip balancing is recommended following any adjustments. Present any trip reductions in the same table as generated trips.

4.4.2 ***Trip Distribution***

This sub-section describes the directional orientation of the site-generated traffic. Depict the study area traffic distribution percentages on a figure with the distributed site-generated volumes and describe the basis for selecting the distribution percentages in the text. Distributed traffic volumes presented shall include daily and peak hour volumes. The distribution percentages should be based on actual traffic. If actual counts are not collected or available for some roads within the study area, distribution may be based on DRCOG estimates,

City Planning estimates, or other appropriate methods as approved by the City Transportation Group. Distribution may also be based on the professional engineer's judgment applied to one or more of the following: regional MPO traffic volume projections, market analysis, existing traffic flows, or applied census data. Regardless of the basis of the estimates, the procedures and rationale used in determining the trip distributions must be fully explained and documented.

Depending on the complexity of the proposed site (i.e., the presence of multiple types of generators/land uses), the City may require additional details regarding distribution. This includes, but is not limited to, distribution percentages by land use and/or intersection turning movement.

4.4.3 Trip Assignment

The project traffic will be assigned to the roadway system according to the trip distribution established above. The resulting project site-generated traffic and total site traffic will be depicted in the figures for each analysis horizon. These figures will include peak hour traffic volume information as well as daily traffic volume information.

4.5 Future Proposed Conditions

The total future traffic includes the future background traffic plus the estimated site-generated traffic. Present a figure showing the background plus site-generated traffic for the peak hours and daily traffic volumes for all adjacent streets. Describe the results in the text. Trip balancing is required following any adjustments. Any recommended changes to the existing geometry shall also be discussed.

This section shall also include a discussion of the analysis of the study intersections' total future traffic operational performance as outlined in Section 3.2. The total future traffic LOS shall be depicted in a figure with the proposed

geometry. Intersection LOS shown on figures shall be the overall LOS, except two-way stop-controlled intersections which shall display the critical movement LOS. A table presenting a more detailed look at LOS by movement shall be provided in accordance with Section 3.2, and mitigation should be discussed for any operation that falls below LOS E or worse.

4.6 Evaluation

Discuss the impact on sensitive areas such as residential areas and streets fronting schools. Justification for proposed geometry and intersection control should also be discussed. A queuing analysis shall be performed in accordance with Section 3.4 and summarized in a table. When signals are recommended, perform and discuss a signal warrant analysis per Section 3.3.2 and provide a table summarizing findings. When auxiliary lanes are recommended, perform and conduct an auxiliary lane analysis per Section 3.4.1 and provide a table summarizing findings.

Site evaluation should also consider, at a minimum, traffic calming needs, pedestrian and bicyclist connectivity and enhancements, and safety as described in the sub-sections below.

4.6.1 Traffic Calming

The City shall determine the need for traffic calming measures during the project scoping meeting. When required, a discussion of the application of elements from the City of Littleton Traffic Calming Toolbox and countermeasures applicable from the FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (latest edition) to address any concerns for speeding, pedestrian crossings, etc. Techniques in the Traffic Calming Toolbox include:

- Advanced Yield Lines
- Enhanced Crosswalk

- High-Visibility Signs and Markings
- In-Street Pedestrian Crossing Signs
- Enhanced Pedestrian Crossing Sign Devices (HAWK or RRFB)
- Mid-Block Lane Narrowing (Pinch Points)
- Curb Extensions
- Pedestrian Median Islands
- Raised Pedestrian Crossings
- Raised Intersections
- Lane Narrowing
- Traffic Circles
- Speed Cushions
- Chicane
- Diagonal Diverters
- Hardened Centerlines

4.6.2 ***Pedestrian/Bicyclist Connectivity and Enhancements***

Analysis of pedestrian/bicyclist connectivity, including vehicle/pedestrian/bicyclist crossing of trails shall be discussed. The TIS should also discuss how pedestrians and bicyclists would access the proposed project to/from the adjacent neighborhood(s) and developments, and the need for special facilities to enhance direct pedestrian and bicycle connectivity. Enhancements will be required and any concerns with sight distance need to be addressed. This section shall include but is not limited to the following:

- Existing and proposed regional bike & ped facilities that service the site (sidewalks, multi-use trails, on street bike facilities, etc.)
- Transit Access
- School Routes
- Proposed bike and ped facilities internal to the site (widths, locations, circulation, destination points)

- Safety: conflict points with vehicles, sight distance at accesses and internal intersections, traffic calming, signing and striping
- Required Figures: Vicinity map of regional bike & ped facilities, internal bike & ped circulation w/ applicable intersection control

4.6.3 **Safety**

This section identifies any traffic safety hazards in the area which may be adversely affected by or created by the layout or traffic volumes of the subject site and presents possible mitigation measures. The evaluation of safety should consider such items as sight distance (based on AASHTO criteria and City standards), driveway approach grades, angles of road intersections, and backing of vehicles. An example of a potential hazard would include the placement of a driveway where the driver sight distance would be limited due to vertical and/or horizontal street alignment or the placement of fences/landscaping. Also identify any potential traffic hazards affecting pedestrian or bicyclist movement and present possible mitigation measures.

4.7 **Conclusions/Recommendations**

The conclusion of the study clearly summarizes all the findings relative to the site's impact and identifies any short- and long-range improvements needed to accommodate the projected traffic volumes. Recommendations for geometric improvements such as pavement markings, median changes, and additional lanes should be included. Discuss whether the existing right-of-way will accommodate the proposed improvements or whether additional right-of-way will need to be dedicated. A table should be used in presenting the recommendations. A graphic may also be used to present proposed short- and long-range improvements. In addition, a table of recommended improvements and the identified responsible party shall be provided. This table shall include the following note:

Future improvements that are identified as outside the scope of improvements

for this site indicate the need for such, but do not identify a funding mechanism or an obligating party to construct.

4.7.1 Conceptual Drawings

When required by the City, conceptual drawings of the intersection alternatives considered shall be provided for key intersections evaluated for geometric improvements or modifications to existing traffic control. The conceptual drawing shall be to scale, and it is preferred to be superimposed on an aerial photo or topographic map. Conceptual drawings for multiway stops, signal control, or any non-traditional intersection shall include the proposed lane configurations, median width (if any), turn lane storage lengths, and transitions to match the existing roadway. Existing right-of-way limits shall be shown.

Except for lane configuration and lane designation, do not include pavement marking, signing, stationing, profiles, or turning radii. The conceptual drawings intend to show the approximate impacts of each intersection control alternative to better assist in determining the appropriate alternative(s).

Conceptual drawings for a roundabout shall include the lane configuration, the roundabout's outer diameter, and the approximate approach alignment geometry. The roundabout concept plan must be well developed to identify approach alignment shifts, corner property requirements, parking impacts, and adjacent access impacts.

5 TRAFFIC IMPACT STUDY SUBMITTAL

Submit an electronic copy of the TIS at the time of the site development application electronic submittal process. The City Transportation Group will review the TIS in conjunction with the submitted application and return any comments with staff comments on the application. Address staff concerns by submitting a revised TIS and comment response document, electronically, with the subsequent development application submittal. Submittals shall be set up for 8 ½" x 11" paper.