# Fehr & Peers 360 Plan Transportation Analysis Study

In 2016, Fehr & Peers conducted a detailed transportation analysis of all local roadway networks within the City Center to evaluate the effects a potential vehicular capacity reduction has on traffic patterns, economic development, and quality of life. The study included use of StreetLight cellphone and GPS data to better capture travel patterns throughout the study area, providing a micro-analysis of motorists' behaviors.

### EXECUTIVE SUMMARY

Fehr & Peers DC analyzed three scenarios to evaluate and provide context for the effects of the roadway modifications proposed as part of the Downtown Dallas 360 Plan: (1) an Existing year 2017 scenario; (2) a Future Baseline year 2040 scenario that includes an increased development density in Downtown (a 51 percent increase) and incorporates recently adopted Thoroughfare Plan Amendments; and (3) a Preliminary Roadway Changes year 2040 scenario that includes the broadest extent of envisioned roadway changes that could be made as part of the Downtown Dallas 360 Plan, including the repurposing of vehicle travel lanes to enhance travel options for non-auto modes. Once the City of Dallas has reviewed the results of these three scenarios, we will analyze a fourth scenario consisting of a subset of the Preliminary Roadway Changes to be selected by the City.

Fehr & Peers DC relied on modified versions of the Year 2017 and Year 2040 North Central Texas Council of Governments (NCTCOG) regional travel demand models. Before embarking on the modeling exercise, we conducted a small area model validation of the Year 2017 model against current year traffic counts and mobile device origin-destination data to ensure the model accurately represents Downtown travel behavior. The comparison indicated that, prior to adjustments applied in the small area validation, the model underestimated traffic interactions between the zones within the Dallas downtown area and overestimated interactions with areas outside the Dallas downtown area, particularly to the south. We adjusted both the 2017 model and 2040 model accordingly in a "Downtown Dallas 360 Model." The small area validation within Downtown Dallas is important, not only in that it allows greater confidence in model applications within Downtown, but also because it may explain why forecasts derived from the Downtown Dallas 360 Model differ from (and are more refined than) prior applications of the NCTCOG model in Downtown Dallas.

Because the NCTCOG Model is intended for regional analysis and its mode choice component is not highly sensitive to small-area land use and local roadway changes, Fehr & Peers DC also conducted off-model analysis to adjust mode split and trip matrices for the effects of increased land use density and diversity (mix) and the provision of bicycle and pedestrian infrastructure.

Fehr & Peers DC used the Downtown Dallas 360 Model to calculate four metrics for each analyzed scenario:

- Vehicle Miles Traveled (VMT) per Capita "the amount of driving per person;" a measure of the total amount of automobile travel attributed to an area relative to the number of residents and employees in that area
- Person Hours of Vehicle Travel per Person Trip (PHVT/PT) "time spent driving per trip;" a measure of the total time people spend traveling in automobiles relative to the number of trips they complete



- automobile volume on a street segment to its theoretical capacity

The analysis results present tradeoffs between localized congestion (measured by V/C ratios) and broader shifts that reduce driving per person (VMT per Capita), time spent driving per trip (PHVT/PT), and the percent of trips made by car (auto mode share).

With a 51 percent increase in population and employment anticipated between 2017 and 2040, the analysis indicates there will be more localized congestion on many Downtown street segments in the Future Baseline 2040 scenario. In particular, road segments in Uptown and Victory Park that already operate above capacity under existing conditions will experience more localized congestion under Future Baseline conditions. Road segments in the Main Street District, most of which operate at low levels of congestion under existing conditions, can generally accommodate increased traffic volumes. Despite these localized challenges, the land use densification and diversification anticipated in the Future Baseline bring substantial transportation benefits: the amount of driving per person (VMT per Capita), time spent driving per trip (PHVT/PT), and percent of trips made by car all decrease across Downtown and dramatically so within the freeway loop.

The introduction of the Downtown Dallas 360 roadway changes amplifies these trends by converting some automobile capacity to provide infrastructure supportive of transit, walking, and bicycling. Reducing vehicle capacity increases V/C ratios in some locations, particularly in the Dallas Farmers Market District, where existing congestion is relatively low, and in the Uptown and Victory Park districts, where existing congestion levels are already high. However, the accompanying mode shift benefits of the Downtown Dallas 360 roadway changes reduce V/C ratios at other locations, particularly in the Main Street District and other parts of Uptown and Victory Park. While the localized congestion effects of the Downtown Dallas 360 roadway changes are mixed, the broader benefits are clear, especially within the freeway loop: VMT per Capita decreases by 5 percent (15 percent inside the freeway loop), time spent driving per trip decreases 6 percent (16 percent within the freeway loop), and percent of trips made by car decreases 4 percent (14 percent within the freeway loop) compared to Future Baseline conditions without the Downtown Dallas 360 roadway changes.

When selecting a final package of Downtown Dallas 360 improvements and planning for implementation, the City and other project stakeholders will need to consider the tradeoffs between moderate increases in localized traffic congestion and more holistic benefits of reductions in the amount of driving per person, reductions in the time spent driving per trip, and reductions in the percent of trips made by car.



• Mode Split – the percent of total trips made by each major mode: auto, transit, walk, and bicycle • Volume/Capacity (V/C) Ratios - a measure of localized traffic congestion; the ratio of total

### METHODOLOGY

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This section provides an overview of the four scenarios that were analyzed and describes the travel demand analysis process used to calculate results for each scenario.

### **SCENARIOS**

Fehr & Peers DC evaluated four scenarios:

- Scenario 1: Existing Reflects the Year 2017 NCTCOG Model
- Scenario 2: Future Baseline Reflects the Year 2040 NCTCOG Model with the following modifications:
  - o Land use adjustments to reflect the City of Dallas' understanding of future development trends and vision for more intensive development in Downtown Dallas than anticipated in the unadjusted 2040 NCTCOG Model. Appendix A includes a table of these land use adjustments
  - o Roadway network changes that reflect recently adopted Thoroughfare Plan Amendments in and near Downtown. Appendix B includes a table of these network changes.
- Scenario 3: Preliminary Roadway Changes includes the same land use adjustments and Thoroughfare Plan Amendments described in Scenario 2. In addition, Scenario 3 includes the broadest extent of envisioned roadway changes that could be made as part of the Downtown Dallas 360 project. When a street segment has been modified in both the recent Thoroughfare Plan Amendment process and the Downtown Dallas 360 project, the Downtown Dallas 360 changes take precedence. Appendix C includes a table of the Downtown Dallas 360 roadway network changes for Scenario 3.
- Scenario 4: Refined Roadway Changes (not yet completed) will include the same land use adjustments and Thoroughfare Plan Amendments described in Scenario 2 and a subset of the Downtown Dallas 360 changes described in Scenario 3, which will be selected based on a review of the results of the Scenario 3 transportation analysis. Appendix D will include a table of the Downtown Dallas 360 roadway network changes for Scenario 4.

Table 1 summarizes the land use totals for Downtown Dallas analyzed in each scenario. "Downtown Dallas" includes the following 18 districts (also depicted on **Figure 1**, below):

West End Historic District

Civic Center

**Reunion District** 

Dallas Farmers Market District

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- Main Street District
- Thanksgiving Commercial Center
- Dallas Arts District
- Design District
- West Dallas
- North Oak Cliff
- Riverfront District

Scenario	Population	% Increase	Employment	% Increase	Service Population (Population + Employment)	% Increase
Scenario 1: Existing	48,500	—	294,300	—	342,800	—
Scenario 2: Future Baseline Scenario 3: Preliminary Roadway Changes Scenario 4: Refined Roadway Changes	131,000	170%	385,600	31%	516,600	51%

### TRAVEL DEMAND ANALYSIS

Fehr & Peers DC relied on modified versions of the Year 2017 and Year 2040 NCTCOG regional travel demand models (the "Downtown Dallas 360 Model") to analyze the scenarios described above. First, the City of Dallas and Fehr & Peers DC provided NCTCOG with modified land use assumptions. NCTCOG then returned full model runs and the model software scripts necessary to conduct an assignment-only run. Next, Fehr & Peers DC modified model trip tables to reflect validation to current year traffic counts and mobile device data; modified model network inputs to reflect background and project roadway changes; and adjusted trip tables to introduce sensitivity to active transportation infrastructure and small-scale land use

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- South Side
- The Cedars
- South Dallas/Fair Park
- Deep Ellum
- Baylor District
- Uptown
- Victory Park

#### **TABLE 1 – DOWNTOWN DALLAS SCENARIO LAND USE SUMMARY**

changes. Finally, Fehr & Peers DC completed the assignment-only model runs and summarized model outputs. This process is described in more detail in the sections that follow.

### MODIFIED NCTCOG MODEL RUN

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The City of Dallas sent Fehr & Peers DC updated land use estimates for the 2040 model year to account for increased housing in the Downtown. Fehr & Peers DC disaggregated from the District level to the Traffic Survey Zone (TSZ) level to create land use inputs for the NCTCOG model scenario runs. NCTCOG then ran two models—a 2017 base year and a modified 2040 base year—and provided Fehr & Peers DC with the trip table results.

### MOBILE DEVICE DATA ADJUSTMENTS

Fehr & Peers DC collected mobile device origin-destination data from 2015/2016 origin-destination data from StreetLight Data for the entire model area to refine peak hour travel patterns in the model. The data was analyzed and used to develop 28 by 28 matrices for the AM and PM peak hours providing trip making patterns from each zone to every other zone.

The unmodified Model year 2017 AM and PM trip tables were then aggregated to the same 28-zone system for which mobile device data was collected. These aggregated zonal values from the model trip tables were compared to the year 2015/2016 mobile device data. In general, the comparison indicated that the model was underestimating traffic interactions among zones within Downtown Dallas (intra-Downtown trips) and overestimating traffic interactions between the zones within the Downtown Dallas and areas outside Downtown (inter-Downtown trips). Fehr & Peers DC then developed factors to refine the Model year 2017 AM and PM trip tables to match the mobile device data. Additional details of the model validation process are provided in the "Dallas Downtown Area Plan Travel Demand Forecasting Model Validation Procedure and Results" memo (Appendix E).

Finally, we refined the 2040 Model for Scenario 2 and Scenario 3 using similar factors to those developed in the 2017 Model validation process to account for the unmodified model's tendency to underestimate intra-Downtown trips and overestimate inter-Downtown trips.

### ELASTICITY-BASED MODE SPLIT ADJUSTMENTS

Because the NCTCOG Model is intended for regional analysis and its mode choice component is not highly sensitive to small-area land use and local roadway changes, Fehr & Peers DC adjusted the modeled mode splits (and hence vehicle trip tables) using: (1) Fehr & Peers' context-sensitive trip generation tool, MXD+, and (2) published research on the effects of new bicycle infrastructure on bicycle ridership levels.



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#### **MXD+ Adjustment**

First, Fehr & Peers DC evaluated the potential of the increased density and mix of uses anticipated in Downtown Dallas—when accompanied by appropriate infrastructure—to support a shift to transit, walking and bicycling to, from, and within Downtown Dallas using Fehr & Peers' MXD+ tool. The methods most commonly used by traffic engineers to estimate the trip generation of proposed land use development fail to account for the effects of projects that have a balanced mix of land uses, compact design, good neighborhood connectivity and walkability, location efficiency and a variety of transportation choices. Several mixed-use trip generation methods including the National Cooperative Highway Research Program (NCHRP) 684 method, Environmental Protection Agency (EPA) MXD method, and combined approaches such as MXD+ reduce this bias and more accurately portray the traffic impacts of mixed use, compact, infill and transit-oriented development. The relationships between these contextual factors and trip generation / mode split were derived from and validated at hundreds of development sites across the U.S., including many in Texas, and incorporated into the MXD+ tool.

Fehr & Peers DC applied the tool to Downtown Dallas to estimate the number of trips that could shift from the auto mode to walking, bicycling, and transit relative to the level estimated by the NCTCOG model's conventional approach. The mode shift benefits calculated using the MXD+ tool were developed based on sites with high-quality internal pedestrian circulation. Supporting infrastructure and a pedestrian-friendly environment in Downtown Dallas will be necessary to fully realize the internalization benefits. We estimate that 20 percent of the shift to walk trips can be captured with existing infrastructure and an additional 80 percent of the benefit can be captured with the implementation of a high-quality pedestrian environment like the one envisioned in Downtown Dallas 360. In Scenario 2, 20 percent of the MXD+ calculated shift to bicycle, walk, and transit trips is applied to all TSZs to reflect the benefits of land use intensification and mixing without improved infrastructure. In Scenarios 3 and 4, TSZs within 1/10 mile of a Priority Roadway receive 100 percent of the MXD+ calculated shift to walk trips, while all other TSZs receive 20 percent of the MXD+ calculated shift (as in Scenario 2).

### **Bicycle Infrastructure Elasticity Adjustment**

In addition to the modest bicycle mode shifts expected from an intensification and diversification of land uses in Downtown Dallas, before/after research on installations of high quality bicycle infrastructure suggests both localized and area-wide increases in bicycle activity resulting from bicycle infrastructure improvements.

Douma and Cleaveland (2008) found relative increases in bicycling commute mode share within 2.5 kilometers (about 1.55 miles) of new bicycle infrastructure ranging from 37 percent in Austin, Texas to 91

percent in Chicago, Illinois.<sup>1</sup> A District (of Columbia) Department of Transportation (DDOT) Bicycle Evaluation Study (2012)<sup>2</sup> found a 200 percent increase in bicycle volumes on facilities with buffered bicycle lanes and between a 200 percent and 272 percent increase in bicycle volumes on facilities with cycletracks. To apply this research conservatively, we used the lower ends of these ranges, increasing the bicycle mode share by 37 percent for TSZs within 2.5 kilometers of a new bicycle facility or by 100 percent for TSZs within a quarter mile of a new buffered bicycle lane (although this is only about half the approximately 200 percent increase indicated in the DDOT study).

### ASSIGNMENT-ONLY RUNS

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For each scenario, the adjusted vehicle trip tables were run through the model in TransCAD 5.0 following the DFX (The Dallas-Fort Worth Regional Travel Demand Model for the Expanded Area) Model Description Summary from NCTCOG. The traffic assignment module is fully automated, and the assignment process components included the creation of a roadway network and the execution of a multimodal multi-class assignment.

The inputs for roadway traffic assignment are vehicle trip tables by time-of-day. The DFX considers four vehicle classes: drive-alone vehicles (DA), shared-ride vehicles with access to HOV facilities (SRHOV), shared-ride vehicles with no access to HOV facilities (SRNOHOV), and trucks (TRUCK). The DFX adopts a generalized cost method for multimodal multi-class roadway assignment. Different vehicle classes have different sets of roadway networks and different parameters for value-of-time. The generalized cost component considers path choice by a combined measure of roadway operating cost, toll cost, and travel time. Furthermore, the congested travel time is sensitive to the capacity and traffic volume of the roadway. The outputs of the roadway traffic assignment are total traffic volumes and travel times stored in the roadway network file, and estimated volumes for each class stored in separate output files.

For the first component of the assignment process, a network file was created for each peak period that included all links and nodes in the network and fields for time, capacity, signalized and unsignalized parameters and the delay function. The second component of the assignment process, the execution of a multimodal multi-class assignment, was performed by using the roadway network file from the first component and the trip tables for all four vehicle classes for the specific peak period. A selection of links was created for all links with a capacity greater than zero, links with a functional classification for highoccupancy vehicles, links with a managed lane facility, and a set of links with high-occupancy vehicles and truck exclusions.

<sup>&</sup>lt;sup>2</sup> https://ddot.dc.gov/page/bicycle-facility-evaluation



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One-hundred iterations of the model were run per scenario. After the traffic assignment was completed for each time period, estimated volumes, vehicle-miles traveled, vehicle-hours traveled and volume-to-capacity ratios for each class are stored in the output files for all zones and roadway links in the study area. These results were subsequently grouped by zone based on geography for reporting purposes.

<sup>&</sup>lt;sup>11</sup> https://www.lrrb.org/pdf/200833.pdf

## RESULTS

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This section presents the transportation analysis results of four metrics that capture the multimodal transportation effects of the analyzed land use and transportation changes:

- Vehicle Miles Traveled (VMT) per Capita "the amount of driving per person;" a measure of the total amount of automobile travel attributed to an area relative to the number of residents and employees in that area
- Person Hours of Vehicle Travel per Person Trip (PHVT/PT) "time spent driving per trip;" a measure of the total time people spend traveling in automobiles relative to the number of trips they complete
- Mode Split the percent of total trips made by each major mode: auto, transit, walk, and bicycle
- Volume/Capacity (V/C) Ratios a measure of localized traffic congestion; the ratio of total automobile volume on a street segment to its theoretical capacity

Additional details on each metric are provided in the subsections below.

### VEHICLE MILES TRAVELED PER CAPITA

### METRIC DESCRIPTION

Vehicle Miles Traveled (VMT) per Capita is a broad measure of transportation efficiency – lowering the VMT per Capita indicates that trips are accomplished with less auto travel. This, in turn, indicates fewer congestion impacts, less emissions, reduced wear and tear on roadways, and likely indicates more active lifestyles and less parking demand. It is a measure of the total amount of automobile travel attributed to an area relative to the number of residents and employees in that area. The measure sums the miles traveled by automobile to and from each TSZ, as generated by the trip-based Downtown Dallas 360 Model. VMT is calculated by adding the VMT associated with trips generated and attracted within the individual TSZ, plus 50 percent of the VMT associated with trips that either begin or end in the TSZ, but have one trip end outside of the TSZ. Each TSZ's VMT is then divided by its total service population, defined as the population plus the number of jobs, to calculate VMT per Capita.

Although VMT itself will increase with the anticipated growth in new residents and employees, the City can reduce VMT on a per-capita basis with land use and transportation policies that help Dallas residents meet their daily needs within a short distance of home, reducing trip lengths; and by encouraging development in areas with more travel choices. The VMT per Capita metric could be reduced if, for example:

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- automobile travel;
- visitors to meet their needs nearby; or
- travelers can shift from driving to using transit or active modes.

Shifts of these trends in the opposite direction would increase VMT per Capita.

### METRIC RESULTS

The City of Dallas estimates that between the Scenario 1 2017 Baseline and future scenarios 2, 3, and 4, employment and population ("service population") within Downtown Dallas will increase by a combined 51 percent from approximately 342,800 to 516,600 (see Table 1, above). Over the same period, the total daily VMT attributable to Downtown Dallas will increase:

- 47% from 7.477.000 VMT in the Scenario 1 2017 Baseline to 10.954.000 VMT in the Scenario 2 2040 Future Baseline; and
- 39% from 7,477,000 VMT in the Scenario 1 2017 Baseline to 10,375,000 VMT in the Scenario 3 2040 Project.

In both future scenarios, the rate of service population growth exceeds the rate of VMT growth, resulting in a lower daily VMT per Capita. Table 2 summarizes the daily VMT per capita for each scenario and provides VMT per Capita values for other cities for comparison. As a major regional employment center, Downtown Dallas would be expected to have relatively high VMT per Capita, reflecting the long distances many commuters travel to reach downtown jobs from around the region. Similarly, Pasadena, CA is relatively employment-rich compared to the broader Los Angeles metropolitan area.



 additional employees and population can be accommodated without a proportional increase in • trip lengths can be shortened by providing more opportunities for residents, employees, and

#### **TABLE 2 – DAILY VEHICLE MILES TRAVELED PER CAPITA SUMMARY**

Scenario	Daily VMT Per Capita	% Change from Existing
Downtown Dallas Scenario 1: Existing (2017)	21.8	—
Downtown Dallas Scenario 2: Future Baseline (2040)	21.2	-3%
Downtown Dallas Scenario 3: Preliminary Roadway Changes (2040)	20.1	-8%
Downtown Dallas Scenario 4: Refined Roadway Changes (2040)	TBD	TBD
Other Locations for	r Comparison	
Downtown Bethesda, MD (2040)	10.3	n/a
City of Los Angeles, CA (2012)	13.0	n/a
City of Pasadena, CA (2014)	22.9	n/a

The decrease in VMT per Capita between Scenario 1 and Scenario 2 primarily reflects an increased proportion of residential uses in Downtown, which provides an option for shortening commute distances for Downtown workers. The accompanying increase in density also creates additional opportunities for shopping, dining, recreation, and other activities within Downtown, enabling new residents to meet needs within Downtown. The additional decrease in VMT per Capita between Scenario 2 and Scenario 3 reflects mode shifts from auto to walking and bicycling, supported by the Downtown Dallas 360 roadway changes.

Table 3 provides additional VMT per Capita detail. Appendix F provides estimates of District-level VMT per Capita detail.<sup>3</sup> Downtown Dallas within the freeway loop experiences the most substantial reduction in VMT per Capita, decreasing approximately 18 percent between existing conditions and future baseline conditions and decreasing an additional 15 percent with the implementation of the analyzed package of Downtown Dallas 360 improvements. The Main Street District, Thanksgiving Commercial Center, and Reunion District experience significant decreases in VMT per Capita.

Outside the freeway loop, Downtown experiences a more modest decrease in VMT per Capita of 5 percent under future baseline conditions and an additional 2 percent under Scenario 3, reflecting less density of land development and fewer Downtown Dallas 360-related roadway changes.

<sup>&</sup>lt;sup>3</sup> District-level detail estimates are provided for informational purposes only and should be interpreted with caution. District-level detail may be useful for comparing relative differences among districts, but estimates for individual districts should not be considered accurate at the level of precision presented in the tables.





VMT per Capita remains generally level for the City of Dallas overall, increasing marginally in the future base scenario and decreasing slightly under Scenario 3.

Figures 1 and 2 illustrate the changes in VMT per Capita among Scenarios 1, 2, and 3.

Geography	Sc. 1	Sc. 2	Sc. 3	Sc. 4	Sc. 2	Sc. 3	Sc. 4	Sc. 3	Sc. 4
	Da	ily VMT	per Ca	pita	Rela vs	ative Cha . Scenario	Relative Change vs. Scenario 2		
Downtown (Within Freeway)	15.3	12.5	10.6	TBD	-18%	-30%	TBD	-15%	TBD
Downtown (Outside Freeway)	29.5	28.1	27.5	TBD	-5%	-7%	TBD	-2%	TBD
Downtown (All Districts)	21.8	21.2	20.1	TBD	-3%	-8%	TBD	-5%	TBD
City of Dallas	13.6	13.7	13.5	TBD	1%	-1%	TBD	-2%	TBD
Dallas-Fort Worth Region	13.9	14.3	14.2	TBD	2%	2%	TBD	0%	TBD

### TABLE 3 – DAILY VEHICLE MILES TRAVELED PER CAPITA



VMT/Capita, Sc. 1: Existing

Downtown

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VMT/Capita, Sc. 2: Future Base







Downtown Within Freeway



Vehicle Miles Traveled per Capita Scenario 2 vs. Scenario 1



## Vehicle Miles Traveled per Capita Scenario 3 vs. Scenario 2

Figure 2



30.<sup>10/0</sup> 20.<sup>30/0</sup> 23.<sup>10/0</sup> 10.<sup>30/0</sup> 10.<sup>30/0</sup> 23.<sup>00/0</sup> 20.<sup>10/0</sup> 20.<sup>10/0</sup>







## PERSON HOURS OF VEHICLE TRAVEL PER PERSON TRIP

### METRIC DESCRIPTION

Person Hours of Vehicle Travel per Person Trip is a measure of the total time a person spends traveling in automobiles on a trip. It is a more holistic measure of the auto travel experience than point-based level of service (LOS) because it encompasses an entire trip. When people talk about traffic conditions, they generally talk about how long it took to get from one place to another, rather than specific points of congestion along the way. The measure sums the travel times for all vehicle trips associated with each TSZ, as generated by the trip-based Downtown Dallas 360 Model. Total time spent traveling by automobile is calculated by adding the travel time associated with vehicle trips generated and attracted within the individual TSZ, plus 50 percent of the travel time associated with vehicle trips that either begin or end in the TSZ, but have one trip end outside of the TSZ. Each TSZ's total vehicle travel time is then divided by its total number of person trips, regardless of mode, to calculate Person Hours of Vehicle Travel per Person Trip.

The total amount of time spent traveling in vehicles may increase with the anticipated growth in new residents and employees, but the City can reduce Person Hours of Vehicle Travel per Person Trip with land use and transportation policies that reduce trip durations by helping Dallas residents meet their daily needs within a short distance of home and encouraging development in areas with more travel choices. The Person Hours of Vehicle Travel per Person Trip metric could be reduced if, for example:

- vehicle trip durations can be shortened by improving the flow of automobile traffic such that the same trip can be completed in a shorter time;
- vehicle trip durations can be shortened by providing more opportunities for residents, employees, and visitors to meet their needs nearby, even if localized congestion increases; or
- travelers can shift from driving to using transit or active modes, which do not require time spent traveling in an automobile.

Shifts of these trends in the opposite direction would increase Person Hours of Vehicle Travel per Person Trip.

Table 4 illustrates the metric with a simplified example of three travelers, each of whom makes three trips: a commute, a grocery trip, and a social trip to go out to dinner. Traveler A drives for all three trips and has a relatively long driving commute. Traveler B also drives for all three trips, but has a shorter commute and lives slightly closer to the grocery store. Traveler C has a longer driving commute than Traveler B, but is able

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to walk to both the grocery store and restaurant. The Driving Time per Trip in this example is a simplified version of Person Hours of Vehicle Travel per Person Trip that assumes individuals travel alone.

#### TABLE 4 – PERSON HOURS OF V

	Traveler A	Traveler B	Traveler C
Trip 1 – Commute	Drive 50 minutes	Drive 25 minutes	Drive 30 minutes
Trip 2 – Groceries	Drive 15 minutes	Drive 10 minutes	Walk 10 minutes
Гrip 3 – Dinner Out	Drive 10 minutes	Drive 10 minutes	Walk 5 minutes
Total Driving Time	75 minutes	45 minutes	30 minutes
Total Trips	3 trips	3 trips	3 trips
Driving Time per Trip	25 minutes	15 minutes	10 minutes

Please note that Person Hours of Vehicle Travel per Person Trip includes all trips, not just driving trips, in the denominator, so it includes the effects of shifts to other modes. It should not be interpreted as a travel time for driving trips, but as the total amount of time spent driving divided by the total of all trips made.

### METRIC RESULTS

Table 5 summarizes Person Hours of Vehicle Travel per Person Trip (PHVT/PT). Appendix G provides estimates of District-level PHVT/PT detail.<sup>4</sup> As with VMT per Capita (described above), the portion of Downtown Dallas within the freeway loop experiences the greatest decrease in PHVT/PT, meaning that travelers are spending less time in automobiles per trip, either through shortened trip distances, reduced travel times, or shifts to transit, walking and bicycling. PHVT/PT decreases approximately 35 percent between existing conditions and future baseline conditions and decreases an additional 16 percent with the implementation of the analyzed package of Downtown Dallas 360 improvements. The Main Street District, Thanksgiving Commercial Center, and Reunion District experience the most significant decreases in PHVT/PT.

<sup>4</sup> District-level detail estimates are provided for informational purposes only and should be interpreted with caution. District-level detail may be useful for comparing relative differences among districts, but estimates for individual districts should not be considered accurate at the level of precision presented in the tables.

EHICLE TRA	VEL PER	PERSON	TRIP	EXAMPLE
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Outside the freeway loop, Downtown experiences a more modest decrease in PHVT/PT of 3 percent under future baseline conditions and an additional 3 percent under Scenario 3, reflecting less density of land development and fewer Downtown Dallas 360-related roadway changes.

PHVT/PT remains generally level for the City of Dallas overall, increasing marginally in the future base scenario and returning to its 2017 level under Scenario 3. Across the region, PHVT/PT increases nearly 10 percent by 2040. **Figures 3 and 4** illustrate the changes in PHVT/PT among Scenarios 1, 2, and 3.

Geography	Sc. 1	Sc. 2	Sc. 3	Sc. 4	Sc. 2	Sc. 3	Sc. 4	Sc. 3	Sc. 4
	Pers Tra	son Hou wel per	rs of Ve Person	hicle Trip	Rela vs	ative Cha . Scenaric	Relative Change vs. Scenario 2		
Downtown (Within Freeway)	12.4	8.1	6.8	TBD	-35%	-45%	TBD	-16%	TBD
Downtown (Outside Freeway)	13.7	13.4	13.0	TBD	-3%	-5%	TBD	-3%	TBD
Downtown (All Districts)	13.2	11.6	10.9	TBD	-12%	-18%	TBD	-6%	TBD
City of Dallas	13.6	13.9	13.6	TBD	2%	0%	TBD	-2%	TBD
Dallas-Fort Worth Region	14.6	15.9	15.8	TBD	9%	8%	TBD	-1%	TBD

TABLE 5 – PERSON HOURS OF VEHICLE TRAVEL PER PERSON TRIP (MINUTES)



PHVT/PT, Sc. 1: Existing





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PHVT/PT, Sc. 2: Future Base





Person Hours of Vehicle Travel per Person Trip (PHVT/PT, minutes) Scenario 2 vs. Scenario 1



PHVT/PT, Sc. 2: Future Base





PHVT/PT, Sc. 3: Preliminary Roadway Changes





Downtown Within Freeway Downtown

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Relative Change in PHVT/PT



Person Hours of Vehicle Travel per Person Trip (PHVT/PT, minutes) Scenario 3 vs. Scenario 2

Figure 4



## **MODE SPLIT**

Mode split accounts for the percent of total trips made by each major mode: auto, transit, walk, and bicycle. 
**Table 6** summarizes mode splits for all analyzed scenarios.

### TABLE 6 – MODE SPLIT SUMMARY

	Downtown Downtown (Within Freeway) (Outside Freeway)		Downtown (All Districts)	City of Dallas								
		Scenario 1: Existing	(2017)									
Auto	63.9%	88.6%	79.1%	91.8%								
Transit	16.6%	3.7%	8.7%	3.3%								
Walk	16.8%	7.5%	11.1%	4.00/#								
Bike	2.7%	0.2%	1.2%	4.9%*								
Scenario 2: Future Baseline (2040)												
Auto	48.9%	88.1%	74.9%	**								
Transit	31.6%	3.2%	12.8%	**								
Walk	15.9%	8.2%	10.8%	**								
Bike	3.6%	0.6%	1.6%	**								
	Scenar	io 3: Preliminary Roadwo	ay Changes (2040)									
Auto	42.0%	86.9%	71.7%	**								
Transit	31.6%	3.2%	12.8%	**								
Walk	19.3%	9.0%	12.5%	**								
Bike	7.1%	1.0%	3.1%	**								
	Scen	ario 4: Refined Roadway	Changes (2040)									
Auto	TBD	TBD	TBD	**								
Transit	TBD	TBD	TBD	**								
Walk	TBD	TBD	TBD	**								
Bike	TBD	TBD	TBD	**								

\*The available National Household Travel Survey data do not differentiate walk and bike modes citywide. \*\*Citywide mode shares could not be estimated for future scenarios since regional travel demand models typically do not provide forecasts for active modes.

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Downtown Dallas already has a lower share of auto trips and a higher share of transit, walk, and bike trips than the City of Dallas as a whole. In future scenarios, Downtown Dallas experiences a reduction in the share of trips made by auto, decreasing approximately 5 percent (4 percentage points) between existing conditions (79.1 percent) and future baseline conditions (74.9 percent) and decreasing an additional 4 percent (3 percentage points) to 71.7 percent with the implementation of the analyzed package of Downtown Dallas 360 improvements. Much of this mode shift is attributable to shifts to transit which increases from 8.7 percent of trips under existing conditions to 12.8 percent in future conditions; walk and bike mode shares also increase between existing conditions and Scenario 3 with the implementation of Downtown Dallas 360 improvements.

Downtown Dallas within the freeway loop experiences a much more significant reduction in the share of trips made by auto, decreasing 23 percent (15 percentage points) between existing conditions (63.9 percent) and future baseline conditions (48.9 percent) and decreasing an additional 14 percent (7 percentage points) to 42.0 percent in Scenario 3. Both transit and bike mode shares roughly double between existing conditions and Scenario 3 conditions within the freeway loop.

Tables 7 through 10 provide additional detail for each mode. Appendix H provides estimates of Districtlevel mode share detail.<sup>5</sup>

Auto mode shares in districts throughout Downtown are generally lower than the citywide average of 91.8 percent, though a few districts outside the freeway loop, particularly the Baylor District and Design District, approach or exceed the citywide average under existing conditions. The same districts that experience the largest decrease in VMT per Capita and Person Hours of Vehicle Travel per Person Trip also experience the largest decrease in auto mode share: Main Street District, Thanksgiving Commercial Center, and Reunion District.

Transit mode shares increase significantly (doubling to nearly quadrupling) in these same three districts; in addition the Dallas Arts District experiences a large, 130 percent increase in mode share from approximately 11 percent of trips to 24 percent of trips.

Changes in walk mode shares are mixed between existing conditions and Scenario 2, which does not have the benefit of Downtown Dallas 360's supporting infrastructure. Between existing conditions and Scenario 3, however, walk mode shares increase in all districts.

<sup>&</sup>lt;sup>5</sup> District-level detail estimates are provided for informational purposes only and should be interpreted with caution. District-level detail may be useful for comparing relative differences among districts, but estimates for individual districts should not be considered accurate at the level of precision presented in the tables.



Although the scale of bike mode share is small (1.2 percent of existing Downtown Dallas trips), it experiences a large relative increase to 1.6 percent in Scenario 2 and 3.1 percent in Scenario 3, a 160 percent increase over existing conditions. Although Downtown outside the freeway loop experiences a larger relative increase, Downtown within the freeway reaches a higher bike mode share of 7.1 percent in Scenario 3.

### **TABLE 7 – AUTO MODE SHARE**

Geography	Sc. 1	Sc. 2	Sc. 3	Sc. 4	Sc. 2	Sc. 3	Sc. 4	Sc. 3	Sc. 4
	A	Auto Mod	le Share		Rel VS	ative Cho 5. Scenari	nge o 1	Relative vs. Scer	Change nario 2
Downtown (Within Freeway)	63.9%	48.9%	42.0%	TBD	-23%	-34%	TBD	-14%	TBD
Downtown (Outside Freeway)	88.6%	88.1%	86.9%	TBD	-1%	-2%	TBD	-1%	TBD
Downtown (All Districts)	79.1%	74.9%	71.7%	TBD	-5%	-9%	TBD	-4%	TBD
City of Dallas	91.8%				Not	Available			

#### **TABLE 8 – TRANSIT MODE SHARE**

Geography	Sc. 1	Sc. 2	Sc. 3	Sc. 4	Sc. 2	Sc. 3	Sc. 4	Sc. 3	Sc. 4
	Tr	ansit Mo	de Share		Relative Change vs. Scenario 1			Relative Change vs. Scenario 2	
Downtown (Within Freeway)	16.6%	31.6%	31.6%	TBD	90%	90%	TBD	0%	TBD
Downtown (Outside Freeway)	3.7%	3.2%	3.2%	TBD	-15%	-15%	TBD	0%	TBD
Downtown (All Districts)	8.7%	12.8%	12.8%	TBD	48%	48%	TBD	0%	TBD
City of Dallas	3.3%				Not	Available			

#### TABLE 9 – WALK MODE SHARE

Geography	Sc. 1	Sc. 2	Sc. 3	Sc. 4	Sc. 2	Sc. 3	Sc. 4	Sc. 3	Sc. 4
	V	Valk Moa	le Share		Relative Change vs. Scenario 1			Relative Change vs. Scenario 2	
Downtown (Within Freeway)	16.8%	15.9%	19.3%	TBD	-5%	15%	TBD	21%	TBD
Downtown (Outside Freeway)	7.5%	8.2%	9.0%	TBD	9%	19%	TBD	10%	TBD
Downtown (All Districts)	11.1%	10.8%	12.5%	TBD	-3%	12%	TBD	16%	TBD
City of Dallas			4.9% C	ombined	d Walk ar	nd Bike M	ode Share		

#### **TABLE 10 – BIKE MODE SHARE**

Geography	Sc. 1	Sc. 2	Sc. 3	Sc. 4	Sc. 2	Sc. 3	Sc. 4	Sc. 3	Sc. 4
	E	Bike Mod	e Share		Rel VS	ative Cho 5. Scenari	Relative Change vs. Scenario 2		
Downtown (Within Freeway)	2.7%	3.6%	7.1%	TBD	32%	164%		100%	TBD
Downtown (Outside Freeway)	0.2%	0.6%	1.0%	TBD	170%	377%		76%	TBD
Downtown (All Districts)	1.2%	1.6%	3.1%	TBD	35%	163%		94%	TBD
City of Dallas			4.9% C	ombined	d Walk ar	nd Bike M	ode Share		

## VOLUME/CAPACITY RATIO

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Volume/Capacity (V/C) ratio is a measure of localized automobile traffic congestion, in this case at a street segment level. It is a simple ratio of the total automobile travel volume on a particular segment divided by that segment's theoretical capacity. Volume/Capacity ratios above 0.8 introduce the potential for delay relative to stable operations. It is important to note that V/C ratio analysis does not account for queue spillback from congested road segments; that is, queues may form for several blocks from a congested road segment segment seperience congestion on segments that are not the source of the congestion. This phenomenon is particularly prevalent on streets approaching freeway ramps where queue spillbacks from the freeway or ramps may impact local streets.

**Figures 5 through 8** illustrate peak Volume/Capacity ratios for each scenario. The Downtown Dallas 360 Model generates volume results for each modeled roadway segment for the AM peak and PM peak separately and also provides separate results for each direction of travel. The figures report the maximum Volume/Capacity ratio for each segment across both peak periods and both directions (where applicable).

Under existing conditions, most analyzed roadway segments operate below a V/C ratio of 0.8. Only a few analyzed segments operate above a V/C ratio of 1.0 on:

- McKinney Avenue
- Maple Avenue
- McKinnon Street
- Harry Hines Boulevard
- Hall Street
- Ross Avenue

Under Scenario 2: Future Baseline, traffic volumes increase on many Downtown roadway segments. Segments on the following roadways operate above a V/C ratio of 1.0 under Scenario 2 conditions:

- Hall Street
- Maple Avenue
- McKinney Avenue
- Harwood Street
- Pearl Street
- Field Street
- Houston Street
- Ross Avenue

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- Market Street
- Main Street
- St. Paul Street

In addition, some streets operate above a V/C ratio of 1.2:

- McKinney Avenue
- McKinnon Street
- Harry Hines Boulevard
- Maple Avenue
- Ross Avenue

Scenario 3: Preliminary Roadway Changes introduces the Dallas Downtown 360 improvements, many of which result in decreased automobile capacity. The preliminary roadway changes are illustrated on Figure 7 in light gray. These automobile capacity reductions are accompanied by streetscape improvements that reduce automobile volumes on some street segments. The result is that Scenario 3 reduces V/C ratios on some street segments and increases V/C ratios on others. Segments on the following roadways operate above a V/C ratio of 1.0 under Scenario 3 conditions:

- Hall Street
- McKinney Avenue
- Pearl Street
- Field Street •
- Ross Avenue
- Ervay Street
- Market Street
- Griffin Street
- Harwood Street

In addition, the following streets operate above a V/C ratio of 1.2:

- McKinney Avenue
- Maple Avenue
- McKinnon Street
- Harry Hines Boulevard
- Ross Avenue

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Harwood Street

Figures 9 through 11 illustrate the percent changes in peak V/C ratios across scenarios, highlighting only the segments where the resulting V/C ratio remains above 0.8.

The Main Street District is resilient to the localized congestion effects of the Dallas Downtown 360 roadway changes. Existing V/C ratios in the Main Street District are already generally low, indicating excess capacity. The tight grid of streets and the change of some existing one-way streets to two-way help to avoid "bottlenecks" by providing more options for rerouting automobile traffic. Substantial shifts to transit, walk, and bike modes also relieve the demand for vehicle capacity.

By contrast, road segments in Uptown and Victory Park are most affected by localized congestion in future scenarios. Segments of McKinney Avenue, Maple Avenue, McKinnon Street, and Harry Hines Boulevard all operate above a V/C ratio of 1.0 under existing conditions and will likely operate above a V/C ratio of 1.2 under future Scenario 2 and Scenario 3 conditions. As illustrated on Figure 10, V/C ratios on Maple Avenue, McKinnon Street, and Harry Hines Boulevard increase only modestly between Scenario 2 and Scenario 3, while the V/C ratios on congested segments of McKinney Avenue, Houston Street, and Field Street improve between the two scenarios.

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Peak Volume/Capacity Ratios

Scenario 1: Existing



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Peak Volume/Capacity Ratios Scenario 2: Future Baseline



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Peak Volume/Capacity Ratios Scenario 3: Preliminary Roadway Changes



Percent Change in Peak Volume/Capacity Ratios Where Resulting V/C > 0.8 Scenario 2 vs. Scenario 1

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Change in V/C Ratio -30% - -20% 9% - 0% -1% - +20% +21% - +40% +41% - +60% +61% - +80% -81% - +100% +100%

Percent Change in Peak Volume/Capacity Ratios Where Resulting V/C > 0.8 Scenario 3 vs. Scenario 2



## CONCLUSION

The analysis results present tradeoffs between localized congestion (measured by V/C ratios) and broader shifts that reduce driving per person (VMT per Capita), time spent driving per trip (PHVT/PT), and the percent of trips made by car (auto mode share).

With a 51 percent increase in population and employment anticipated between 2017 and 2040, the analysis indicates there will be more localized congestion on many Downtown street segments in the Future Baseline 2040 scenario. In particular, road segments in Uptown and Victory Park that already operate above capacity under existing conditions will experience more localized congestion under Future Baseline conditions. Road segments in the Main Street District, most of which operate at low levels of congestion under existing conditions, can generally accommodate increased traffic volumes. Despite these localized challenges, the land use densification and diversification anticipated in the Future Baseline bring substantial transportation benefits: the amount of driving per person (VMT per Capita), time spent driving per trip (PHVT/PT), and percent of trips made by car all decrease across downtown and in particular within the freeway loop.

The introduction of the Downtown Dallas 360 roadway changes amplifies these trends by converting some automobile capacity to provide infrastructure supportive of transit, walking, and bicycling. Reducing vehicle capacity increases V/C ratios in some locations, particularly in the Dallas Farmers Market District, where existing congestion is relatively low, and in the Uptown and Victory Park districts, where existing congestion levels are already high. However, the accompanying mode shift benefits of the Downtown Dallas 360 roadway changes reduce V/C ratios at other locations, particularly in the Main Street District and other parts of Uptown and Victory Park. While the localized congestion effects of the Downtown Dallas 360 roadway changes are mixed, the broader benefits are clear, especially within the freeway loop: VMT per Capita decreases by 5 percent (15 percent inside the freeway loop), time spent driving per trip decreases 6 percent (16 percent within the freeway loop), and percent of trips made by car decreases 4 percent (14 percent within the freeway loop) compared to Future Baseline conditions without the project.

When selecting a final package of Downtown Dallas 360 improvements and planning for implementation, the City and other project stakeholders will need to consider the tradeoffs between moderate increases in localized traffic congestion and more holistic benefits of reductions in the amount of driving per person, reductions in the time spent driving per trip, and reductions in the percent of trips made by car.

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Figure 10

Figure 9