I. INTRODUCTION

Background

Land use and transportation are strongly interdependent. Transportation facilities and services are essential for development to occur, and high levels of mobility and accessibility are needed to attract economic development to provide and maintain a high quality of life.

The transportation decisions made in the land development process have a significant cumulative effect on the safety and efficiency of a community's street system. There is a strong correlation between the amount of access provided to major streets and the safety and efficiency on those streets. Therefore, it is in the long-term interests of all parties to balance the mobility and safety needs of the traveling public with the accessibility to development.

Purpose

The primary purpose for evaluating the impact of development through transportation impact studies is to protect the integrity of the transportation systems. Neither public nor private interests are well served if transportations systems needlessly degrade due to poor planning and design.

In order to accomplish this objective, the review of transportation systems associated with development needs to be more extensively scrutinized and needs to take a long-term perspective. What might be acceptable today may not be as an area develops and matures. This is certainly consistent with the City's long-range planning for land use, major streets and other infrastructure. Both long term traffic impact needs should be considered but also long term city maintenance needs. New development should not take away from the City's ability to maintain its existing infrastructure.

These transportation impact study guidelines, and the resulting work products, will allow for more informed decision-making and could lead to a framework for the negotiation of mitigation measures for the impacts created by development.

II. EXTENT OF STUDY REQUIRED

The necessity to review all land development applications from a transportation perspective as well as the wide variety of land use types and intensities suggest that multiple thresholds or triggers be established to warrant a transportation impact study. The following guidelines will be followed.

All Applications

1. Identify the specific development plan under study and any existing development on and/or approved plans for the site (land use types and intensities and the arrangement of buildings, parking and access). Also identify land uses (including types and the arrangement of buildings, parking and access) on property abutting the proposed development site, including property across public streets.

2. Identify the land uses shown in the Lawrence/Douglas County Comprehensive

Plan for the proposed development site under study, as well as the ultimate arterial and collector street network in the vicinity of the site (at least the first arterial or collector street in each direction around the site).

3. Identify the functional classification of the public street(s) bordering the site and those streets on which access for the development is proposed. The functional classification is shown on the Major Thoroughfares Plan, which is incorporated into the Comprehensive Plan.

4. Identify allowable access to the development site as defined by City design criteria and/or access management guidelines and adopted Access Management Plans for arterial and collector streets in Lawrence.

5. Document current public street characteristics adjacent to the site, including the nearest arterial and collector streets (number and types of lanes, speed limits or 85th percentile speeds, and sight distances along the public street(s) from proposed access(es)).

6. Compare proposed access with established design criteria (driveway spacing, alignment with other streets and driveways, width of driveway, and minimum sight distances). Identify influences or impacts of proposed access to existing access for other properties. If appropriate, assess the feasibility of access connections to abutting properties, including shared access with the public street system.

7. Estimate the number of trips generated by existing and proposed development on the site for a typical weekday and weekday peak hours using the latest edition of Trip Generation published by the Institute of Transportation Engineers. Local trip generation characteristics may be used if deemed to be properly collected and consistent with the subject development application with appropriate documentation provided for review. The City Engineer shall make such determination. Calculate the net difference in trips between existing and proposed uses. If the development site already has an approved plan, also estimate the number of trips that would be generated by the approved land uses. If the development application proposes a land use different than indicated in the Comprehensive Plan, also estimate the number of trips that would be generated by the land use indicated in the Comprehensive Plan. The City Engineer or designee shall approve the potential land use intensity in such cases.

Development or Site Plan Generates 100 to 499 Trips in a Peak Hour
A Standard Transportation Impact Study will be required. The study area may tend to be confined to the street or streets on which access is proposed but should be extended to at least the first major intersection in each direction.

Development or Site Plan Generates 500 or More Trips in a Peak Hour
A Standard Transportation Impact Study will be required. The study area may extend beyond the streets onto which access is proposed.

Proposed Land Use Deviates from Comprehensive Plan
Determine the extent of a transportation impact study based on anticipated trip generation. Conduct comparative analyses using the proposed land use and the land use identified in the comprehensive plan.

III. QUALIFICATIONS TO CONDUCT AND REVIEW A STUDY

The parties involved in a land development application sometimes have different objectives and perspectives. Further, the recommended elements of a transportation impact study require skills found only in a trained professional engineer with specific experience in the field of traffic engineering.

For these reasons, the person conducting and the person reviewing the study must be registered professional engineers with demonstrated experience in the preparation or review of transportation impact studies for land development.

The City Engineer or designee shall determine whether an individual professional engineer is qualified to conduct a transportation impact study. Credentials shall be provided upon request. If the City Engineer determines that it is appropriate to engage an engineer or engineering firm to conduct a Traffic Impact Study, the City shall give the applicant written notice of that determination 10 business days before work on the Traffic Impact Study begins. This study shall be conducted for the City at the applicant's expense. If the applicant objects to the TIS requirement, the application process shall be suspended until an acceptable TIS is completed.

IV. REVIEW AND USE OF STUDY

A transportation impact study should be viewed as a technical assessment of existing and projected transportation conditions. The extent to which individual professional judgment has to be applied will be minimized by provision of community policies and practices with respect to street and traffic control design and land development.

Ultimately, a transportation impact study will be used by professional staff to make recommendations to the planning commissions and governing bodies charged with reviewing and approving development applications. Transportation is one element amongst many that must be considered.

City personnel charged with reviewing transportation impact studies have several functions to consider:

- Determine whether the impacts of development have been adequately assessed.
- Ensure that proposed access is properly coordinated with existing and planned facilities, fits into the ultimate configuration of the street system, and is appropriately designed at its connection to the public street system.
- Determine whether proposed improvements for the public street system are sufficient to mitigate the impacts created, and that the improvements meet local requirements.
- Ensure that the development plan considers the needs of pedestrians, bicyclists, and transit users.
- Determine whether the development layout can accommodate all anticipated vehicle types.
- Invite other responsible and applicable transportation agencies or entities, e.g., Kansas Department of Transportation, to participate in the study and review processes.
- Provide consistent, fair, and legally defensible reviews.

STANDARD TRANSPORTATION IMPACT STUDY PROCEDURES

Step 1 Study Methodology Determination

Prior to conducting any transportation impact study it is necessary to determine the minimum technical responsibilities and analyses that will be performed. It is the applicant's responsibility to ensure that the study utilizes the techniques and practices accepted by the City and other participating agencies.

The following items shall be considered, discussed and agreed to by the City Engineer or designee (and others if appropriate) and the applicant for transportation impact studies prior to performing any analysis. If the applicant does not submit a study methodology prior to submitting a traffic impact study, then the review schedule may require resubmittal of the traffic impact study prior to plat or site plan approval.

- Definition of the proposed development, including type and intensity of the proposed land uses and proposed access.
- Study area limits based on the magnitude of the development.
- Impact or influence on access for adjacent and nearby properties.
- Time periods to be analyzed, e.g., weekday A.M. and P.M. peak hours.
- Scenarios or conditions to be analyzed, e.g. existing conditions, existing plus development conditions, and Long Range Transportation Plan Horizon Year conditions.
- Future analysis year(s), including special study procedures for multi-phase development plans.
- General assumptions for trip generation, trip distribution, mode split, and traffic assignment.
- Traffic analysis tools and acceptable parameters.
- Availability and applicability of known data.
- Traffic data collection requirements and responsibilities, including time periods in which traffic counts will be collected.
- Transportation system data, e.g. traffic signals, transit stops, bicycle and pedestrian facilities, etc.
- Planned transportation system improvements, including the anticipated timing, for all modes of transportation, e.g. street widening, bicycle trails, transit stops, etc.
- Methodology for projecting future traffic volumes.
- Current level of service and access management requirements.
- Acceptable mitigation strategies.

<u>Study Area</u>
The study area and the intersections and street segments to be included will vary for a number of reasons - the type and intensity of the development, the maturity of other development in the vicinity, the condition of the street network, etc. The study area should be large enough to assess the impact or influence of proposed access along street segments and to evaluate the ability of streets and intersections to absorb the additional traffic.

The study area should at least include those street segments onto which access is proposed and should typically extend to the next major intersection (arterial/arterial, arterial/collector, or collector/collector) in each direction. Final determination of the study area will be determined by the City Engineer or designee.

Analysis Periods
Transportation impact studies should be based on peak-hour analyses. The analysis period(s) should be based on the peaking characteristics of both the public transportation systems and development traffic. The typical analysis periods for most development are the A.M. and P.M. peak hours, of a typical weekday (Tuesday, Wednesday, and/or Thursday). Retail development that is typically not open early in the morning may not warrant study for the A.M. peak hour. On the other hand, intense retail activity in an area may warrant study during the Saturday peak hour.

Analysis Years
In general, the analysis years should be related to the opening date of the proposed development and the horizon year in the City's long-range transportation plan.

Method of Determining Future Traffic Volumes
Future daily traffic volumes on arterial and collector streets shall be identified from the long- range transportation plan or from the traffic model used to develop the plan for each arterial and collector street segment in the study area.

Step 2 Data Collection and Safety Analysis

Once the parameters for the transportation impact study have been established, the first step in the study process is to collect relevant data and assess existing conditions. The following data should be assembled for each TIS.

2.1 Project Site Characteristics

Identify the specific development plan under study and any existing development on and/or approved plans for the site. This includes land use types and intensities and the arrangement of buildings, parking and access. Also identify land uses (including types and the arrangement of buildings, parking and access) on property abutting the proposed development site, including property across public streets.

Information for the proposed development shall be displayed on a scaled drawing. If detailed information regarding abutting property is not shown on the development plan, it may be exhibited on a current aerial photograph, or other drawing, along with the proposed development.

This information is needed to assess the proposed access in relation to existing driveways and side streets at the site and along the street corridors on which access is proposed. This process should also consider potential access for undeveloped land in the vicinity.

2.2 Transportation System

This includes the physical and functional characteristics of the transportation systems in the study area. Data to be collected includes:

a. Functional classification for each street
b. Posted speed limit
c. The number and types of lanes for all intersections and street segments
d. Intersection control information (two-way stop control, roundabout, traffic signal, etc.)
e. Existing signal phasing, including left-turn phasing
f. Available sight distance at access points. New access points may require field measurements
g. Pedestrian and bicycle facilities (existing and planned)
h. Existing or proposed transit routes
i. Identify any planned streets that have not yet been built
j. Planned improvements for each street and/or intersection (either programmed for construction or included in the long-range transportation plan).

2.3 Transportation Demand Data

This includes current traffic volumes (intersection turning movement counts), percent trucks, peak hour factors, transit patronage, bicycle usage, and pedestrian usage. For some studies, additional data such as right-turn-on-red usage, traffic distribution by lane, or other similar data may be required.

Intersection turning movement counts shall be taken on a Tuesday, Wednesday, and/or Thursday for weekday conditions. It is preferred that morning and afternoon counts be taken on the same day. For a study requiring traffic counts at several intersections that cannot be accomplished all in one day, the counting program should be organized so that adjacent intersections are counted as close in time as possible. As a minimum, traffic volumes should be measured at any existing site driveway and on the adjacent streets, including the nearest arterial/arterial or arterial/collector intersection in each direction along streets bordering the development site. If a proposed driveway or street will line up with an existing driveway or street opposite it, traffic volumes shall be collected at the existing intersection. The time periods in which existing traffic is counted should generally coincide with the highest combination of existing traffic plus traffic expected to be generated by the proposed development. A minimum of one hour is required but the count periods should extend at least 15 minutes before and at least 15 minutes beyond the anticipated peak hour to ensure that the highest one hour of traffic is identified. Traffic volume counts at intersections shall document left-turn, through and right-turn movements on all approaches and shall be tabulated in no greater than 15-minute increments. All traffic counts should include pedestrian and bicycle counts by direction of movement. The City Engineer or designee shall determine, based on the nature of the development, additional time periods in which current traffic volumes shall be documented.

2.4 Safety Analysis

Safety analysis for a TIS shall include review of available crash data for the roadway segments and intersections located withing the study area over a five-year period. Crash data can be requested from KDOT at the link below.

https://kdotapp.ksdot.gov/KORA/KORR/RequestForm?request=CData&level=public

The safety analysis should specify whether any part of the site is on the high injury network or on the vulnerable road user high injury network. These can be found in the Vision Zero Transportation Safety Action Plan.
https://lawrenceks.gov/mpo/vision-zero/

The safety analysis should provide a summary of the crash types, severity, and crash rate for the study intersections. The analysis should also provide discussion of any patterns and possible mitigation strategies.

Intersection crash rate:

$$R = \frac{1{,}000{,}000 \times C}{365 \times N \times V}$$

R = Crash rate for intersection expressed in crashes per million entering vehicles (MEV)

C = Total number of intersection related crashes in the study period

N = Number of years of data

V = Traffic volumes entering the intersection daily

Step 3 Background Traffic Growth

Background traffic is the expected increase in traffic volumes over time except for the specific development under study. Background traffic needs to be estimated out to the applicable horizon year in order to assess future traffic conditions.

Future daily traffic volumes on arterial and collector streets shall be identified from the traffic model used to develop the long-range transportation plan or developed using a growth rate based on review of historic traffic volumes. The existing background volumes should be projected using the calculated growth rate. Project generated trips will be added to the future year background volumes.

Step 4 Trip Generation

Trip generation is the process used to estimate the amount of travel associated with a specific land use or development. Trip generation is estimated through the use of “trip rates” that are based on some measure of the intensity of development, such as gross leasable area (GLA) or gross square footage (GSF).

Anticipated traffic for the Project shall be estimated using trip generation methods and procedures defined in the ITE Trip Generation Manual, 11th Edition or latest edition. The Trip Generation Manual should be used to determine the process for selecting the appropriate average rate or equation for each land use code. If the Trip Generation Manual recommends local data to be collected, prior approval from the City Engineer is required.

A table to summarize the trip generation for the Project shall be included in the TIS report. The table should include the land use code, unit used (i.e. square feet, number of dwelling units, rooms, etc.), projected ADT, peak hour volumes including directionality, and summary of project phases for larger developments.

Trip generation shall be calculated for the development analysis periods. Trip generation tables for the peak hour of the adjacent street should typically be used. For conditions during non-typical peak periods, ITE Trip Generation Manual “Peak Hour of Generator” rates may be used of those conditions.

Trip generation for redevelopments, mixed-use developments, larger developments and certain types of land uses may choose to use some of these more advanced tools when determining the number of trips a site generates.

Net Trips: Redevelopment sites may determine the previously generated number of trips based on the ITE land use codes and subtract those from the proposed site development with approval from the City Engineer. Depending on the intensity of the former development and the proposed development, this may result in the proposed development generating a net number of trips less than, approximately equal to, or more than, the existing site.

Mode Split: Mode split is the estimated number of travelers anticipated to use transportation modes other than automobiles. Mode split would require typical trip generation rates to be modified when the influence of non-automobile transportation modes is demonstrated and documented. Approval must be received from the City Engineer prior to implementing a trip generation reduction for Mode Split. Mode split should occur prior to applying pass-by trips.

Pass-by Trips: If pass-by trips are used for the TIS, the generation of the pass-by trips should be documented and noted within the TIS report. Methods described in the ITE Trip Generation Handbook should be used to estimate pass-by trips. Pass-by trip rate should not exceed 10 percent of the adjacent street or 25 percent of the proposed development site-generation potential, whichever is less.

Mixed-Use Internal Capture: For mixed-use developments, internal site-generation capture procedures may be used. Methods defined in the Trip Generation Handbook for internal capture should be used. Approval must be received from the City Engineer prior to implementing internal capture across collector or thoroughfare roads. The internal capture method should be clearly documented, and worksheets shall be provided with the TIS appendix.

Step 5 Trip Distribution and Assignment

Trip distribution is the general direction of approach and departure to/from a development site. Trip distribution rates should be developed by reviewing the existing traffic patterns near the development and the respective location of the site within the

City. The trip distribution percentages should be documented in a figure to visually represent the origins and destinations for the site-generated traffic. Good judgment is necessary to develop reasonable estimates of trip distribution.

Estimated vehicle-trips will be assigned to the existing and proposed street network using the trip distribution rates. Traffic assignment should be completed using judgement for the best routes to/from the development site for the identified analysis periods (i.e. AM and PM peak hours). Site generated traffic volumes should be documented in a figure. The proposed development volume scenario figures should include the total traffic with the site-generated traffic included in parenthesis. The resulting trip distribution and roadway assignment should be reviewed and approved by City staff prior to proceeding with analysis. Provide traffic volume figures to summarize the traffic assignment for each traffic volume summary. Figures shall include total movement volumes, site-generated volume and how pass-by trips were assigned, if used.

Step 6 Traffic Signal Warrant Analysis

Project access points or existing unsignalized intersection(s) that have volumes anticipated to meet one or more traffic signal warrants will require a traffic signal warrant analysis to be completed. Traffic signal warrant analysis should be completed using Manual on Uniform Traffic Control Devices (MUTCD) methodologies to determine which signal warrants may be met, if any. Signal warrant analysis should be included in the TIS and a recommendation with justifications should be provided. Note that Warrant 3, Peak Hour Warrant, shall be applied only in unusual cases as described in the MUTCD. Meeting only Warrant 3 may be insufficient evidence to justify the installation of a signal. It is ultimately the decision of the City to determine if/when a signal will be constructed at any given location.

Step 7 Turn Lane Analysis

For locations where a new access point is added to a corridor that does not have the necessary turn lanes, either a left or right turn lane, turn lane warrant analysis will need to be completed. Left and right turn lanes provide separation of vehicles that are slowing or stopped to turn from the vehicles that are going through the intersection. Separating the turning vehicles minimizes turn-related crashes and eliminates unnecessary delay to the through vehicles. Based on data reported in the National Cooperative Highway Research Report (NCHRP) 457, crash rate for unsignalized intersections can be reduced by 35 to 70 percent with the addition of a left-turn lane.

To evaluate the need for the auxiliary lanes, the turn lane warrant procedure documents in NCHRP 457 should be used. Variables used in the turn lane warrant analysis involve two-lane vs four-lane facility, major roadway speed, percent left-turn volume, advancing movement and the opposing volume. NCHRP 457 includes an Excel spreadsheet to assist with the turn lane warrant analysis. NCHRP Figure 2-5 should be used for the evaluation of left-turn lane at a two-way stop controlled intersection. NCHRP Figure 2-6 should be used to evaluate right-turn lanes.

7.1 Unsignalized Intersections – General Considerations

A recommendation for either a left or right turn lane at an unsignalized location requires evaluation of both vehicular and non-vehicular impacts. Additional non-vehicular factors may need to be evaluated further. For any given turning location, the engineer should evaluate the vehicular traffic desires and when it can be demonstrated that vehicular operations may warrant a turn lane, an analysis of non-vehicular impacts shall be completed based on location specific factors. The City Engineer has ultimate decision for the addition of a left or right-turn lane in the Public Right-of-Way, especially on a 4-lane roadway or in tight urban dense environments.

Non-vehicular factors that should be considered include but are not limited to:

- Potential negative impacts to the usability of adjacent previously developed property.
- Utility relocations that may be required to accommodate the widened section and whether the cost and overall impact of such relocations outweigh the benefit of the turn lane.
- Impacts to adjacent sidewalks/trails. The engineer should evaluate whether the roadway widening will negatively impact the safety of pedestrians and bicyclists due to potentially requiring the trail/sidewalk to be located closer to the street and increased crossing distances.
- A contextual analysis of the need for a turn lane should be completed. For example, a turn lane may be warranted in a suburban type of environment involving lower density land uses where prior development in the area also provided turning lanes, while it may be inappropriate to recommend a turn lane in a denser urban type area if prior development did not provide turn lanes.
- Existing or proposed on-street bike lanes where a right turn lane would create a weaving movement for more vulnerable roadway users.

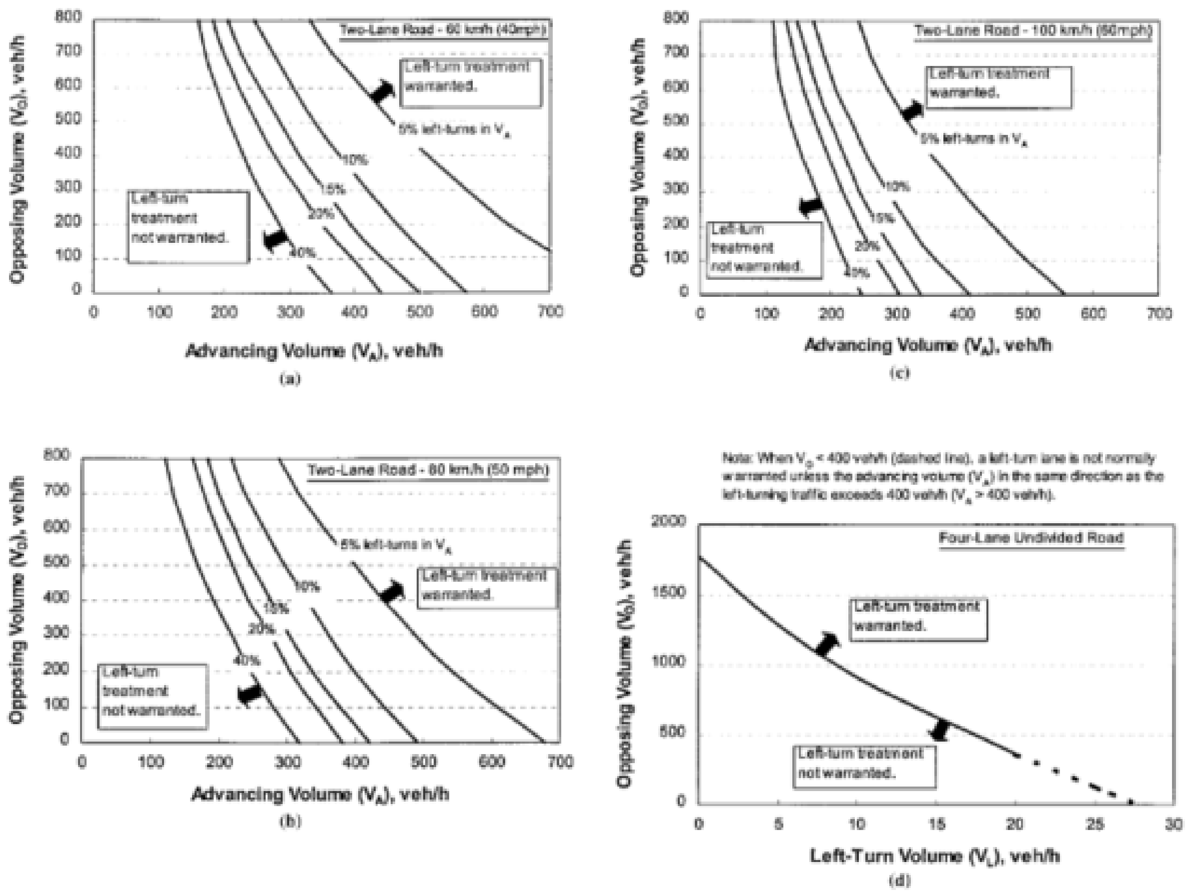
7.2 Unsignalized Intersections – Left Turns

Table 1 below provides guidance on requirements for left turn lanes at unsignalized intersections on arterial streets. For collector streets, the need for turn lanes should be evaluated in a similar manner. Generally on collector streets, a left turn lane is required at the approach to arterial streets and at heavy uses that have a primary access to a collector street. For intersections listed as requiring further evaluation, the engineer should provide an analysis of the non vehicular traffic factors listed in Section 7.1 above with a review of turning traffic shown in NCHRP 457 Figure 2-5.

Table 1: Left-Turn Guidance for Access from a Thoroughfare Road-Unsignalized Intersections

Intersecting Street/Drive Land Use	Intersecting Street or Drive	Thoroughfare Section				
		2 lane undivided	2 lane divided	4 lane undivided	4 lane divided	6 lane divided
Residential**	Driveway	Not Required *	Not Required *	Not Required *	Not Applicable	Not Applicable
Residential**	Local Street	Not Required *	Not Required *	Not Required *	Required	Required
Residential**	Collector Street	Evaluate ***	Required	Required	Required	Required
Non Residential	Driveway	Evaluate ***	Evaluate ***	Evaluate ***	Required	Required
Non Residential	Local Street	Evaluate ***	Evaluate ***	Evaluate ***	Required	Required
Non Residential	Collector Street	Evaluate ***	Required	Required	Required	Required
Non Residential	Thoroughfare	Evaluate ***	Required	Required	Required	Required

** Not required except in cases where stopping sight distance is insufficient for advancing vehicles behind a stopped left turning vehicle.*
*** Residential defined as “Residential Low Density” (R-1 & R-2)*
**** Evaluate peak hour turning movement and directional peak hour through volume according to NCHRP 457 Figure 2-5 below. Also evaluate impact to pedestrian/bicycle facilities and other factors listed in 7.1 above.*



NCHRP 457 Figure 2-5: Guideline for determining the need for a major road left turn bay at a two-way stop-controlled intersection

<u>Left-turn Geometric Considerations</u>

- Left turn lanes shall be 200 feet plus the taper at the intersection with another arterial street and 150 feet plus the taper at other locations.
- Dedicated left-turn lanes are required on side streets or driveways intersecting arterial streets at full median breaks. Minimum distance shall be 150 feet plus the taper.
- The length of the left-turn lane shall be increased as necessary to accommodate estimated queue length. The minimum length shall be exceeded based on the estimated 95th percentile queue length determined for future traffic volume projections. The queue length shall be estimated using analysis procedures outlined in the latest edition of the Highway Capacity Manual published by the Transportation Research Board. Where the analysis is based on traffic signal control, existing cycle lengths shall be used when available, otherwise a 120 second cycle length should be used in the analysis.
- Unless otherwise approved by the City Engineer, left-turn lane lengths shall cover the full-width segment between the taper and the end of the lane at an intersection with a public street or driveway. The end of the lane at the intersection shall be determined as the point of curvature for the turning radius used for design of the particular intersection. Turning radius shall meet City of Lawrence design standards.

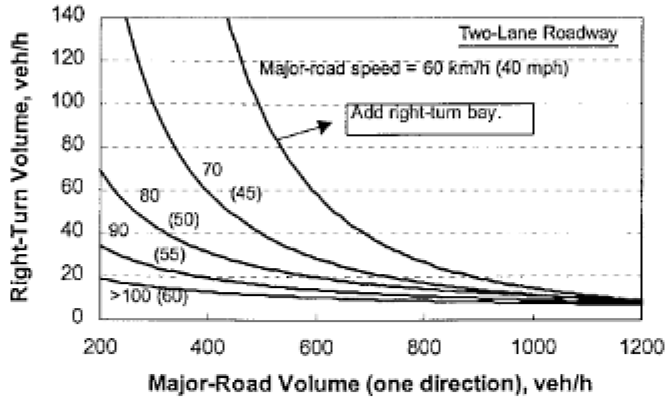
7.3 Unsignalized Intersections – Right Turn Lanes

Table 2 below provides guidance on requirements for right turn lanes at unsignalized intersections on thoroughfares. For intersections listed as requiring further evaluation, the engineer should provide an analysis of the non-vehicular traffic factors listed in Section 7.1 above along with a review of turning traffic shown in NCHRP 457 Figure 2-6.

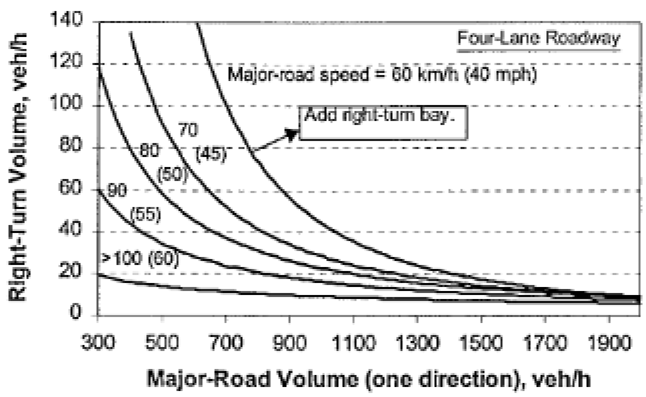
Table 2: Right Turn Lane Guidance on Thoroughfare Roads-Unsignalized Intersection

Intersecting Street/Drive Land Use	Intersecting Street or Drive	Thoroughfare Section				
		2 lane undivided	2 lane divided	4 lane undivided	4 lane divided	6 lane divided
Residential**	Driveway	Not Required	Not Required	Not Required	Not Required	Not Required
Residential**	Local Street	Not Required	Not Required	Not Required	Not Required	Not Required
Residential**	Collector Street	Evaluate *	Evaluate *	Evaluate *	Evaluate *	Not Required
Non Residential	Driveway	Evaluate *	Evaluate *	Evaluate *	Evaluate *	Not Required
Non Residential	Local Street	Evaluate *	Evaluate *	Evaluate *	Evaluate *	Not Required
Non Residential	Collector Street	Evaluate *	Evaluate *	Evaluate *	Evaluate *	Evaluate *
Not Applicable	Thoroughfare	Evaluate *	Evaluate *	Evaluate *	Evaluate *	Evaluate *

**Evaluate peak hour turning movement and directional peak hour through volume according to Figure 4 and 5 below. Also evaluate impact to pedestrian/bicycle facilities and other factors listed in Section 12.C above.*
*** Residential defined as "Residential Low Density" (R-1 & R-2)*



(a)



(b)

NCHRP 457 Figure 2-6: Guideline for determining the need for a major road right- turn bay at a two-way stop-controlled intersection

7.4 Signalized Intersections

Determinations about whether to provide either left or right turn lanes for individual movements at signalized or future signalized intersections should be based on evaluation of level of service with goals to provide acceptable level of service, or in cases where this is not feasible for existing intersections, to maintain an appropriate level of service.

Step 8 Capacity Analysis

Capacity analysis shall be performed for each study intersection using methodologies described in the Highway Capacity Manual (HCM), 6th edition, or latest edition. All capacity analysis should be performed using city-approved software programs. The capacity analysis results should be reported using HCM methodologies.

8.1 Capacity Analysis Criteria

The capacity analysis will be completed using the criteria defined below:

Level of Service (motorized): TIS should include computation of motorized LOS for the study intersection(s) using the methods described in the HCM. The traffic analysis should be completed using approved traffic engineering software listed below. LOS should be reported for each movement (or lane group) at the intersection.

Approved Traffic Engineering Software:
• Synchro/Sim Traffic Suite, version 11 or latest edition
• Highway Capacity Software (HCS), version 2023 or latest edition
• Vissim for special conditions
• Any other traffic engineering software must be approved in advance by city staff.

City staff can request additional analysis and/or access to electronic files for specialized software for more complicated traffic studies. Example software may include, but limited to, PTV Vissim, PTV Vistro, or SIDRA software. LOS should be reported for each movement (or lane group) at the intersection.

Traffic simulation should be conducted for closely spaced intersections, or complex traffic conditions. All traffic analysis files should be submitted electronically to the City as part of the TIS submittal.

Impact thresholds for overall intersection LOS are:
LOS D – is typically acceptable on all arterials and collectors
LOS C – is typically acceptable on all other roadways (the highest class of road defines an intersection)

Individual turning movements should operate with LOS E or better for all intersections. For locations with LOS F, additional information or explanation should be provided (i.e. vehicle queue length, signal warrant and geometric or traffic control recommendations should be included in the TIS). A TIS that results in LOS F for individual intersections or movements may not preclude acceptance of the TIS and the development by the City.

Vehicle Queuing: TIS should provide 95th percentile queue length for the individual turning movements. This information is beneficial in determining appropriate turn lane lengths or issues of driveways/streets being blocked by the traffic queue from an adjacent study intersection.

8.2 Intersection Analysis

a. Unsignalized Intersections: HCM results should be reported for unsignalized capacity analysis. Analysis should include the following information:

    1. Existing and proposed lane configurations and traffic control.
    2. Existing volume data should be included in the analysis. Factors shall include PHF, heavy vehicle (truck) percentage, and approach grades.
    3. The results of the capacity analysis should be summarized in a figure showing the lane configurations and individual movement level of service.
    4. Vehicle queue lengths can be reported to the nearest 5-foot intervals with the minimum queue assumed to be 25 feet for queues reported between 0.0 and 1.0 vehicles. HCM output results should be converted from number of vehicles in queue to vehicle queue length

(1 vehicle = 25 feet). Vehicle queue information should be provided in the TIS to note when vehicle queues from intersections block left-turn lane(s) and/or other nearby intersection(s). Vehicle queue information should be obtained from a traffic analysis program.

5. The vehicle queue information should be noted if the queue lengths extend beyond the available turn lane storage. Vehicle queues for the Project access point(s) or side street(s) should not extend into the circulatory roadway within the development. Internal development intersections should not spill back onto the public street system.

b. <u>Signalized Intersections:</u> Capacity analysis should include the following items:

1. Basic Inputs: Existing traffic volume data – PHF, heavy vehicle percentage, number of lanes, lane widths, approach grades, location to nearest traffic signal, and other inputs (i.e. on-street parking, storage bay lengths, number of pedestrians, etc.)
2. Existing signal timings, if available. If no timings are available, the analysis should be completed with a 120 second cycle length.
3. Existing left-turn signal phasing should be documented and used in the analysis (i.e. protected left-turn, permissive left-turn, protected/permissive left-turn, etc. Lawrence typically uses leading protected-permissive left turns when needed.).
4. For signals located within a corridor, the same cycle length should be used. Half cycle lengths can only be used if approved by City staff
5. Existing clearance intervals should be used when available. If clearance intervals are not available, a clearance interval ranging from 5 to 6 seconds should be used. Typical clearance intervals for modeling purposes are 2 seconds all-red with 4 seconds yellow. Actual clearance intervals can be calculated using ITE Signal Timing Methodologies.
6. Signalized capacity analysis results should be summarized on figures to illustrate the number of lanes, individual movement Level of Service, 95th percentile vehicle queue length, and overall intersection Level of Service.
7. Lane utilization factors can be adjusted to help replicate the existing conditions for lane unbalance. Adjustments such as these should be documented in the appendix. This condition typically occurs near major intersections or near interchanges.
8. Traffic simulation results are typically the best way to document the vehicle queue behavior and interaction between multiple intersections. For a study corridor, a minimum of 10 traffic simulation runs should be completed to provide the vehicle queue information.
9. Vehicle queue information should be provided in the TIS to note when vehicle queues from intersections block left-turn lane(s) and/or other nearby intersection(s).
10. All capacity analysis results should be analyzed using HCM methodologies and reports should be included in the TIS appendix.

c. <u>Roundabout:</u> Roundabouts shall be evaluated and compared with traffic signal operation at all potential locations including arterial-arterial, arterial-collector and collector-collector intersections. HCS should be used to analyze any existing or proposed roundabouts. Existing and proposed site-generated traffic volume data should be included in the analysis. Factors shall include PHF, heavy vehicle (truck) percentage, approach grades, and other required inputs. Vehicle queue information should be included in the analysis results. City staff can request additional analysis using SIDRA or VISSIM software for more complicated TIS's. Roundabouts should provide v/c ratios of 0.85 or below for all approaches for the design year.

d. Non-Standard Interchange or Intersection Concepts: Should a non-standard interchange or intersection concept be proposed, the capacity analysis should be completed using Vissim or other approved method to adequately evaluate the traffic operation.

Step 9 Site Circulation

TIS should include a review of the on-site circulation. This would include an assessment of the proposed access points onto the existing street network. The review should evaluate driveway throat lengths, vehicle turn radii, sight distance, internal driveway distance from the internal street network and connection points to the external system.

Vehicle Circulation: Vehicle turn radii assessment may require a review of truck access. Truck access should be evaluated to document the design vehicle that can enter and exit the development without causing impacts outside the proposed street network. Autoturn or other approved methods shall be used to assess the truck circulation. The design vehicle should be approved by City staff. At minimum, any non-residential development shall be able to accommodate an SU-40 design vehicle in areas outside of the downtown Form District and SU-30 in the Downtown Form District. The City Bus design vehicle should be used if a Lawrence Transit bus is anticipated to enter the site based on the proposed route. Bus turnouts may be planned for specific corridors or intersections, or adjacent to major generators.

Drive-Thru Vehicle Queue: Understanding the anticipated vehicle queue concerns is essential for site circulation review. For development sites with a proposed drive-thru, vehicle queue analysis should be completed using queuing theory analysis to estimate the anticipated number of vehicles for the drive-thru facility. The queuing analysis should be completed using current service rates from similar facilities and the arrival rates for the proposed development site (ITE trip generation rate). Assurances should be provided that the site can still function with the estimated drive-thru vehicle queue.

Step 10 Pedestrian and Bicycle Considerations

While transportation impact studies primarily address automobile traffic, recognition of other vehicle types and travel modes is appropriate, particularly in a community that strives for multi-modal choice. The following text by no means represents a comprehensive list of site planning elements but each must be addressed.

Pedestrians
Sidewalks along public streets or off-street paths provide mobility for pedestrians. Pedestrians should be provided with the opportunity to readily travel between these public infrastructure and adjacent land uses. All development plans should provide this connectivity.

Lawrence Pedestrian Plan:
https://www.lawrenceks.org/wp-content/uploads/2025/03/LawrencePedPlan.pdf

Bicyclists

Similar to pedestrians, development sites should provide reasonable opportunities to travel between adjacent public streets or bicycle trails and the land use. This does not imply that separate facilities are needed; rather, the conditions within a development site should be comparable to conditions adjacent to and near the site. Adequate and properly placed parking facilities for bicycles are a key component to encouraging bicycle travel. The Lawrence Bikes Plan should be consulted to determine if additional bicycle facilities are required.

Lawrence Bikes Plan: https://assets.lawrenceks.org/mpo/bicycle/BikePlan.pdf

APPENDIX

The Traffic Impact Study (TIS) should be prepared according to generally acceptable professional practice and should address the study elements listed below. City of Lawrence staff must approve all major assumptions. The TIS should provide sufficient text, maps, graphics, and tables to describe the study findings, recommendations, and appendices.

1. **Introduction and Study Scope**: This section should explain the context of the TIS and the scope of work.

2. **Existing Conditions**: The TIS should document existing transportation conditions covering infrastructure/service inventory, existing demand/usage, safety issues, and operational performance.

3. **Development Project Description**: This section should provide the following information:
    a. Proposed site location, layout, access (motorized and non-motorized), land uses, and development phasing
    b. Existing site access (motorized and non-motorized), land uses (types, intensities, building arrangement), and parking
    c. Information on nearby parcel access and land use, and their relationship to the proposed development project
    d. Trip generation using the latest edition of the ITE Trip Generation Manual and ITE Trip Generation Handbook procedures
    e. Traffic assignment and distribution should be summarized and illustrated onto figures

4. **Traffic Operation Analysis Sections**: The traffic operational analysis should be summarized for each of the traffic volume scenarios. Discussion should include individual motorized Levels of Service (LOS) by movement and vehicle queueing along with the overall intersection LOS, if applicable. This section should include traffic signal warrant analysis and any turn lane recommendations.

    a. **Existing Conditions (No Development):** The TIS should present the existing background transportation conditions. The existing conditions analysis should provide a summary of the current traffic operations and current geometrics.

    b. **Existing Conditions plus Site Generated Traffic (Full Build Only):** This section should present the opening day conditions with the proposed development project added. If the Project will cause traffic operation issues to the existing street network, mitigation measures should be identified, and their effect on the performance of the relevant mode should be identified. Acceptable levels of service are defined in Section 13.0

    c. **Existing Conditions plus Site Generated Traffic (Major Phases to Full Build):** A Project with trip generation levels that exceed 500 peak hour trips will require additional traffic operation analysis scenarios.

Depending on the number of phases, additional phased conditions may need to be developed for the TIS. Operations not meeting the acceptable levels of service will need to be mitigated.

d. **Future Year Background Traffic (No Build):** This analysis scenario is to provide a base scenario to compare against “Full Build Project” conditions.

e. **Future Year Background Traffic plus Site Generated Traffic (Full Build):** This analysis scenario is to determine the ultimate impact the Project will have on the street network for the future year scenario. Operations not meeting the acceptable levels of service will need to be mitigated.

5. Site Plan Review

a. Site Plan Circulation
b. Access Management Review
c. Intersection sight distance evaluation
d. Pedestrian circulation and connection
e. Bicycle consideration
f. Transit
g. Drive thru

6. Summary and Recommendations: This section should provide a summary of the study process and geometric improvement recommendations.

7. Appendix: All trip generation assumptions, internal capture rates, and traffic analysis reports should be provided in an appendix with sufficient detail to recreate the process and assumptions at a later date.