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DOWNTOWN LEXINGTON (KY) TRAFFIC MOVEMENT AND REVITALIZATION STUDY

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Abstract

The purpose of the *Downtown Lexington Traffic Movement and Revitalization Study* was to provide a structured, systematic process for evaluating the potential conversion of one-way streets to two-way operation and to provide information to decision makers regarding the impacts and mitigation of these conversions. Study objectives were:

- Assess the ability of the downtown street system to accommodate current and future traffic conditions with all streets converted to two-way
- Determine if conversion can reduce driver confusion, increase accessibility of businesses, and moderate vehicle speeds for improved safety
- Determine negative impacts and problem spots and propose practical solutions
- Engage public participation
- Provide information to decision makers

The overall study area was subdivided into smaller, focused areas that were functionally homogenous in terms of land use, functional characteristics of the one-way streets, and affected stakeholders. The project was then executed as separate subarea analyses of these three focus areas and that the results and recommendations were integrated into an overall mobility plan for the entire Downtown Area.

A downtown area microscopic traffic simulation model was developed and used to quantify the impacts of alternatives for converting one-way streets to two-way. The study also considered impacts on pedestrian, bicycle and transit travel modes.

Conclusions for each of the three subarea analyses were provided to decision makers, along with area-wide recommendations for improving mobility, safety, wayfinding, walkability, parking and freight deliveries. In the North subarea, it was concluded that two-way conversions could be made without adverse operational impacts, given that circulation plans for specific areas of interest were developed first. In the South subarea, it was determined that conversion impacts would produce traffic congestion and backups that would be detrimental to the University of Kentucky (especially bus operations) and to area businesses. In the downtown Core subarea, positive and negative impacts were associated with both of the conversion alternatives that were evaluated. No recommendations were made and the city council has deferred any decision until other area transportation projects have been completed.

The project also involved an extensive community involvement effort that included elected officials, stakeholders and the general public. The final report, including the recommended Mobility Plan, was published in September, 2015.

DOWNTOWN LEXINGTON (KY) TRAFFIC MOVEMENT AND REVITALIZATION STUDY

1. INTRODUCTION

History of One-Way Streets in Lexington

Like many U.S. cities that were established in the late 1700's, Lexington was centered on a downtown core that served as the economic and social hub for the region. Major roads connected downtown with neighboring communities, providing a regional transportation system in a wheel-and-spoke configuration that exists today. As far back as the Eighteenth Century, downtown Lexington was a destination.

After World War II, Lexington began to experience the growth and suburbanization that were products of the post-war economic boom. Many neighborhoods that we think of as being centrally located today were "in the suburbs" in the 1950's. As suburban shopping centers and malls sprang up, downtown was becoming a destination for fewer people. Efforts to preserve the downtown core as a destination and provide a basis for future development included efforts to improve traffic flow.

Lexington's history with one-way streets dates back to 1950, when the City created three one-way pairs: Maxwell Street and High Street, Second and Short streets, and Mill and Upper streets. The plan was implemented by the Lexington Police Department on a 90-day trial basis in an effort to solve downtown traffic problems. Mill and Upper streets had been one-way previously, but in opposite directions. The other one-way couplets were new. Broadway, Limestone and Main streets remained as two-way.

In the late 1950s, the Mill/Upper couplet was changed. Mill Street was converted back to two-way and the one-way flow on Upper Street was reversed to the southerly direction. Limestone Street was made one-way in the northerly direction.

Urban renewal efforts in the late 1960s and early 1970s led to significant changes downtown. Railroad tracks were removed for the planned widening of Vine Street into a four-lane, tree-lined street accommodating two-way traffic. The intent was to provide a spacious, tree-lined streetscape, incorporating plaza-type sidewalk areas catering to the pedestrian. The overarching objective was to build an atmosphere that would be the basis for future downtown development.

At the time, two-way Main and Vine streets and a one-way pairing of these both were considered as viable options. In 1971, the one-way pairing option won out, for several reasons:

- Main Street could be three lanes wide instead of four, providing more room for sidewalks and on-street parking;
- Through capacity could be increased by eliminating the need for turn lanes at intersections;
- Wider sidewalks meant that overhead utilities could be placed underground;
- Wider sidewalks meant better pedestrian access for retail businesses; and
- A three-lane Main Street provided an overall better appearance and environment for retail business (which was cited as the most important factor).

Interestingly, the one-way conversions were made in an effort to preserve downtown retail and fight the advent of the suburban shopping malls. From the Transportation Plan:

"These... (and other) improvements are considered imperative if the necessary attractability and accessibility are to be designed into the downtown development plan. These elements are very critical in allowing the CBD retail businesses to compete with the outlying shopping centers where convenience of location, access and parking are far more attractive at this time, 1969."

By the mid-1970s, there were five one-way couplets downtown:

- Main and Vine

- Limestone and Upper
- Maxwell and High
- Short and Second
- Third and Fourth

The street system remained this way until late 1999, when the majority of Third and Fourth streets were converted to two-way.

Resolution

In 2009, the Lexington-Fayette Urban County Council passed a resolution which adopted a process flow chart for conversion of any one-way street to two-way. The resolution was a procedural first step in the culmination of a decade-long attempt to convert downtown streets to two-way operation. The resolution also authorized a feasibility study for a two-way conversion of Short and Second streets, including the development of a strategic phasing scheme for the conversion. The Council resolution also authorized feasibility studies for two-way conversion initiatives for Limestone and Upper streets, Maxwell and High streets, and Main and Limestone streets.

Study Purpose and Objectives

The purpose of the Downtown Lexington Traffic Movement and Revitalization Study was to provide a structured, systematic process for evaluating the conversion of one-way streets to two-way and to provide information to decision makers regarding the impacts and mitigation of these conversions. The study objectives were as follows:

- Assess the ability of the downtown street system to accommodate current and future traffic conditions with all streets converted to two-way
- Determine if conversion can reduce driver confusion, increase accessibility of businesses, and moderate vehicle speeds for improved safety
- Determine negative impacts and problem spots and propose practical solutions
- Engage public participation
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2. EXISTING STREET SYSTEM

Lexington has a radial street system, with major arterial routes radiating out from the downtown center like spokes on a wheel. These radial streets are connected by New Circle Road, a circumferential route that surrounds a compact downtown core. This is illustrated in **Figure 1**. The street system configuration implies that travel through the downtown area is important along with travel within, into and out of downtown. Origin-destination data collected during this study support this idea; the data showed between 35 and 40 percent of the peak period trips in the downtown area were trips passing through downtown. Interstates 64 and 75, which skirt the metropolitan area, do not provide direct access to downtown.

Study Area and One-Way Pairs

The study area is generally bounded by Fourth Street to the northeast, Newtown Pike/Oliver Lewis Way to the northwest, Avenue of Champions/Euclid Avenue to the southwest, and Ashland Avenue to the southeast. The study area boundary is highlighted on the map that is shown in **Figure 2**.

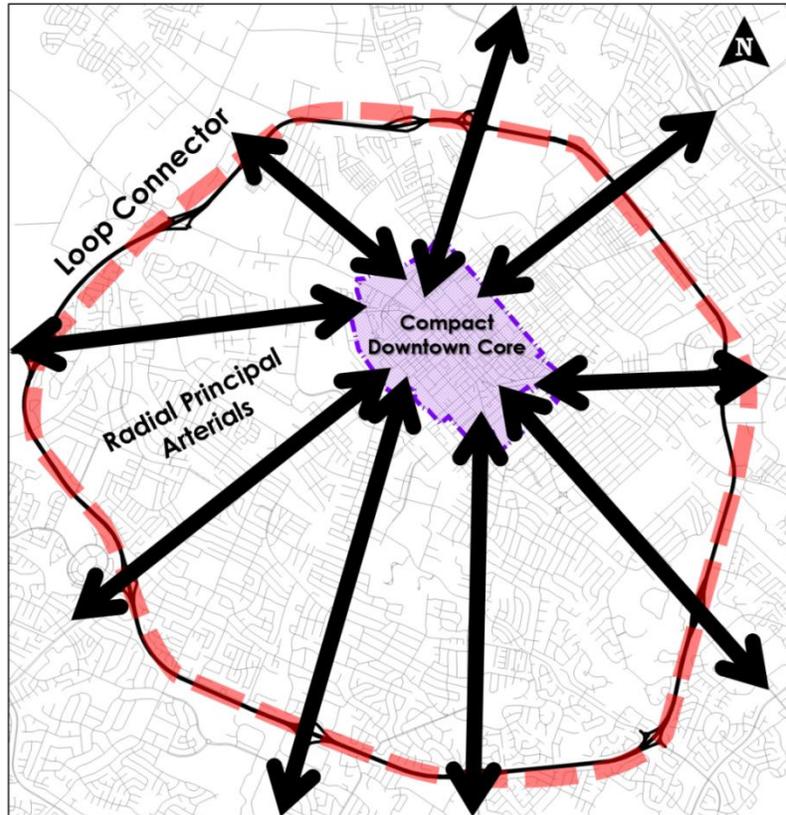


Figure 1. Lexington Street System

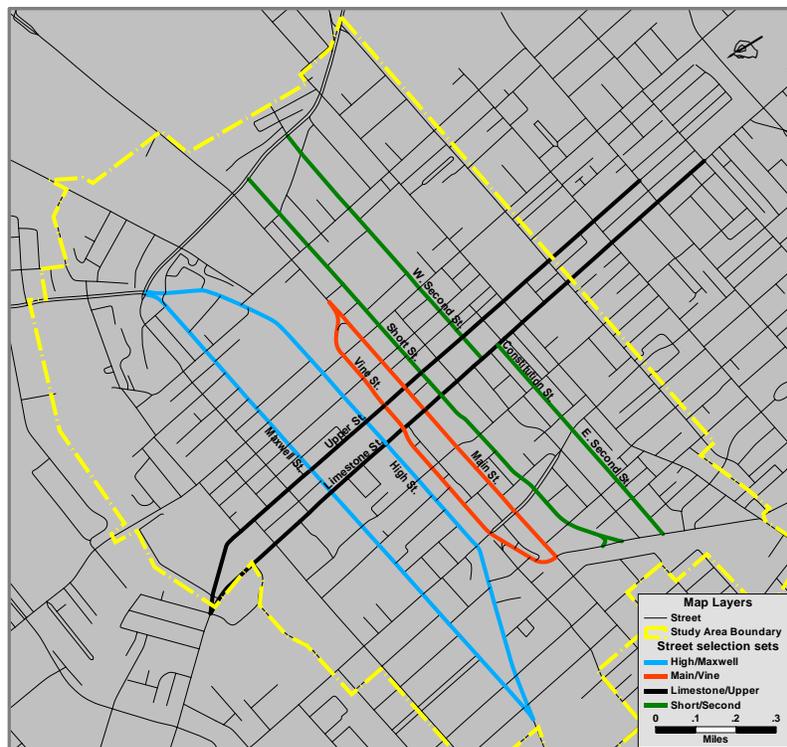


Figure 2. Downtown Study Area and One-Way Street Pairs

Lexington's downtown street system includes four one-way pairs. They are:

- Main Street/Vine Street
- Limestone Street/Upper Street
- Maxwell Street/High Street
- Short Street/Second Street

Focus Areas

Within the study area are smaller, focused areas that are functionally homogenous in terms of land use, functional characteristics of the one-way streets, and affected stakeholders. Those Focus Areas are:

- North Area
- Core Area
- South Area

Because each of these smaller areas are individually unique, it was determined that the best approach would be to execute the study as separate subarea analyses of individual focus areas and then integrate the results and recommendations into an overall mobility plan for the entire Downtown Area. A map highlighting the study area and existing one-way streets according to the focus area in which they fall is shown in **Figure 3**.

3. TWO-WAY ALTERNATIVES

This study offered a comparison of downtown streets in their current one-way configuration with the hypothetical scenarios where individual one-way pairs are converted to two-way. The comparisons were made at two levels:

- Overall, for the entire downtown study area as a whole
- Individual streets or street sections and intersections

Limestone and Upper streets are the only two one-way routes that cross focus area boundaries. Two-way consideration of this couplet was split at Main Street. Consideration of North Limestone and North Upper was included in the North Area study, while two-way South Limestone and South Upper were considered as part of the South Area study. For the Core Area analysis, Limestone and Upper streets were considered in their current one-way configuration.

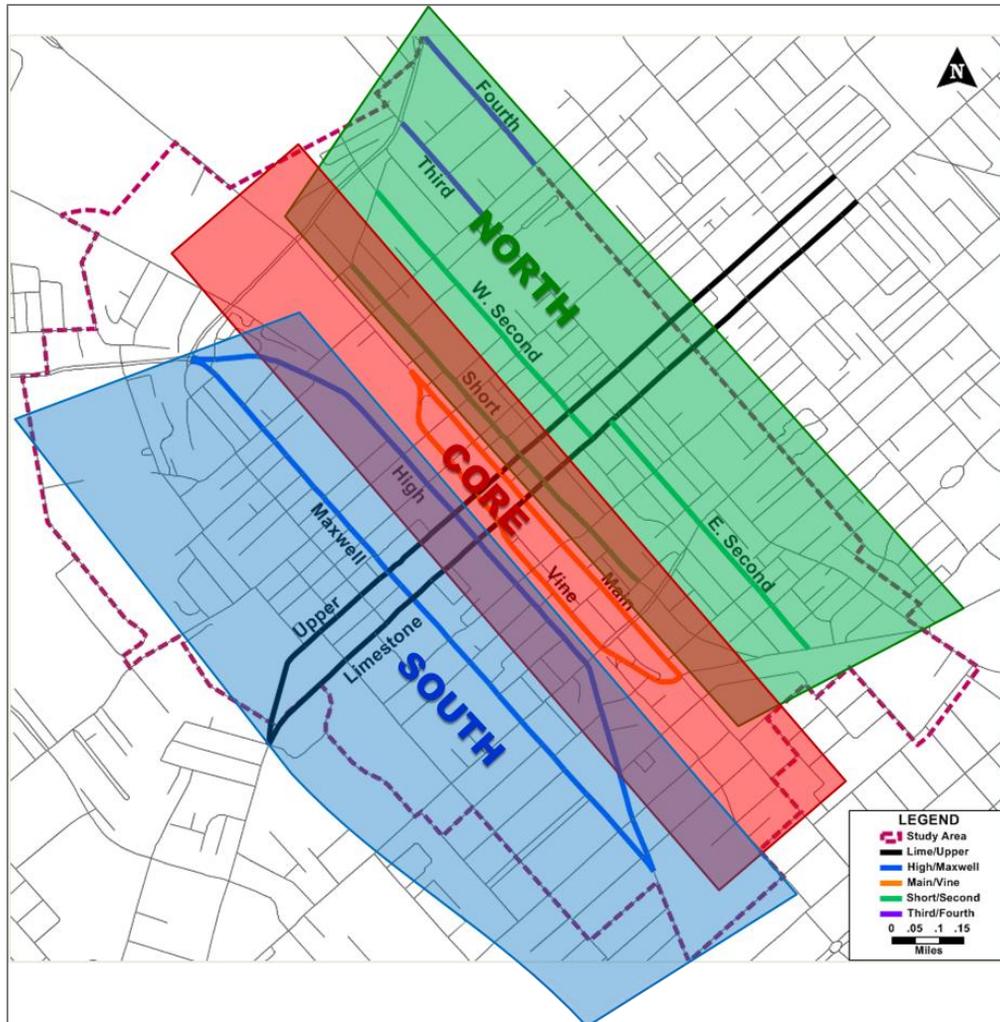


Figure 3. Focus Areas

The comparisons were made primarily using performance measures or metrics from analytical tools to allow for a quantitative comparison of one-way versus two-way traffic conditions. The performance measures were centered on traffic operations and safety (safety performance measures were limited to crash frequencies and rates). The study did not venture into metrics not related to traffic (economic impact, quality of life, sense of place, etc.). These aspects are an important part of the overall consideration, but were beyond the scope of this study. It did encompass other categorical elements not directly linked to analytical tools, such as presence or absence of bike lanes, pedestrian crossings, on-street parking, etc.

A rendering of a conceptual alternative for converting one of the core one-way streets to two-way is shown in **Figure 4**.

Analysis Tools

Two traffic modeling tools were used in performing the analyses. The TransModeler® microscopic traffic simulation software by Caliper Corporation was used to perform detailed operational analysis of projected traffic conditions for the various two-way conversion scenarios. The software was used to create calibrated base year models that replicate current traffic conditions under one-way flow. Alternative model scenarios then were created in which the one-way streets were converted to two-way. Performance

measures from the model scenarios were used to compare one-way versus two-way operation for the streets being evaluated.



Figure 4. Conceptual Two-Way Alternative

The TransModeler simulation software includes the ability to model the impacts of other travel modes – namely, buses, bicycles within the traffic stream, and pedestrians crossing the street. The software was used to evaluate traffic conditions for the downtown street network; i.e. the streets inside the study area boundary.

The second tool used in the evaluation was the Lexington Area Metropolitan Planning Organization (LAMPO) Travel Demand Model. This is a macroscopic tool that provides a “big picture” perspective of travel patterns and demand in Fayette and Jessamine counties. The LAMPO model runs on the TransCAD® software platform, also developed by Caliper Corporation. A number of the data elements of the LAMPO model were used in the development of the Downtown area simulation model.

The LAMPO model is an important complement to the downtown area simulation model. Whereas the simulation model provides a detailed assessment of traffic conditions within the study area under various two-way conversion scenarios, the LAMPO model was used to answer questions that the simulation model cannot; for example:

- How much traffic will be diverted to streets outside the study area with downtown streets being converted to two-way?
- How much of the traffic entering and leaving downtown is passing through the area?
- What will be the impact of completing the Newtown Pike (Oliver Lewis Way) Extension on travel demand in the Downtown area?

A third tool was used to perform a multimodal level of service analysis to quantify existing conditions for autos and trucks, bus riders, pedestrians and bicyclists. Quality of service, one of many dimensions of transportation system performance, describes how well (or poorly) a facility or service operates. Level of service (LOS) is the quantitative stratification of performance measures that represent quality of service; it is used to translate the results of complex analytical methods into a simple A (best) through F (worst) system that is representative of travelers’ perceptions of the quality of service provided by a facility (i.e.

street) or service (transit, for example). The analyses that were performed, based on methods documented in the 2010 edition of the Highway Capacity Manual, were used to estimate levels of service based on anticipated traveler perceptions for the four modes typical of an urban street corridor: automobiles, pedestrians, bicycles and bus transit riders. The methods are sensitive to the interaction among modes and the impacts that a change in one mode (adding a bicycle lane, for example) will have on the other three modes.

Performance Measures

A performance measure is defined as a quantitative characterization of some aspect of service provided by the transportation system. Within the context of this study, performance measures generated by traffic modeling tools were used to make quantitative comparisons of two-way conversion scenarios with the current one-way street system configuration. There are two main types of performance measures: 1) system-wide measures; and 2) facility-specific measures.

System-wide performance measures reflect impacts on the study area as a whole – they help quantify the “big picture” impacts of a change to the system. Beyond the localized impacts of making the change (e.g. converting a one-way couplet to two-way), they help to quantify the total impact to the system, within the defined system boundaries. System-wide performance measures can be divided into two groups:

- Aggregate measures
- Per trip measures

Aggregate measures reflect the summation of the metric by all vehicles or travelers within the system during the analysis period. They are useful in quantifying and comparing the effects on variables such as the change in circuitous travel associated with conversion from one-way to two-way.

Per trip measures are computed by dividing the summation of the aggregate measure by the number of vehicles or travelers making the trips during the analysis period. These “average” trips are representative trips that could occur over any portion of the system at any time during the analysis period. They provide the decision maker, stakeholder or member of the public with a reference to a “typical” trip that might occur with which that person can relate.

Facility-specific measures are computed for individual streets, street segments and intersections within the study area. They quantify the direct effect of changes to the system on these individual elements. These performance measures can be experienced or sensed by the traveler directly; for example:

- The change in travel time between Point “A” and Point “B” that would be expected if a street were changed from one-way to two-way
- The length of traffic backup on an intersection approach if that street were converted to two-way

A list of performance measures, definitions and how they were used in the study is shown as **Table 1**.

The number of completed trips, incomplete trips and queued trips are performance measures specifically associated with the simulation software. They were used to compare the ability of the downtown street system to “process” travel demand under the current one-way and alternative two-way street scenarios.

This project included a heavy public involvement component. While the traffic modeling tools were able to produce a wealth of performance measures for use in comparing alternatives, these were all quantitative metrics that were often confusing or hard to grasp by non-technical stakeholders, decision makers, and members of the general public. One of the biggest challenges of this study therefore was the translation of analytical results so they could be comprehended by non-technical people. The approach to this issue was: 1) select just a few key measures and focus on those for the sake of comparing alternatives and making decisions; and 2) translate and apply those metrics into something to which could be related and understood by the average citizen.

Table 1. Performance Measures

Performance Measure	Definition	How Used in the Study
System-wide Aggregate		
Vehicle-Miles Traveled (VMT)	The sum total distance traveled by all vehicles completing their trips.	Quantifies the overall change in circuitous travel.
Vehicle-Hours Traveled (VHT)	The sum total travel time experienced by all vehicles completing their trips.	Reflects the change in travel time associated with converting to two-way. Travel time changes include longer duration trips due to slower speeds plus longer intersection delays due to increased congestion.
Total Delay (in hours)	The total difference between experienced travel time and free-flow (i.e. unencumbered) travel time, summed over all vehicles completing their trips.	Reflects the change in congestion levels associated with conversion. A disproportionate change in total delay compared with the change in VMT reflects the impact of the conversion on congestion.
Number of Completed Trips	Number of simulated trips that begin/end within the analysis period.	Reflects ability of the street system to serve the peak travel demand.
Number of Incomplete Trips	The number of simulated trips that begin but are not completed within the analysis period.	Indicator of increased congestion attributable to a system change when the number of incomplete trips increases.
Number of Queued Trips	The number of simulated trips that are scheduled to begin before the end of the analysis period but are unable to enter the network due to congestion.	Reflects the portion of travel demand that would be served outside the analysis period (i.e. before or after the peak hour).
System-wide Per Trip		
Average Travel Time (in minutes)	The average duration for all trips. For trips beginning and/or ending outside the downtown study area, the trip terminus is the time the study area boundary is crossed.	Reflects the change in travel time to complete a typical trip when a part of the system is changed from one-way to two-way.
Average Speed (in mph)	The average distance traveled divided by the average travel time.	Reflects the change in overall average travel speed for a typical trip when a part of the system is changed from one-way to two-way.
Average Delay (in seconds per vehicle)	Total cumulative delay divided by the number of completed trips, where delay is the additional travel time experienced by drivers beyond that required to travel at a desired speed.	Reflects the portion of the change in travel time related to a change in congestion for a typical trip when a part of the system is changed from one-way to two-way.
Average Stop Rate (in stops per mile)	Total number of stops experienced during a trip averaged over all vehicles that completed their trips.	Reflects the change in stopping activity for a typical trip when a part of the system is changed from one-way to two-way.
Facility-Specific		
Average Travel Time (in minutes)	The average travel time of all vehicles on a street segment or section. This includes stopped time at intersections.	Reflects the change in time to travel a defined distance for one-way flow compared to the same facility under two-way flow.

Performance Measure	Definition	How Used in the Study
Average Speed (in mph)	The average speed of all vehicles on a street segment or section. This includes delay time at signals.	Reflects the difference in average travel speed for one-way flow compared to the same facility under two-way flow.
Average Intersection Delay (in seconds/vehicle)	The average delay experienced at intersections due to traffic control (i.e. signals) compared with an uncontrolled condition.	Reflects additional time required to clear an intersection as a result of converting one or more approach legs from one-way to two-way flow.

For comparing system-wide results, those metrics and their translations were:

- Vehicle Miles Traveled, VMT (“Change in Circuitous Travel,” as two-way streets often are touted to reduce the “driving-around-the-block” pattern that one-way streets promote)
- Vehicle-Hours of Travel, VHT (“Change in Travel Time”)
- Total Delay (“Change in Congestion”)

Graphics were relied upon heavily to communicate the message, as illustrated in **Figure 5**. In the Core Area, two alternatives were considered for converting Main and Vine streets to two-way:

1. A three-lane alternative with a center left-turn lane, bike lane, and on-street parking retained
2. A four-lane alternative without turn lanes, no bike lanes, no on-street parking, and left-turn prohibition at a number of intersections

The difference in vehicle-miles traveled, or VMT (an output from the simulation model), was used to convey the relative difference in circuitous travel (i.e. “driving around the block”) that would be associated with the one-way street alternatives when compared with the current one-way scheme.

The four-lane alternative was considered because Main and Vine streets are heavily traveled principal arterials through downtown.

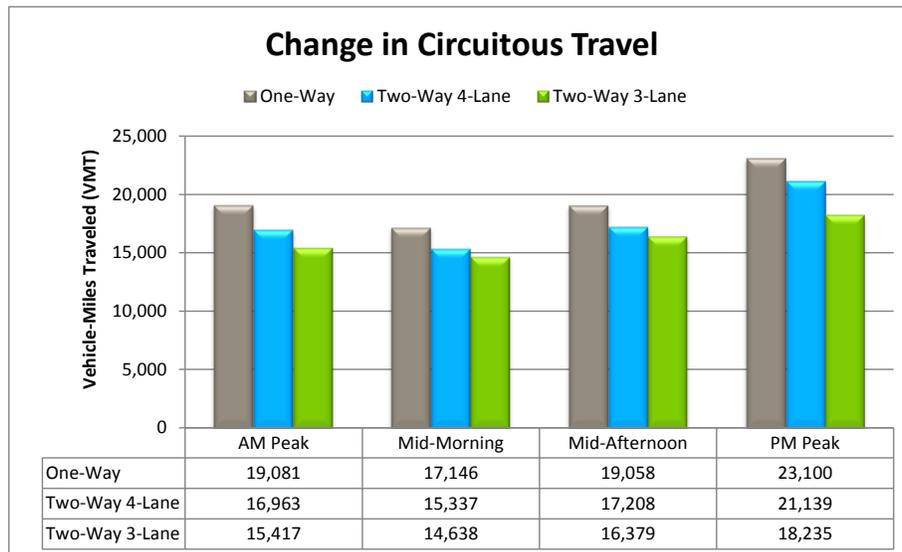


Figure 5. Core Area VMT Comparison

Through the discourse with stakeholders and citizens on the comparisons among alternatives, “How much longer will it take?” was a question that typified the desire to know how one-way streets would operate if converted to two-way. In response, per trip performance measures were generated for all scenarios. Within each focus area, an origin-destination pair for a typical trip within that area was

identified. The pairs were selected arbitrarily, with one important criterion – that the routing between origins and destination could be different under two-way flow when compared with one-way flow. Trip-based metrics used for comparing alternatives included average trip speed, average travel time, and average delay per trip. An example comparison is shown in **Figure 6**.

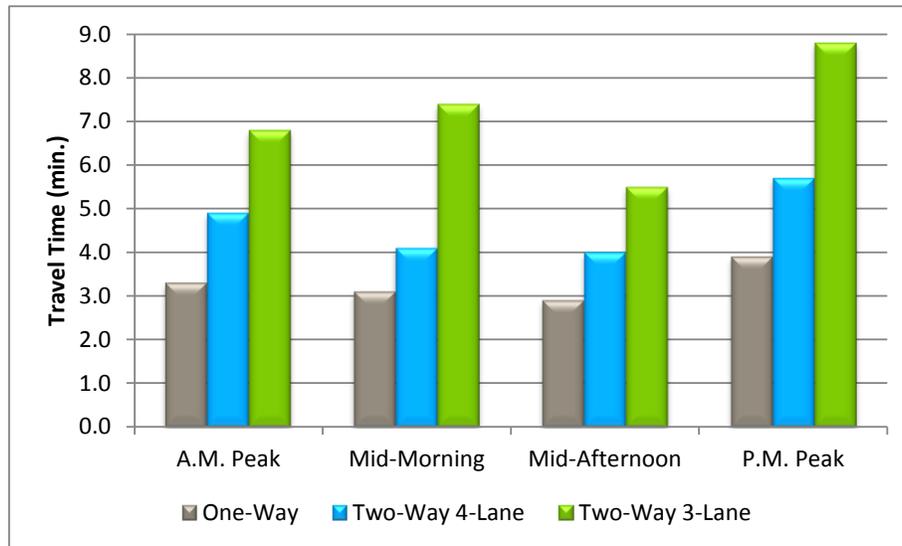


Figure 6. Average Travel Time per Trip

4. CONCLUSIONS

From the North Area analysis, it was concluded that conversion of North Limestone, North Upper, Short and West Second Streets would be feasible from a mobility perspective in that the analyses did not identify any major problems associated with their conversion. Conversely, it would not be feasible to convert East Second Street (Midland Avenue to North Limestone) to two-way (due to loss of residential parking). If the decision was made to convert North Area streets, there were several areas of concern for which mitigation measures would be necessary before the conversions should take place.

In the South Area, it was concluded that converting one-way streets to two-way would result in longer travel times, higher delays and more stops. These impacts were deemed to be more significant than the anticipated reduction in circuitous travel. Lengthy backups along South Limestone Street could be expected during peak periods. Conversion to two-way would eliminate some on-street parking spaces in the vicinity of signalized intersections to make way for needed left-turn lanes. Dedicated bicycle lanes would be lost at these locations also, for the same reason. Stakeholder input – especially from the University of Kentucky and South Area businesses – showed a lack of interest to convert, if not opposition to it.

From the Core Area analysis, when considering impacts of converting Main and Vine streets on the entire downtown area, two-way flow would reduce circuitous travel, increase travel times, reduce trip speeds and increase travel delay, when compared with the existing one-way system. These contrasts with one-way flow were more pronounced for the Three-Lane alternative than with the Four-Lane alternative. Where serving auto travel demand can be thought of as beginning and completing a trip into, out of or within the downtown area, the two-way alternatives showed it would take longer to serve this demand than the one-way system. Additionally, as was also observed in simulation for the South Area, converting Main and Vine to two-way would increase backups along arterials and collectors leading into downtown, especially Midland Avenue/Winchester Road, East Main Street/Richmond Road, East High Street, and Rose Street. As with other area-wide metrics, the contrasts with the one-way system were more pronounced for the Three-Lane alternative than the Four-Lane alternative.

In addition to the traffic flow metrics, the following impacts were noted for the Four-Lane alternative:

- Loss of on-street parking (including 45 – 50 spaces along Main Street)
- Loss of bike lanes within the right-of-way
- Street widening for turn lanes at seven key intersections (which would impact sidewalk widths and pedestrian mobility and would add over \$2 million to the construction cost)

The study concluded in September 2015. To date, no conversions have been made. An overarching factor: with the exception of the one-way couplets in the North Area, the remaining one-way streets, in part or totally, are designated as U.S. routes and are on the National Highway System. This means that the ownership of those streets lies with the Commonwealth of Kentucky (represented through the Kentucky Transportation Cabinet, or KYTC) and not the Lexington-Fayette Urban County Government (LFUCG), who has been the driving force behind the conversion movement. As conversion to two-way was demonstrated to increase downtown congestion and as one of the seven national goals of Moving Ahead for Progress in the 21st Century Act (MAP-21) is to achieve a significant reduction in congestion on the National Highway System, the KYTC to date has been reluctant to advance the discussion, particularly where it concerns Main and Vine streets, which form the backbone of the downtown street system.

5. LESSONS LEARNED

One-way-to-two-way conversions have been popular in the United States within the last few years, though the issue has been around longer than that. A review of available literature on the subject revealed that few if any projects have been at the scale of the Downtown Lexington Traffic Movement and Revitalization Study, both geographically and in magnitude of potential impact. The study has provided a valuable opportunity to identify and share lessons learned that can be applied in future conversion studies.

Analytical Tools and Methods

- Area-wide impacts of conversion cannot be ignored, particularly traffic diversion that may occur. The study area network should be of sufficient size so that the diversion can be both identified and quantified. This study employed both a regional travel demand model and an extracted subarea traffic simulation model to identify the conversion and quantify its impacts (i.e. accounting for a slightly reduced travel demand in the downtown study area).
- Microscopic traffic simulation software was a necessity for providing quantifiable metrics that allowed for the comparison of two-way alternatives with the existing one-way system. In an urban environment, the software must be able to simulate not only automobile traffic, but other modes that are part of a downtown fabric – pedestrians, buses, bicycles and delivery trucks. Simulation modeling enables the testing of alternatives in a “virtual laboratory” before making any commitment to physical change.
- Traffic signal operations are part of any downtown street network and will be controlling parameters in a one-way-to-two-way conversion study. New signal timing plans must be generated, not only for converted streets, but possibly for others as well. Prior to evaluating these hypothetical scenarios, coordination with the local traffic engineering department should be established so that controlling parameters can be identified (e.g. system cycle lengths, progression speed, phasing sequences, pedestrian walk intervals, etc.). Choice of signal timing software and its ability to integrate with the traffic simulation software can have an impact on workflow efficiency.
- Performance measures are critical for establishing an objective, quantifiable basis for comparing the operation of one-way versus two-way streets. Performance measures should be sufficient for describing anticipated traffic operations under any given scenario, both in the number that are used and in the type of information provided. Too many metrics, however, can lead to confusion, especially among non-technical stakeholders and members of the public.
- Being able to clearly communicate what the performance measures are saying is perhaps more important than the actual measures themselves, given that most of the stakeholders, members of the public, and especially decision makers likely will not be engineers or planners. For example,

while the concept of delay is readily understood by traffic engineers, it can be very confusing for the average citizen. However, comparing the travel time between two points for a one-way versus a two-way scenario is easily understood by everyone.

- Many factors are involved in the conversion of one-way streets and some of them are difficult to quantify, especially those dealing with sense of place, quality of life, etc. Others may be quantifiable but fall outside the realm of a traffic study – impact on property values, for example. It is important to keep a study like this within its proper context and having a well-defined scope of work is crucial. Regardless, there will be expectations for this type of study to answer more questions than it is capable of doing. Placing limits on those expectations at the outset helps temper those expectations.

Public Involvement

- One-way-to-two-way conversion is an emotional issue. People were either very strongly in favor or very strongly opposed – there seems to be little middle ground. In conducting a study of this type, because of these strong emotions, it is desirable to perform an objective, fact-based analysis from which decision makers can make the best informed decision.
- Public involvement should occur at various levels and not in just the traditional public meeting fashion. In fact, vocal minorities can adversely impact a well-intended, objective public information meeting. Public involvement also should occur at the stakeholder level – neighborhood groups, churches, business associations, etc., as well as at the one-on-one level. Many people or groups simply want an opportunity to express their opinion on the subject.
- The public involvement program should be well-documented and the information should be summarized as part of the materials provided to decision makers.

The project final report and all relevant accompanying materials can be found on the website of the Lexington Area Metropolitan Planning Organization at <http://lexareampo.org/downtown-lexington-traffic-movement-revitalization-study/>.