

APPENDIX B



**Public Works and Development
Engineering Services Division
Guidelines for Traffic Impact Studies**

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TABLE OF CONTENTS

| | | |
|-----------|---|-----------|
| A. | Introduction..... | 1 |
| B. | General Procedure and Requirements..... | 1 |
| | 1. Pre-Study Meeting..... | 1 |
| | 2. When is a TIS required?..... | 2 |
| | 3. Analysis Categories..... | 2 |
| C. | Analysis Approach and Methods..... | 4 |
| | 1. Introduction/Project Description | 4 |
| | a. Study Area | 4 |
| | b. Study Horizon Years..... | 4 |
| | c. Analysis Time Periods | 5 |
| | d. Seasonal Adjustments | 5 |
| | 2. Data Collection (Existing Conditions) | 5 |
| | a. Intersection Traffic Volumes | 5 |
| | b. Roadway Traffic Volumes..... | 5 |
| | c. Accident Data | 5 |
| | d. Roadway and Intersection Geometrics | 5 |
| | e. Traffic Control Devices | 6 |
| | 3. Multimodal Components..... | 6 |
| | 4. Trip Generation (Proposed Conditions) | 6 |
| | a. Trip Generation Budget | 6 |
| | 5. Trip Distribution and Assignment | 7 |
| | 6. Existing and Committed Transportation Network (Future Conditions)..... | 7 |
| | 7. Background Traffic Volume Forecasts | 7 |
| | 8. Capacity Analysis (Traffic Evaluation)..... | 7 |
| | a. Intersections..... | 8 |
| | b. Roadways..... | 8 |
| | 9. Traffic Signal Needs and Access Locations | 8 |
| | 10. Safety Analysis..... | 9 |
| | 11. Queuing Analysis | 9 |
| | 12. On-Site Circulation..... | 9 |
| | 13. Improvement Analysis | 9 |
| | a. Level of Service | 9 |
| | b. Sight Distance | 10 |
| | c. Acceleration and Deceleration Lanes | 10 |
| | d. Multimodal Considerations..... | 10 |
| | e. Special Analysis/Issues..... | 11 |
| D. | Study Format (Outline) | 11 |
| E. | Acceptance..... | 12 |
| F. | Traffic Impact Study Checklist | 12 |

A. Introduction

This document contains guidelines for conducting Traffic Impact Studies (TIS) for submittal to Arapahoe County. These guidelines are required to ensure consistent and proper traffic planning and engineering practices when land use actions are being considered within the County. These guidelines provide for a standard process, set of assumptions, set of analytic methods, and presentation format to be used in the preparation of such traffic impact studies.

The procedures contained herein are provided to:

- Assist developers through the approval process by outlining the requirements and level of detail of traffic analysis that will be required of them during the approval process
- Standardize the types and details of analysis required in the assessment of traffic impacts for developments with similar levels of size and intensity
- Ensure consistency in the preparation and review of a TIS through standardization of the studies.

B. General Procedure and Requirements

The need for a Traffic Impact Study (TIS) should be assessed as early as possible in the development process when there is maximum flexibility for eliminating traffic-related problems. Since the need for a TIS 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.

The need for a TIS or a revised TIS or the acceptance of the TIS waiver will be determined by the Department of Public Works and Development, Engineering Services Division in accordance with the intent of these guidelines. The County reserves the right to waive or modify the requirements for a TIS as outlined within these guidelines. However, the Developer may still be required to mitigate traffic delays or complete roadway improvements necessary to ensure acceptable traffic operations, regardless of whether or not a TIS is required.

1. Pre-Study Meeting

A Pre-Study Meeting shall be held with the Engineering Services Division. The Developer will be notified of the Pre-Study Meeting requirement at the Pre-Submittal meeting, which is coordinated by the Planning Division. The Developer will be given a list of items to provide for the Pre-Study Meeting via the Pre-Submittal Meeting notes.

The purpose of the Pre-Study Meeting is to determine the level of detail and extent to which the TIS for the specific development project addresses these guidelines. The TIS shall be prepared by a Colorado-registered Professional Engineer with a background in traffic engineering (the Developer's Transportation Consultant Engineer). The Developer's Transportation Consultant Engineer should attend this meeting. The Developer must provide the following information **prior to** the Pre-Study meeting:

- Project description, including type of land uses (single family, fast food, etc.), and size (number of dwelling units, square footage, etc.)
- Preliminary project site plan, showing proposed access locations and land uses
- Estimates for the number of vehicle trips generated by the overall proposed development with no trip reductions applied (Average Daily Traffic and peak hour traffic based on the latest ITE Trip Generation Manual)
- Vicinity Map showing the location of the site and its relationship to adjacent properties and their existing access(s) with the local and regional road network surrounding the proposed site (area based on the expected Analysis Category from the overall development trip generation estimate).
- Anticipated project completion date and project phasing

The information must be received by the Engineering Services Division a minimum of seven days prior to the Pre-Study Meeting being scheduled.

The Analysis Category for the study will be discussed at the Pre-Study Meeting for concurrence by the Engineering Services Division. The need to establish a Trip Generation Budget for the development will be determined. The level of detail to be utilized in the TIS will be established including study area boundaries, scope of traffic data collection, study intersections, study time periods, and the background committed transportation network. The results of the discussion will be documented by Engineering Services Staff on the 'Pre-Study Summary' worksheet. This worksheet will be signed for concurrence by County Staff and the Developer's Transportation Consultant to represent a general agreement between the County and the Consultant for the initial submittal requirements of the TIS, but may not be all inclusive. The County retains the right to require additional information and/or analysis if found that the level of detail was insufficient for a complete evaluation of the proposed development. The signed worksheet should be included within an appendix of the TIS.

The Engineering Services Division has the authority to waive the Pre-Study Meeting requirement. If the Pre-Study Meeting was conducted more than 6 months prior to submittal of the actual case, the County Case Engineer may require another Pre-Study meeting.

2. When is a TIS required?

A TIS is generally required for all new development. TIS requirements for the redevelopment of existing areas will be determined on a case-by-case basis. Mitigation or improvements by the Developer may be required regardless if a full TIS is required.

A TIS requirement may be waived if all of the following conditions are met:

- The average trip generation of the proposed project is less than 250 trips per day or 25 trips in the peak hour
- The combination of the proposed development traffic plus existing traffic does not exceed an average of 150 vehicles per day on any unpaved road
- Access is not being requested to either a State Highway or County arterial roadway
- A special variance is approved by the County

If these waiver conditions are satisfied and the Engineering Services Division does not have other concerns with the transportation aspects of the proposed project, a memo shall be prepared by the Developer's Transportation Consultant Engineer (stamped by a Colorado Professional Engineer)

This memo shall include the following:

- the trip generation of the development
- recent traffic counts along the immediately adjacent roads (less than one year old).
- conclusion that no transportation impacts are anticipated as a result of the proposed project.

The memo shall be submitted to the County Case engineer who administered the Pre-Submittal Meeting (coordinated by the Planning Division) for review and recommendation by the Engineering Services Division. Waiver response will generally be provided two weeks after a Thursday submittal.

The validity of a traffic study shall expire 18 months after the study is received by the County. If a project has not been approved in that timeframe, a new traffic study with updated count information and project area assumptions will be required.

3. Analysis Categories

The specific analysis requirements and level of detail for a TIS are determined by the following Analysis Categories. The developer must first estimate the overall number of vehicle trips generated by the proposed development with no trip reductions applied.

The developer must obtain the concurrence of the Engineering Services Division at the Pre-Study Meeting on the number of trips generated by the development, if a TIS is required, and the Analysis Category.

CATEGORY I – Developments which generate 250 or more daily trips but fewer than 500 average trips per day. A Category I TIS may also be required for sites generating less than 250 average trips per day for any of the following reasons:

- The existence of any current traffic problems or concerns in the local area such as an offset intersection or a high number of traffic accidents
- The proximity of site drives to other drives or intersections
- Other specific problems or concerns that may be aggravated by the proposed development

CATEGORY II – Developments which generate 500 or more average trips per day but fewer than 1,000 average trips per day.

CATEGORY III – Developments which generate 1,000 or more average trips per day but fewer than 1,500 average trips per day.

CATEGORY IV – Developments which generate more than 1,500 average trips per day.

Table 1. Analysis Category Definitions

| Analysis Category | Development Characteristic^(a) | Study Horizons^(b) | Minimum Study Area^(d) |
|--------------------------|---|---|---|
| I | Small Development 250 – 499 daily trips | <ul style="list-style-type: none"> • Opening year | <ul style="list-style-type: none"> • Site access drives • Adjacent roadways • Adjacent signal controlled intersections within ¼ mile and/or major street intersections without signal control and driveways within 500 feet |
| II | Moderate Development 500 – 999 daily trips | <ul style="list-style-type: none"> • Opening year • 5 years after opening | <ul style="list-style-type: none"> • Site access drives • Adjacent roadways • All signal controlled intersections within ½ mile and/or major street intersections without signal control and major driveways within ½ mile |
| III | Large Development 1,000 – 1,500 daily trips | <ul style="list-style-type: none"> • Opening year • 5 years after opening • 20 years after opening (or regional planning horizon^(c), if longer) | <ul style="list-style-type: none"> • Site access drives • Adjacent roadways • First signalized intersection in each direction from the site • All signal controlled intersections within 1 mile and major street intersections and driveways without signal control within 1 mile |
| IV | Regional Development > 1,500 daily trips | <ul style="list-style-type: none"> • Opening year • 5 years after opening • 20 years after opening (or regional planning horizon^(c), if longer) | <ul style="list-style-type: none"> • Site access drives • Adjacent roadways • First signalized intersection in each direction from the site • Key signal controlled intersections and major street intersections without signal control within 3 miles |

^(a) The number of trips includes all trips generated by the site, including pass-by trips, with no internal trip reduction.

^(b) Developments may require assessment of additional horizon years due to surrounding land use availability and timing of development as directed by the County.

^(c) Regional planning horizon based on the current Denver Regional Council of Governments (DRCOG) Regional Transportation Plan.

^(d) An enlarged study area may be required when the identified minimum study area does not provide sufficient information to meet the intent of the Traffic Impact Study guidelines.

No matter what Analysis Category, developments may require assessment of additional horizon years due to surrounding land use availability and timing of development as directed by the County.

C. Analysis Approach and Methods

The Traffic Impact Study (TIS) shall be prepared under the supervision of a Colorado-registered Professional Engineer with a background in traffic engineering.

The proposed improvements for the study area transportation facilities (including roadways, intersections, and multimodal infrastructure) required to mitigate the operational, safety, and physical impacts of the development shall be clearly identified within the Proposed Mitigation Measures section of the TIS. **The mitigation measures shall ensure that the roadway or intersection will operate at a level of service at or above the desired level of service thresholds** established in the current *Arapahoe County Transportation Plan*. (In the *2035 Arapahoe County Transportation Plan*, Arapahoe County has established LOS thresholds of LOS D or better for arterial roadways in urban and semi-urban areas and LOS C or better for arterial roadways in rural areas and collector roadways in all area types.) Where it is shown that a study area roadway or intersection will operate below the established LOS threshold in the horizon year(s) without the development, the traffic impact of the development shall be mitigated to provide the same level of service in the horizon year(s) with an increase in overall intersection vehicular delay of no more than 10%. The Proposed Improvements summary table shall include who is responsible and the timing for each improvement.

Prior to beginning any analysis the developer or his authorized representative shall contact the Arapahoe County Department of Public Works and Development, Engineering Services Division to arrange for a Pre-Study Meeting to discuss the elements, approach, methodology, and scope of the study. **The results of the discussion will be documented and Engineering Services Division must provide concurrence for the decisions presented within an appendix of the TIS.**

The TIS shall include text following this general outline and include figures and tables as required or necessary. Sections D and F of these guidelines shall also be used when preparing the TIS.

1. Introduction/Project Description

The project description will include a site plan showing proposed land use with access locations and types (signalized, right-in/right-out, etc.) and distances between adjacent and opposing site accesses illustrated. Location of parking areas and parking capacity should be discussed. The mixture or variable combination of land uses and the flexibility/interchangeability of land uses within the overall site will be discussed, if applicable. Any proposed project construction phasing will be discussed with the anticipated completion date(s).

A summary of current and proposed zoning is to be included. The trip generation of the site under the existing zoning will be provided in a table. The land use and zoning discussion will also include areas that are within the study area, but are not part of the development for which this TIS is being prepared. Specific attention should be paid to property adjacent to the site and any undeveloped land in the study area, including land in other jurisdictions.

a. Study Area

The study area shall be determined by the proposed development size and overall trip generation, in accordance with the criteria in Table 1. An enlarged study area may be required when the identified minimum study area does not provide sufficient information to meet the intent of the Traffic Impact Study guidelines. For example, a large (Category III) development in a rural area located two miles from a freeway interchange from which most of the trips are anticipated to access the development may require an enlarged study area to include the assessment of the freeway interchange.

The limits of the study area will be determined at the TIS Pre-Study Meeting with concurrence provided by the Engineering Services Division.

b. Study Horizon Years

The study horizon years shall be determined by the project type and size in accordance with the criteria in Table 1. The specific study years will be determined by the Engineering Services Division with concurrence provided at the TIS Pre-Study Meeting.

c. Analysis Time Periods

Both the morning and afternoon/evening weekday peak hours shall be analyzed. If the proposed project is expected to generate no trips, or a very low number of trips, during either the morning or evening peak periods the requirement to analyze one or both of these periods may be waived by the Engineering Services Division.

Where the peak traffic hour in the study area and/or peak hour traffic from the site's proposed land uses occur during a different time period other than the normal morning or afternoon peak travel periods (for example, midday), or occurs on a weekend, or if the proposed project has unusual peak characteristics, these additional peak hours shall also be analyzed and discussed under Special Analysis/Issues section of the TIS. The Engineering Services Division has the right to request additional analysis.

d. Seasonal Adjustments

When directed by the Engineering Services Division, the traffic volumes for the analysis hours should be adjusted for the peak season, in cases where seasonal traffic data is available.

2. Data Collection (Existing Conditions)

All data shall be collected in accordance with the latest edition of the *Institute of Transportation Engineers Manual of Transportation Engineering Studies* or as directed by the Engineering Services Division.

a. Intersection Traffic Volumes

Turning movement counts shall be obtained for all existing cross-street intersections in the study area during the approved analysis time periods for a minimum of two hours for each time period and shall include fifteen (15) minute count data to clearly identify the peak hours. Turning movement counts may be required during other periods as directed by the Engineering Services Division.

Available turning movement counts may be used for the analysis provided the date of the collected information is **no more than one year** from the date of the initial study submittal with written concurrence from the Engineering Services Division.

Raw traffic count data shall be provided in the appendices of the TIS. A graphic of the existing turning movements at all study intersections shall be included.

b. Roadway Traffic Volumes

The current daily traffic volumes on the arterial and collector roadways within the study area shall be presented in the study. Available daily traffic count data may be obtained from previous transportation and traffic studies provided the date of the collected information is **no more than one year** from the date of the initial study submittal with written concurrence from the Engineering Services Division.

Where daily count data are not available or such counts are over one year old, new counts shall be required. New traffic counts shall include a breakdown of traffic by types of trucks and buses on each roadway, reported by standard FHWA classification types. Raw traffic count data shall be provided in the appendices of the TIS.

c. Accident Data

Traffic accident data should be obtained for the most current three to five-year period available.

d. Roadway and Intersection Geometrics

Roadway geometric information shall be obtained and included in the TIS. This includes, but is not limited to, roadway classification, roadway width, number of lanes, auxiliary lanes, vertical grade, posted speed limit(s), location of driveways, pedestrian facilities, and lane configuration at intersections. Sight distance at intersections to be impacted by the development shall be evaluated per the *Arapahoe County Infrastructure Design and Construction Standards*.

e. Traffic Control Devices

The location and type of traffic control shall be identified. Existing signal timing for each traffic signal within the study area shall be obtained from the agency maintaining the signal.

3. Multimodal Components

The types of multimodal facilities that exist or are planned within the study area shall be described. This includes, but is not limited to, transit routes, bus stops, trails, and sidewalks. When directed by the Engineering Services Division, bicycle and pedestrian volumes shall be collected.

4. Trip Generation (Proposed Conditions)

The latest edition of the *Institute of Transportation Engineers (ITE) Trip Generation* shall be used for selecting trip generation rates. Other rates may be used with the prior approval of the Engineering Services Division in cases where the *ITE Trip Generation* does not include trip rates for a specific land use category, or includes only limited data, or where local trip rates have shown to differ from the ITE rates.

Site traffic shall be generated for daily, AM, and PM peak hour periods. Adjustments for pass-by and internal traffic volumes shall follow the methodology outlined in the latest edition of the *ITE Trip Generation Handbook*. A pass-by traffic volume discount for commercial centers **will not exceed 25%** unless approved by the Engineering Services Division. Reduction due to internal interactions applied to mixed-use development in the estimated trip generation **will not exceed 10%** unless approved by the Engineering Services Division.

A trip generation summary table shall be prepared showing proposed land use, trip rates used, and vehicle trips for daily and peak hour periods. The *ITE Trip Generation* land use type, with number, shall be provided for each land use.

For modal split, any assumptions regarding trips that will access the site using transit, pedestrian or bicycle modes shall be described. Justifications for the reasonableness of these assumptions are to be provided and resulting trip reductions must be approved by the Engineering Services Division.

For studies submitted with preliminary development plans or developments proposing a variable combination of land uses, trip generation shall be based on the maximum dwelling units permitted and/or the maximum trip generation, non-resident development allowed for the proposed development. With a final development plan action, trip generation shall be based on actual dwelling unit counts and square footage indicated in the final plan.

a. Trip Generation Budget

It is imperative that the TIS be sufficiently conservative to account for the full impact of the proposed development. To assure that a TIS submitted with a Preliminary Development Plan adequately addresses the full impact of the development, the trip generation of the proposed development in the TIS will establish a Trip Generation Budget defining the maximum number of trips permitted by the development. The Trip Generation Budget will be tracked by the daily and/or peak hour trip generation of each land use. The Trip Generation Budget shall be documented on the Preliminary Development Plan and updated with each individual Final Development Plan. The TIS shall either establish the Trip Generation Budget or document where the development is within a previously-established Trip Generation Budget.

Specific mitigation measures for development impacts shall be identified for each expected phase of development. If the Trip Generation Budget is reached prior to full occupancy, the County reserves the right to request supplemental traffic analysis and/or additional mitigation prior to granting full occupancy permits. If the project is fully occupied and it is determined that the development traffic exceeds the Trip Generation Budget established in the TIS, then the property owner may be required to conduct additional traffic analysis and provide additional mitigation.

Not every development will require a Trip Generation Budget. The need for establishing a Trip Generation Budget shall be discussed at the Pre-Study Meeting.

5. Trip Distribution and Assignment

Projected trips shall be distributed and added to the projected background (non-site) traffic on the study area roadways and intersections for the study years. Trip distribution may be based on regional traffic forecasts, market analysis, existing traffic flows, census data, and professional judgment. The specific assumptions and data sources used in deriving trip distribution and assignment shall be documented in the TIS.

A figure will be required showing site-generated daily and peak period turning movement volumes for each study intersection. In addition, a figure should be prepared showing the background volumes with site-generated traffic added to the roadway network. The total projected traffic volumes on the roadway network for each study year shall be shown in a table, including the traffic volume in each direction with estimates of the breakdown of future traffic by types of trucks and buses, based on the existing vehicle classification data and future land uses. The number of future RTD buses that can be expected on a roadway (assuming the roadway is or may become an RTD bus route) should be included in the breakdown of vehicle types.

Trips shall not be assigned to roadways that are not yet constructed or roadways that will be improved and/or constructed after the analysis year. Trip distribution may be permitted on roadways expected to be improved by other developments, provided such is documented and evaluated as an alternate scenario.

6. Existing and Committed Transportation Network (Future Conditions)

The applicant shall obtain from the Engineering Services Division any current or planned transportation improvement projects expected to occur during the study horizon years within the study area. These improvement projects will be added to the existing roadway network to define the Existing and Committed Transportation Network to be used for the traffic analysis of future conditions. Alternative transportation network scenarios may be required for analysis.

7. Background Traffic Volume Forecasts

Future traffic volumes should be estimated using information from transportation models or applying an annual growth rate to the existing traffic volumes. The future background traffic volumes (without project traffic) should represent the horizon year for the project development. If the annual growth rate method is used, the County must give prior approval for the growth rate.

In addition, traffic forecasts for any nearby area proposed development projects, other recent transportation studies, and forecasts within the *Arapahoe County Transportation Plan* should be taken into consideration when forecasting future traffic volumes. Background volumes may come from the application of growth rates to existing volumes, traffic models or a combination of the two.

Any change in the percent of daily traffic occurring in the peak hour from the existing traffic counts to the horizon year(s) background traffic forecasts must be discussed in the TIS with analytic support.

8. Capacity Analysis (Traffic Evaluation)

The operational analysis will show impacts on the existing roadway system and the expected future roadway system. The latest version of the *Highway Capacity Manual* methods for operational analysis shall be used to evaluate intersection and roadway operations. **Worksheets from the operational analysis software illustrating the inputs and outputs are to be included in the appendices of the TIS. Electronic input/output files shall also be included with the TIS submittal.**

Level of Service (LOS) shall be calculated for each of the following conditions:

- Existing peak hour traffic volumes (illustrated in a figure)
- Horizon year(s) traffic volumes without Project (background traffic) (illustrated in a figure)
- Horizon year(s) traffic volumes with Project (illustrated in a figure)
- LOS and delay results for each traffic volume/network scenario (shown in a table)

The existing conditions analysis will include only the existing transportation network. Each of the future conditions analyses will include the Existing and Committed Transportation Network, which includes any current or planned transportation improvement projects expected to occur during the study horizon years, as provided by the Engineering Services Division. Several scenarios for the transportation network may be required for analysis.

The LOS table will include LOS results for the AM and PM peak periods and additional analysis time periods, if applicable. The table will show overall LOS conditions with the corresponding vehicle delays at signalized intersections and LOS conditions for the critical movements at unsignalized intersections. For signalized intersections, the LOS conditions and average vehicle delay should be provided for each movement and the overall intersection.

The operational analysis of existing signalized intersections for existing traffic conditions should utilize existing phasing, timing, splits, and cycle lengths as obtained from the agency maintaining the signal.

The timing sheet from the controller showing the existing signal timing shall be included in the appendices of the TIS.

If the new development is scheduled to be completed in phases, the TIS will include a LOS analysis for each separate development phase in addition to the analysis for each horizon year. A figure will be required for each horizon year of phased development.

a. Intersections

Level of Service (LOS) shall be computed for signalized and unsignalized intersections in accordance with the latest edition of the Highway Capacity Manual. Traffic analysis software that implements HCM methods, such as Synchro, is acceptable so long as the electronic files are included with the TIS submittal. Pedestrian and/or bicycle movements will need to be considered in the LOS evaluation for intersections. **Peak hour factors for future conditions shall not exceed 0.90.** The use of peak hour factors based on existing traffic counts or the consideration of special land uses (such as schools or event centers) will require prior approval by the Engineering Services Division. The following peak hour factors shall be used unless otherwise approved by the Engineering Services Division:

- PHF = 0.80 for < 75 vph per lane
- PHF = 0.85 for 75 – 300 vph per lane
- PHF = 0.90 for > 300 vph per lane

b. Roadways

For urban roadways and rural highways where signalized intersections are less than one mile apart, the capacity of the roadway is generally dominated by the capacity of the adjacent signal controlled intersections. Roadway levels of service need not be computed for these facilities.

For rural highways where signal controlled intersections are more than one mile apart, the level of service on the highway may be estimated in accordance with the latest edition of the Highway Capacity Manual or by evaluating the roadway volume-to-capacity (v/c) ratio. The v/c ratio evaluation shall use the capacities defined in the *2035 Arapahoe County Transportation Plan* considering the surrounding area and roadway classification. These capacities have been defined as the maximum daily traffic volumes on roadways to achieve the established Arapahoe County LOS criteria.

9. Traffic Signal Needs and Access Locations

A traffic signal warrant study based on the *Manual on Uniform Traffic Control Devices (MUTCD)* shall be conducted for all arterial/arterial, arterial/collector, and collector/collector intersections within the study area for the opening year. If the warrants are not met for the opening year, they will be evaluated for each horizon year. Warrant analysis for additional years may be required, as determined by the Engineering Services Division.

Traffic signal progression is of paramount importance to roadway corridor capacity. Consequently, potential signalized intersections should not be placed any closer than at ½-mile intervals on arterials and at ¼-mile intervals on non-residential collectors. Other locations will be considered based on progression analysis with the following criteria:

- Progression band width will be 40-second minimum in both directions
- Cycle length will be 120 seconds or as directed by Engineering Services Division
- Progression speed will be the speed limit of the study roadway
- Minimum splits for left turns shall be 11 seconds
- Minimum splits for through movements shall be 15 seconds
- Minimum yellow time shall be 3 seconds

A time-space diagram for each analysis period shall be prepared and included in the appendix of the TIS if new signals or modifications are expected.

10. Safety Analysis

If directed by the Engineering Services Division, an analysis of three to five-years of accident data shall be conducted to determine if the level of safety will deteriorate due to the addition of site traffic or if special traffic safety concerns may result in an increase in traffic accident rates for a roadway segment.

This section will identify traffic safety hazards in the area which may be adversely affected or created by the layout or traffic volumes of the project site. The evaluation of safety should consider such items as driveway approach grades, angles of road intersections, weaving and merging, pedestrian crossings, and backing of vehicles. Potential traffic hazards affecting pedestrian movements should also be identified.

11. Queuing Analysis

Queuing analyses will be completed to identify appropriate vehicle storage at all intersections within the study area. **The queuing analyses must indicate that vehicle storage will be provided for adequate storage in turn lanes 95 percent of the time during peak hours.** For closely-spaced intersections or other complex analysis, micro-simulation of queuing characteristics during peak hours may be required.

If additional turn, acceleration or deceleration lanes are recommended, include calculations for the length of the auxiliary lanes in Proposed Mitigation Measures section of study. See the Improvement Analysis section of these guidelines for further guidance.

12. On-Site Circulation

This section will identify the main circulation patterns within the site and focus on the site design elements that will minimize impacts to the County transportation network. Based on the type of land use, this will include discussions of design elements to reduce the potential for vehicular queues reaching external roadways, truck delivery routes and access, emergency access, pedestrian crossings, access to adjacent developments, and the potential for cut through traffic. Parking locations and drive aisles within the site will also need to be considered in relation to any traffic signals and/or external intersections.

13. Improvement Analysis

a. Level of Service

The roadways and intersections within the study area shall be analyzed with and without the proposed development to identify any projected impacts in regard to level of service and safety. The Level of Service and delay under each condition and horizon year shall be summarized for the overall intersection and each movement.

The *Arapahoe County Transportation Plan* contains established Level of Service (LOS) and associated delay thresholds for road segments and intersections by roadway classification and area type. **Where a roadway or intersection will operate at a level of service below the desired level of service thresholds established in the current *Arapahoe County Transportation Plan*, improvements that mitigate these impacts shall be identified as part of the study.** For example, based on the *2035 Arapahoe County Transportation Plan*, in rural areas where the intersection will operate at LOS C or better without the development (critical movements for unsignalized intersections and overall performance for signalized intersections), the traffic impact of the development on the intersection shall be mitigated to LOS C (as the level of service threshold).

If using the volume-to-capacity ratio for the LOS evaluation of rural highways where signal controlled intersections are more than one mile apart, the capacity of the roadway shall be as defined in the *2035 Arapahoe County Transportation Plan* considering the surrounding area and roadway classification. These capacities have been defined as the maximum daily traffic volumes on roadways to achieve the established Arapahoe County LOS criteria. Therefore, road segments with a v/c ratio greater than one operate below the established LOS threshold.

Where it is shown that a study area roadway or intersection will operate below the established LOS threshold in the horizon year(s) without the development, the traffic impact of the development shall be mitigated to provide the same level of service in the horizon year(s). At intersections, the traffic impact shall be mitigated with an allowable increase in overall intersection vehicular delay of no more than 10%.

Changes in the LOS and delay for individual intersection movements associated with the development shall be identified and discussed in the TIS. Mitigation requirements for impacts to intersection movements will be determined on a case-by-case basis.

b. Sight Distance

The intersection sight distance calculations shall be conducted at all project access and internal intersections. Sight distance shall be calculated based on the methods outlined in the latest version of the *Arapahoe County Infrastructure Design and Construction Standards*.

c. Acceleration and Deceleration Lanes

Storage and taper lengths for acceleration and deceleration lanes shall be identified for the proposed lane configuration resulting from the queuing analysis at the study area intersections. In addition, all proposed development accesses shall be evaluated for required acceleration and deceleration lanes per the latest version of the *Arapahoe County Infrastructure Design and Construction Standards* and the most recent release of the *Colorado Department of Transportation State Highway Access Code* for those roadways classified as State Highways.

Acceleration and deceleration lane storage and taper lengths shall be based on the methods outlined in the latest version of the *Arapahoe County Infrastructure Design and Construction Standards*. All results should be rounded up to the nearest 25 foot interval. The minimum turn lane storage length shall be 50 feet.

d. Multimodal Considerations

Pedestrian and bicycle connections are encouraged and the location and circulation of these multimodal facilities should be identified. Design elements that will mitigate safety concerns with pedestrian/bicycle and vehicular conflicts, such as multi-use path roadway crossings, should be discussed.

If transit use, pedestrian/bicycle connectivity, and/or Transportation Demand Management (TDM) actions are claimed as a trip reduction strategy, analytic support must be provided. Optimistic assumptions regarding transit use, pedestrian/bicycle volumes, and TDM actions will not be accepted unless accompanied by specific implementation plans that will become a condition of approval. Such implementation plans must have a reasonable expectation of realization within a five-year period after project initiation.

e. Special Analysis/Issues

This section provides the County with opportunities to request specific traffic analyses relevant to the proposed development, such as access control, cut-through traffic and residential quality of life, event planning and management, safe routes to schools, emergency routes, or other conditions. This section may also contain environmental and regional air quality conformity analysis as necessary.

Special conditions and analysis requirements shall be discussed at the Pre-Study Meeting.

D. Study Format (Outline)

The Traffic Impact Study (TIS) shall be typed, bound, and stamped by a Colorado-registered Professional Engineer with a background in traffic engineering. It shall contain a table of contents and lists of figures and tables. The TIS shall include the Arapahoe County Case Number (which will be given after the initial submittal) and study submittal dates on the cover sheet. These dates shall include the date of the original study submittal and each subsequent submittal.

It is incumbent on the Applicant to have all of the required data and information clearly identified in the appropriate sections of the study. It is very important that the information contained in the study be accurate and complete in every way. Text contained in the TIS shall discuss items as identified in Section C of these guidelines, be comprehensive and complete, yet be kept brief and to the point.

The TIS shall follow this general outline and include the following figures and tables together with text as described above.

- Traffic Impact Study Content Checklist – completed, signed and sealed
- Introduction/Project Description
 - Figure: Vicinity Map
 - Figure: Proposed Project Site Plan
- Existing Conditions
 - Figure: Existing Transportation Network and Traffic Volumes (daily & peak hour volumes)
 - Table: Existing LOS and Delay Summary (overall intersection & movements)
- Proposed Conditions
 - Site Trip Generation
 - Table: Trip Generation Summary (daily & peak hour trips)
 - Trip Distribution
 - Figure: Site Trip Distribution
 - Site Traffic Volumes
 - Figure: Projected Site Traffic Volumes (daily & peak hour volumes)
- Future Conditions
 - Background Traffic Volumes
 - Figure: Future Background Traffic Volumes (daily & peak hour volumes) (Opening Year & Horizon Year(s), as applicable)
 - Total Future Traffic Volumes (background plus site traffic)
 - Figure: Total Future Traffic Volumes (daily & peak hour volumes) (Opening Year & Horizon Year(s), as applicable)
- Traffic Evaluation
 - Level of Service (LOS)
 - Figure: LOS for Future Background Traffic Volumes (without Project) (Opening Year & Horizon Year(s), as applicable)
 - Figure: LOS for Total Future Traffic Volumes (with Project) (Opening Year & Horizon Year(s), as applicable)
 - Table: Future LOS and Delay Summary (overall intersection & movements)

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- Traffic Signal Needs and Access Locations
 - Safety Analysis
 - Queuing Analysis
 - On-Site Circulation
 - Improvement Analysis
 - Roadway/Intersection Modifications
 - Figure: LOS for Total Future Traffic Volumes with Mitigation Measures (Opening Year & Horizon Year(s), as applicable)
 - Table: Future LOS and Delay with Mitigation Measures Summary (overall intersection & movements)
 - Sight Distance
 - Acceleration and Deceleration Lanes
 - Table: Lane Storage and Taper Lengths
 - Multimodal Considerations
 - Special Analysis/Issues
 - Proposed Mitigation Measures
 - Table: Proposed Improvements (include who is responsible & timing for each improvement)
 - Appendix
 - Pre-Study Meeting Notes
 - Traffic Count Data (including vehicle classification)
 - Existing Signal Timing (sheets from maintaining agency)
 - Level of Service Analysis Reports (all horizon years and scenarios with and without Project) (input and output)
 - Time-Space Diagrams (if applicable, for any signal modifications or new signals)
 - Electronic files of input and output data

E. Acceptance

The Traffic Impact Study (TIS) shall be submitted to the Department of Public Works and Development, Engineering Services Division for acceptance. The County has no set time limit whereby review comments and/or acceptance of the document must be completed. Therefore, review times may vary.

The Engineering Services Division shall review the TIS for completeness and acceptance of the proposed mitigation measures. Written comments will be provided to the developer or his/her authorized representative upon completion of any County reviews. **Written responses to all County comments are required with subsequent TIS submittals.**

Once reviewed with no further comments, the County will request hard copies and an electronic portable document format (PDF) of the TIS with all tables and figures included in study. Once the hard copies and electronic document are received, the County Case engineer will issue a Letter of Acceptance for the TIS.

F. Traffic Impact Study Checklist

(See attached)

Arapahoe County Traffic Impact Study – Checklist

| | |
|--------------|-------------------|
| Development: | Date: |
| Case No: | Submittal Number: |
| Consultant: | Reviewed By: |

NOTE: Before a review is conducted, Arapahoe County will check the completeness of the Traffic Impact Study. If the study is missing any of the items listed below, it will be returned for revision prior to review.

Required Discussions – To be completed by the Transportation Consultant Engineer:

| Report Section | Completed | Not Applicable | Comments (i.e., Why Not Applicable?) |
|--|-----------|----------------|---|
| COVER | | | |
| Arapahoe County Case No., Original & revision dates | | | |
| Dated, checked, sealed & signed by Colorado P.E. | | | |
| INTRODUCTION/PROJECT DESCRIPTION | | | |
| Vicinity Map (figure) | | | |
| Proposed Project Site Plan (figure) | | | |
| Proposed development phasing | | | |
| Site Trip Generation with Existing Zoning (table) | | | |
| Existing & proposed land uses surrounding site | | | |
| EXISTING CONDITIONS | | | |
| Intersection and roadway counts < one year old | | | |
| Existing Transportation Network and Traffic Volumes (figure) | | | |
| Existing LOS & Delay Summary (table) | | | |
| PROPOSED CONDITIONS | | | |
| Trip Generation Summary (table) | | | |
| Internal trip reduction justification (<10%) | | | |
| Pass-by trip reduction justification (<25%) | | | |
| Trip distribution assumptions | | | |
| Site Trip Distribution (figure) | | | |
| Projected Site Traffic Volumes (figure) – each horizon year/scenario | | | |
| FUTURE CONDITIONS | | | |
| Existing and committed transportation network – all scenarios | | | |
| Background traffic growth method & assumptions | | | |
| Background Traffic Volumes (figure) – each horizon year/scenario | | | |
| Total Future Traffic Volumes (figure) – each horizon year/scenario | | | |
| TRAFFIC EVALUATION | | | |
| LOS & Delay – each horizon year/scenario (figures/table) | | | |
| Traffic signal warrant analysis - each horizon year/scenario | | | |
| Traffic signal progression | | | |
| Safety analysis | | | |
| Queuing analysis | | | |
| IMPROVEMENT ANALYSIS | | | |
| LOS & Delay with mitigation – each horizon year/scenario (figures/table) | | | |
| Sight distance | | | |
| Acceleration and deceleration – storage & tapers (table) | | | |
| Multimodal - Pedestrian, bicycle, transit, and TDM | | | |
| Special Analysis/Issues | | | |
| PROPOSED MITIGATION MEASURES | | | |
| Proposed Improvements (table) | | | |
| APPENDIX | | | |
| Pre-Study Meeting Notes | | | |
| Traffic Count Data | | | |
| Existing Traffic Signal Timing | | | |
| Level of Service Analysis Reports (all periods) (input & output) | | | |
| Time-Space Diagrams | | | |
| Electronic files of input and output data | | | |

“I have reviewed the attached report with this checklist and all required items have been included except as noted above.”

Signature of Professional Engineer