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MTP 2050

Appendix I

Travel Demand Model (TDM) Forecasts

APPX I

In July 2022, WAMPO issued a Request for Proposals (RFP) seeking a qualified consultant to update the travel demand model (TDM) that WAMPO maintains for the Wichita, KS metropolitan area. The TDM simulates the interaction between regional land development patterns and the transportation system and allows the region to understand the impact transportation investments and land-use decisions have on travel. The TDM was used to inform the development of Metropolitan Transportation Plan 2050 (MTP 2050), including the scoring of candidate transportation projects (see Appendix C: Project Scoring Model), by looking at transportation-system and travel changes associated with anticipated job and household growth. These forecasts of travel helped identify future transportation system needs and provided a snapshot of future system performance. They also were a critical input to the MTP 2050 Environmental Justice analysis (see Section 2.8 and Section 7.3).

The TDM update project began in September 2022 and concluded in 2024; WAMPO staff and consultants will continue to update, calibrate, and validate the model on an ongoing basis, possibly changing some of the model outputs. The following sections provide an overview of the TDM's development and structure and a review of the changes in travel that it currently forecasts between a base year of 2022 (2022 Base Scenario) and the horizon year of 2050 (2050 Build Scenario), wherein all of the projects in the MTP 2050 Fiscally Constrained Project List (see Chapter 7) are assumed to be completed.

Travel Demand Model Background

The intent of the WAMPO travel demand model (TDM) is to forecast the future state of the transportation system in the Wichita metropolitan area. The purposes for which it is used include the following:

- Forecasting future traffic congestion and transportation needs in the WAMPO region under different scenarios for the Metropolitan Transportation Plan (MTP).
- Identifying current or anticipated high-traffic-volume or congested areas of the region for the purpose of prioritizing projects.
- Supporting the development of the Congestion
- Management Process (CMP) for the region.
- Supporting Environmental Justice (EJ) analyses.
- Fulfilling requests from WAMPO member jurisdictions for projected transportation demand, traffic patterns, and congestion under specific circumstances, such as:
    - Road widening/narrowing
    - Road additions/removals
    - New interchanges
    - Large land developments

- Integrating with the U.S. Environmental Protection Agency's (EPA's) MOtor Vehicle Emission Simulator (MOVES) model and providing inputs to air quality conformity analyses.

Importantly, there are also some things that a TDM cannot do, such as:

- Simulate traffic for specific sections of roadway or a specific intersection
- Model small or local roads very accurately
- Model bottlenecks
- Show the land-use impact of a new road
- Show the impacts of small developments

MODEL STRUCTURE

The WAMPO TDM is a conventional four-step travel demand model, as illustrated in Figure I.1:

1. Trip Generation: Estimate how many trips are made, based on data on household locations and characteristics and jobs by location and industry.
2. Trip Distribution: Predict where trips are made to/from.
3. Mode Choice: Ascertain the modes of transportation for trips (e.g., single-occupant vehicle, multiple-occupant vehicle, public transit, bicycle, pedestrian, school bus).
4. Trip Assignment: Assign the routes followed between specific trip origins and destinations, depending on the relative travel time of each route.

A more detailed representation of the structure of the WAMPO TDM is in Figure I.2. Some things to note about this model structure are:

- The model iterates through a feedback loop, such that, after the initial round of trip assignments, any resulting changes in traffic congestion are made inputs to a re-run of the trip-distribution, mode-choice, and trip-assignment steps. This is repeated until the results of successive iterations converge to within a given tolerance.
- The model simulates both home-based trips (assumed to form round trips) and non-home-based trips (where a traveler stops at a second non-home destination before returning home).
- In addition to modeling person trips and automobile trips, the TDM also represents commercial truck traffic throughout the region, separated out into the categories of light-duty trucks, medium-duty trucks, and heavy-duty trucks.
- Besides trips between locations within the WAMPO region, the TDM also models external trips, wherein at least one end of the trip is outside of the WAMPO region. This includes through trips, where both the origin and the destination are outside of the region, but the roadway network within the region is still utilized.

Figure I.1: Travel Demand Modeling Process

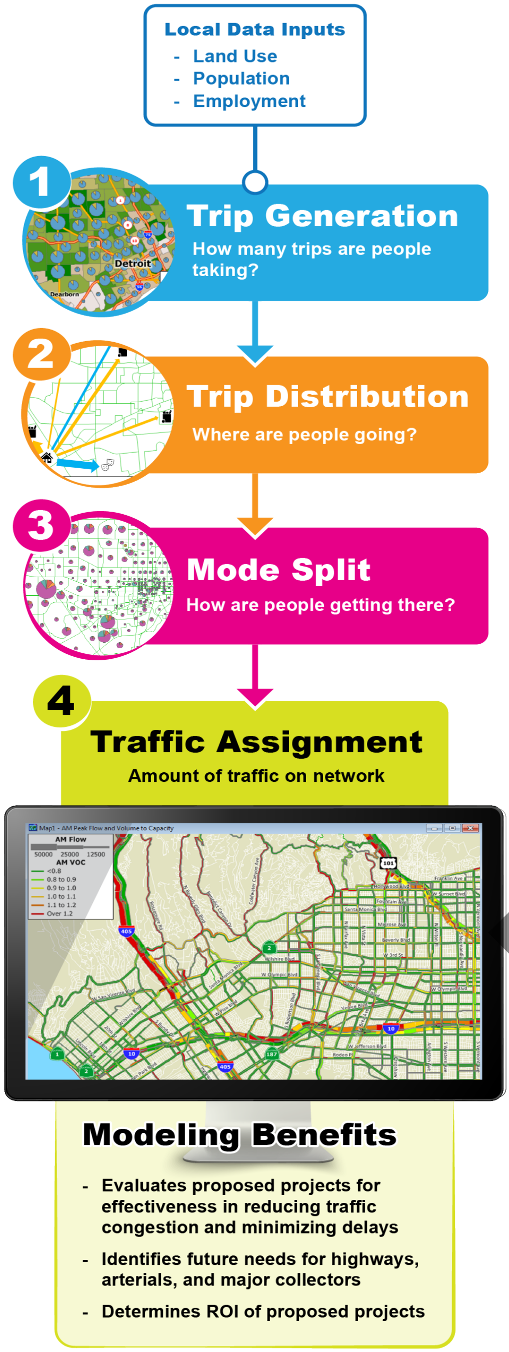
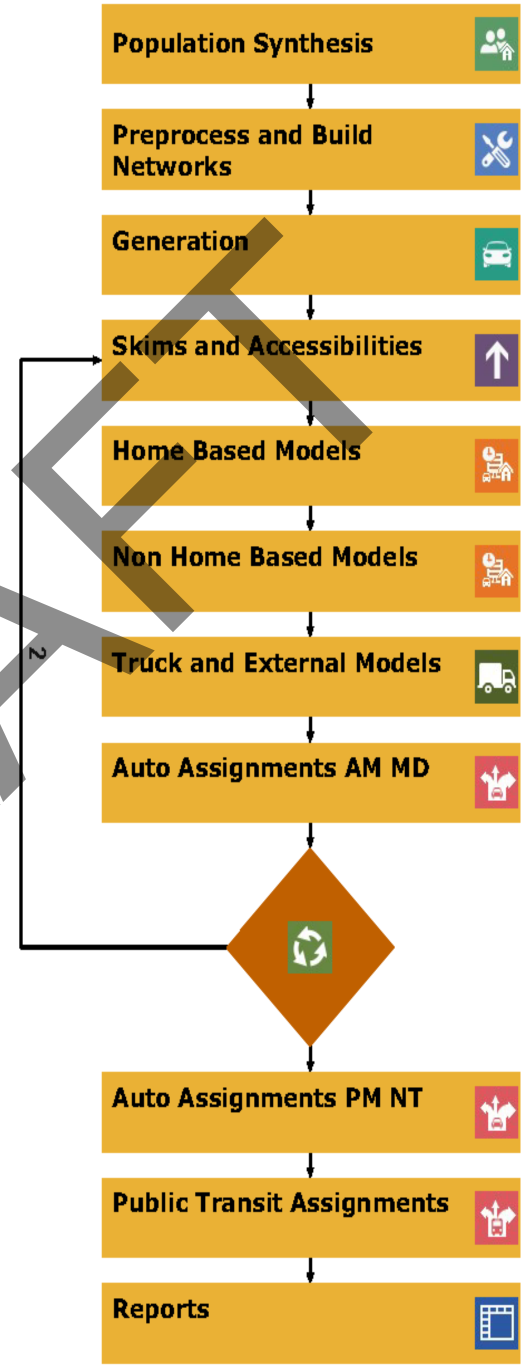


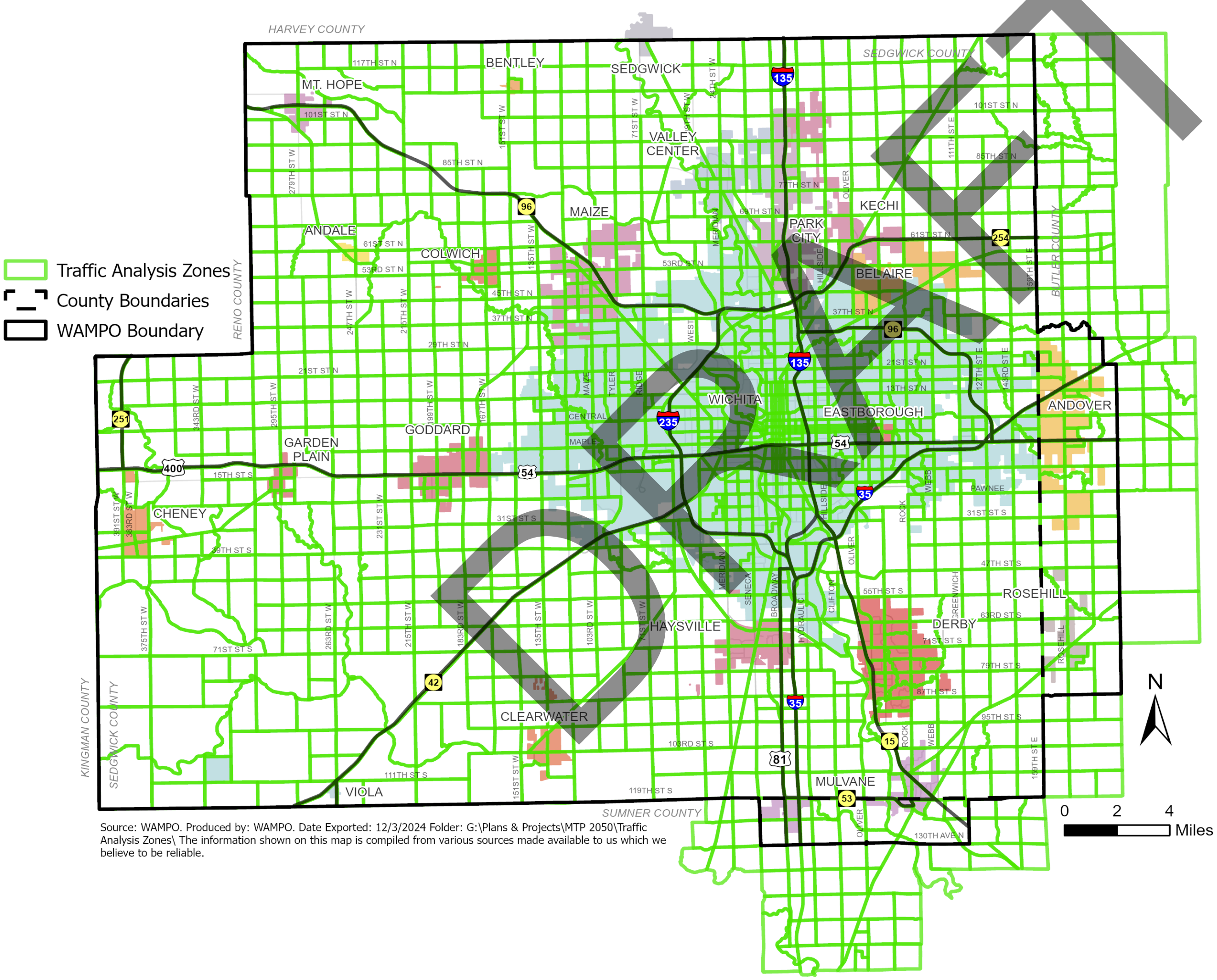
Figure I.2: WAMPO Travel Demand Model Structure



Demographic and Socioeconomic Inputs

The WAMPO TDM uses input data specific to 1,667 Traffic Analysis Zones (TAZs), into which the region is divided. As shown in Map I.1, these TAZs extend beyond the current bounds of the WAMPO Metropolitan Planning Area (MPA), in order to capture a larger share of the region's travel shed. In addition to the 1,667 TAZs, the model includes 37 externals stations, in all the places where modeled roadways pass into/out of the model area; for the external-trips model, these external stations function as pseudo TAZs, with asserted relative levels of trip production and attraction.

Map I.1: WAMPO TDM Traffic Analysis Zones



Associated with each TAZ are current actual and projected future demographic and employment statistics, as well as enrollment figures for TAZs that contain K-12 schools or universities. Jobs in each TAZ are distinguished according to the major economic sectors/industries that the jobs fall into, including:

- Agriculture
- Manufacturing
- Wholesale
- Retail
- Transport/Construction
- Finance/Real Estate
- Education
- Healthcare
- Services
- Public Administration

The demographic information that is associated with each TAZ and used to run the model consists of a set of synthesized households, and persons in those households, created from U.S. Census Bureau Public Use Microdata Sample (PUMS) data and American Community Survey (ACS) results. Each synthesized household is distinguished by the number of people in the household, household income, whether there are children in the household, whether there are seniors in the household, and whether it is a zero-vehicle household, a vehicle-insufficient household (with at least one motor vehicle, but fewer motor vehicles than people old enough to drive), or a vehicle-sufficient household (with at least as many motor vehicles as people old enough to drive). Each synthesized person within those synthesized households is further distinguished by their age, gender, whether they are employed, and, if they are employed, what sector/industry they work in.

Network Inputs

Trips to and from each of the TAZs and external stations are loaded onto a modeled roadway network (used for both motorized and nonmotorized trips) and modeled public-transit network (consisting of Wichita Transit's fixed-route network). Trips within TAZs are also accounted for.

The TDM roadway network does not show every roadway in the WAMPO region. Instead, minor roadways are represented by "centroid connectors" that link the centroids of each TAZ (and the external stations) to the rest of the network. Each link in the roadway network is coded with several attributes that are used to estimate its capacity and the perceived utility of choosing to travel on it:

- Facility Type (e.g., minor/major collector, minor/major arterial, freeway/interstate)
- Area Type (Central Business District (CBD), Urban, Suburban, Rural)
- Number of lanes in each direction
- Roadway divider/left turn lane (Y/N)
- Speed limit
- Tolls (KTA only, currently)
- Freeflow speed

Because public transit buses in the WAMPO region travel on roadways that are also used by other vehicles, the TDM fixed-route public transit network is built upon the TDM roadway network. However, portions of some public transit routes are on minor roadways whose alignments are not traced in the roadway network onto which modeled general vehicle traffic is loaded; to address this, extra links are added to the roadway network that only transit buses are modeled as using, even though the real-life counterparts to those links are open to all vehicle types. The TDM public transit network includes both the bus routes and the bus stops where travelers are allowed to get on and off. Attributes of transit routes used to estimate the perceived utility of traveling on them include:Facility Type (e.g., minor/major collector, minor/major arterial, freeway/interstate)

- Transit fare price
- Headway time between bus arrivals (peak and off-peak periods)
- In-vehicle travel time (peak and off-peak periods)
- Wait time at bus stops (peak and off-peak periods)

Pedestrians and bicycle riders are assumed to travel along the same modeled roadway network as motor vehicles do, except where a nonmotorized-travel-only link is included in the network, usually representing a pedestrian/bicycle pathway that does not run alongside a roadway. Pedestrians are assumed to travel at an average speed of 3 mph and bicycle riders are assumed to travel at an average speed of 10 mph.

Surveys

A Household Travel Survey was conducted in the WAMPO region in Fall 2010 through Spring 2011. This survey collected data about the travel behavior of WAMPO-region residents, for the specific purpose of supporting the development of the WAMPO travel demand model, which, at that time, had a base year of 2010. The survey collected responses from 3,376 randomly selected households, as well as 200 additional samples collected from traditionally underserved populations in the region. The results of this survey were used to develop parameters in the TDM that describe the likely travel behavior of persons and households with various characteristics. Then, the parameters were calibrated and validated to produce model outputs that approximate more recent observations of overall travel levels.

Commercial-truck trip rates were derived from a 2008 commercial-vehicle survey performed by the Community Planning Association of Southwest Idaho (COMPASS) Area. Meanwhile, the external-trip component of the WAMPO TDM was based on an external-station survey conducted in 2012.

TRIP GENERATION

Trip productions (the home end of a home-based trip or the origin of a non-home-based trip) and trip attractions (the non-home end of a home-based trip or the destination of a non-home-based trip) are generated for each of the region's 1,667 TAZs, based on the demographic and employment inputs described above and a set of calibrated parameters (i.e., coefficients in the equations used). The numbers and types of trip productions that synthesized persons/households are taken to result in depend on such factors as household income, whether a person is employed, the sector/industry in which they are employed, whether they are a student (either K-12 or university), and whether the household includes children or other individuals who cannot easily travel everywhere they want to go unassisted (e.g., adults without access to vehicles). Meanwhile, the numbers and types of trip attractions that jobs are taken to result in depend on the sector/industry of the job; for example, office jobs and manufacturing jobs mostly just attract commute trips by those that hold the jobs, whereas retail and service jobs also attract trips by customers. A TAZ's trip attractions also go up according to how many students are enrolled at K-12 schools or universities within it. Finally, households within a TAZ may serve as both producers and attractors of trips, since people sometimes travel to visit other people's homes.

The trips generated in this model step include the following trip purposes, to which different equations and parameters are applied throughout the TDM:

- Home-Based Work (HBW)
- Home-Based Shopping (HBShop)
- Home-Based K-12 School (HBSchool)
- Home-Based University (HBU)
- Home-Based Other (HBO)
- Non-Home-Based Work (NHBW)
- Non-Home-Based Other (NHBO)

Different trip types are taken to have different likelihoods of occurring during the peak travel periods of the day (7:00 AM-9:00 AM and 4:00 PM-6:00 PM) or during the off-peak travel periods of the day (9:00 AM-4:00 PM and 6:00 PM-7:00 AM).

TRIP DISTRIBUTION

Once the trip productions and trip attractions of each TAZ have been estimated, each TAZ-specific trip production is matched with a particular attraction TAZ (which could potentially be the same TAZ). The likelihood of a trip of a given purpose (HBW, HBShop, HBSchool, HBU, HBO, NHBW, or NHBO) being made to a particular attraction TAZ is primarily based on two things:

- The modeled number of trip attractions for the given trip purpose in the potential attraction TAZ (based on jobs by sector/industry, households, and K-12 school/university enrollment).
- The travel time between the production TAZ and the potential attraction TAZ in the peak or off-peak period of the day, as applicable. As the model iterates through the feedback loop discussed earlier in this appendix, these TAZ-to-TAZ travel-time skims are updated. How sensitive members of a given synthesized household are to the travel time and travel distance between TAZs is influenced by whether the household has zero vehicles, insufficient vehicles (more than zero but fewer than the number of household members old enough to drive), or sufficient vehicles (at least as many as the number of household members old enough to drive).

MODE CHOICE

Most person trips in the WAMPO region are made by one of the following modes:

- Single-occupant vehicle
- Multiple-occupant vehicle
- Public transit (bus)
- Bicycle
- Pedestrian
- School bus

However, external trips (those with at least one end outside of the region) are assumed to all be by either single-occupant vehicle or multiple-occupant vehicle.

When trips are made by multiple-occupant vehicle (not bus), assumed vehicle occupancies are used by trip purpose, as shown in Table I.1.

Table I.1: Assumed Numbers of People in Multiple-Occupant Vehicles by Trip Purpose in the WAMPO TDM

Trip Purpose	Vehicle Occupancy if >1
HBW	2
HBShop	2.5
HBO	2.5
HBSchool	2.25
HBU	2.25
NHBW	2
NHBO	2.5

What mode of transportation someone is modeled as choosing for a trip between a given production TAZ and a given attraction TAZ depends on the amount of time required to make the trip by each of the possible modes. However, how burdensome the traveler perceives that travel time to be depends on the mode in question. For example, time spent waiting at a bus stop is perceived as a greater disincentive to use public transit than is time spent on the bus while it is moving. For another example, longer automobile trips entail more fuel and maintenance costs whereas longer pedestrian and bicycle trips entail more physical effort.

Other inputs to the mode-choice model include whether one or both of the trip ends is/are in a Central Business District (CBD), whether both trip ends are in the same TAZ (intrazonal trip), public-transit fare prices, and the availability of vehicles in the traveler's household.

TRIP ASSIGNMENT

After simulated trips have been generated and distributed between origin and destination TAZs, with peak/off-peak time-of-day designations and mode choices, each vehicle trip is assigned to a route along the TDM roadway network between the origin TAZ and the destination TAZ, depending on the relative travel times of the routes available. After the first time this is done for all the trips in either the AM peak period or the midday off-peak period, resultant traffic congestion and reductions in average travel speed are estimated on the basis of roadway capacity and traffic volume. Then, revised TAZ-to-TAZ travel-time skims are fed back into new iterations of the trip-distribution, mode-choice, and trip-assignment steps. These iterations continue until the outputs converge (when there is little to no difference between the results of subsequent iterations). After this iterative process produces a final set of AM peak and midday off-peak trip assignments for a given scenario (e.g., 2022 Base Scenario, 2050 Build Scenario), vehicle-trip-route assignments are made for the PM peak period and the nighttime off-peak period, as those periods of the day are presumed to have similar characteristics to the AM peak period and midday off-peak period, respectively. Finally, public-transit trips are assigned to specific Wichita Transit routes and stops (Wichita Transit being the only fixed-route, as opposed to demand-response, public transit service in the region as of this writing), based on modeled travel time.

Travel Demand Model Forecasts

The TDM was used to inform MTP 2050 by looking at transportation-system and travel changes associated with anticipated job and household growth. These forecasts of travel helped identify future transportation system needs and provided a snapshot of future system performance. A comparison of TDM outputs for the base year (2022) and for the future scenario year (2050), with anticipated housing and employment growth and planned future transportation projects (see Chapter 7: Project Selection & List), predicts some noteworthy changes in travel between now and 2050. However, as the model continues to be updated, refined, calibrated, and validated, these outputs may change.

Table I.2 summarizes the 2022 and 2050 demographic and socioeconomic inputs to the TDM. Current and projected jobs by sector/industry and enrollment numbers for K-12 schools and universities are static inputs to the 1,667 Traffic Analysis Zones, whereas persons and households are synthesized from U.S. Census Bureau data at the levels of Block Groups and Public Use Microdata Areas and applied to the TAZs as an initial step of running the TDM. Most of these counts of overall, regionwide persons/households/jobs/enrollments are projected to increase between 2022 and 2050, resulting in more demand for transportation.

Table I.2: Summary of 2022 and 2050 Socioeconomic Inputs to Traffic Analysis Zones in the WAMPO Travel Demand Model

Socioeconomic Inputs	2022	2050
Synthesized Persons in TAZs	542,004	644,582
Synthesized Households in TAZs	220,587	261,268
Synthesized Persons per Household	2.46	2.47
K-12 School Enrollment	100,772	130,009
University Enrollment	31,157	34,130
Jobs: All Sectors/Industries	326,719	396,122
Jobs: Agriculture	514	557
Jobs: Manufacturing	63,248	62,931
Jobs: Wholesale	9,598	9,878
Jobs: Retail	38,892	40,232
Jobs: Transport/Construction	36,653	41,246
Jobs: Finance/Real Estate	39,193	46,996
Jobs: Education	22,735	33,345
Jobs: Healthcare	57,897	81,555
Jobs: Services	48,565	68,580
Jobs: Public Administration	9,424	10,802

Table I.3 summarizes the outputs of the TDM for the 2022 Base Scenario and the 2050 Build Scenario, which includes all of the changes to the roadway network that are called for in the MTP 2050 Fiscally Constrained Project List (see Chapter 7). In response to population and employment growth, person trips within the model region (which is slightly larger than the official WAMPO region) are forecast to increase almost twenty percent over a period of 28 years, with a slight increase in the average number of trips per person. Corresponding, but slightly smaller, increases are forecast for vehicle trips, vehicle miles traveled (VMT), and vehicle hours traveled (VHT). However, VMT and VHT per capita are forecast to slightly decrease. This is reflective of a forecast slight decrease in both average vehicle-trip distance and average vehicle-trip duration. This is at least partially explained by a forecast slight decrease in average vehicle trip speed (resulting from traffic congestion), which discourages motor-vehicle travel. Another likely explanation for shorter vehicle-trip distances and durations is that increases in the numbers of people and jobs in the region reduces the average distance/travel time between origins and potential destinations.

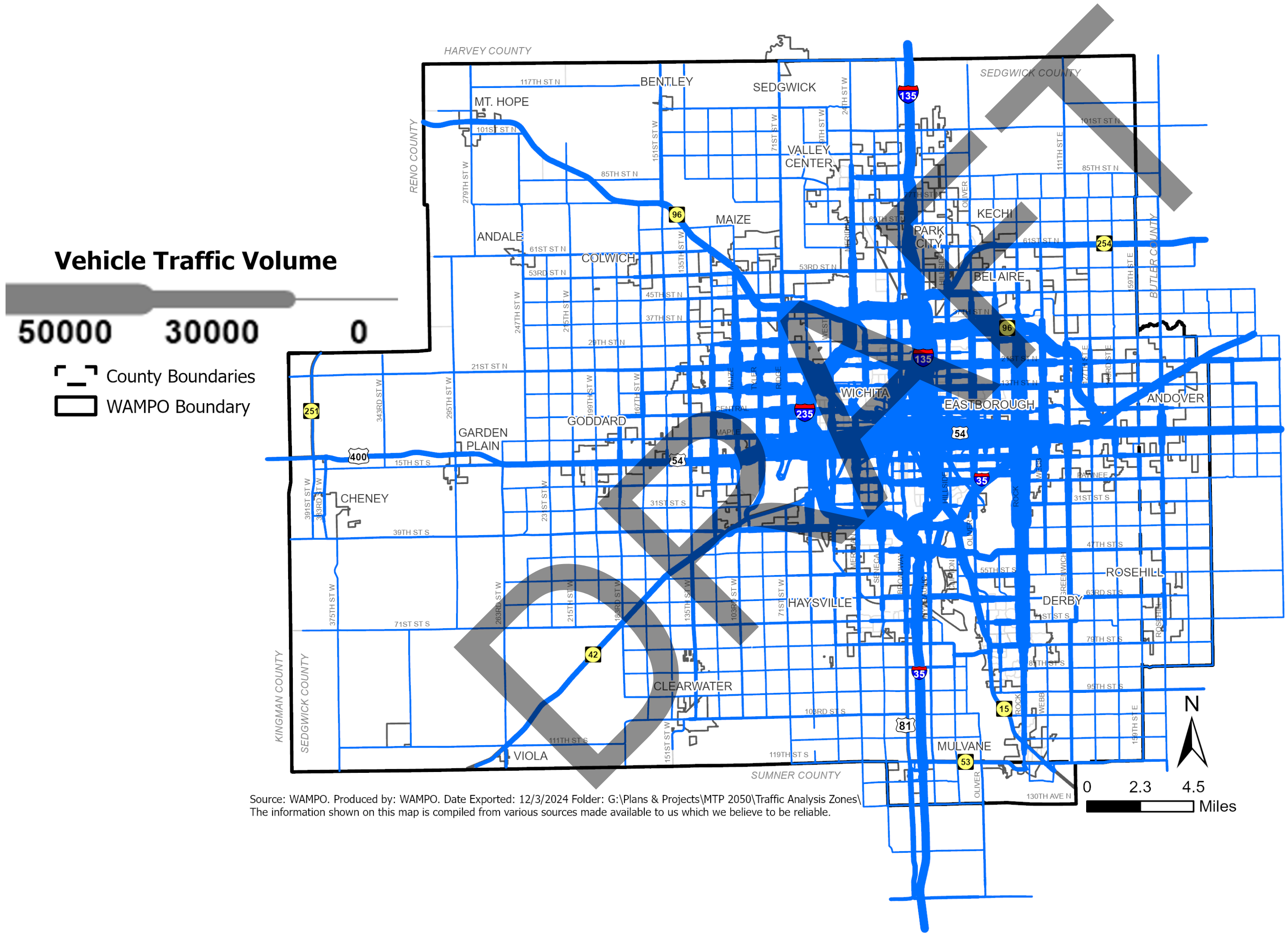
Table I.3: Summary of 2022 Base Scenario and 2050 Build Scenario Outputs from the WAMPO Travel Demand Model

TDM Output Summary Statistics	Scenario		Difference	% Difference
	2022 Base	2050 Build		
Person Trips (internal to the region)	1,837,310	2,204,331	367,021	19.98%
Person Trips Per Capita	3.39	3.42	0.03	0.88%
Vehicle Trips (including external trips & truck trips)	1,530,805	1,810,366	279,562	18.26%
Vehicle Miles Traveled	12,768,085	14,781,246	2,013,161	15.77%
Vehicle Miles Traveled Per Capita	23.56	22.93	-0.63	-2.66%
Vehicle Hours Traveled	318,009	371,077	53,068	16.69%
Vehicle Hours Traveled Per Capita	0.59	0.58	-0.01	-1.88%
Average Vehicle Trip Distance (miles)	8.34	8.16	-0.18	-2.11%
Average Vehicle Trip Duration (minutes)	12.46	12.30	-0.17	-1.33%
Average Vehicle Trip Speed (mph)	40.15	39.83	-0.32	-0.79%

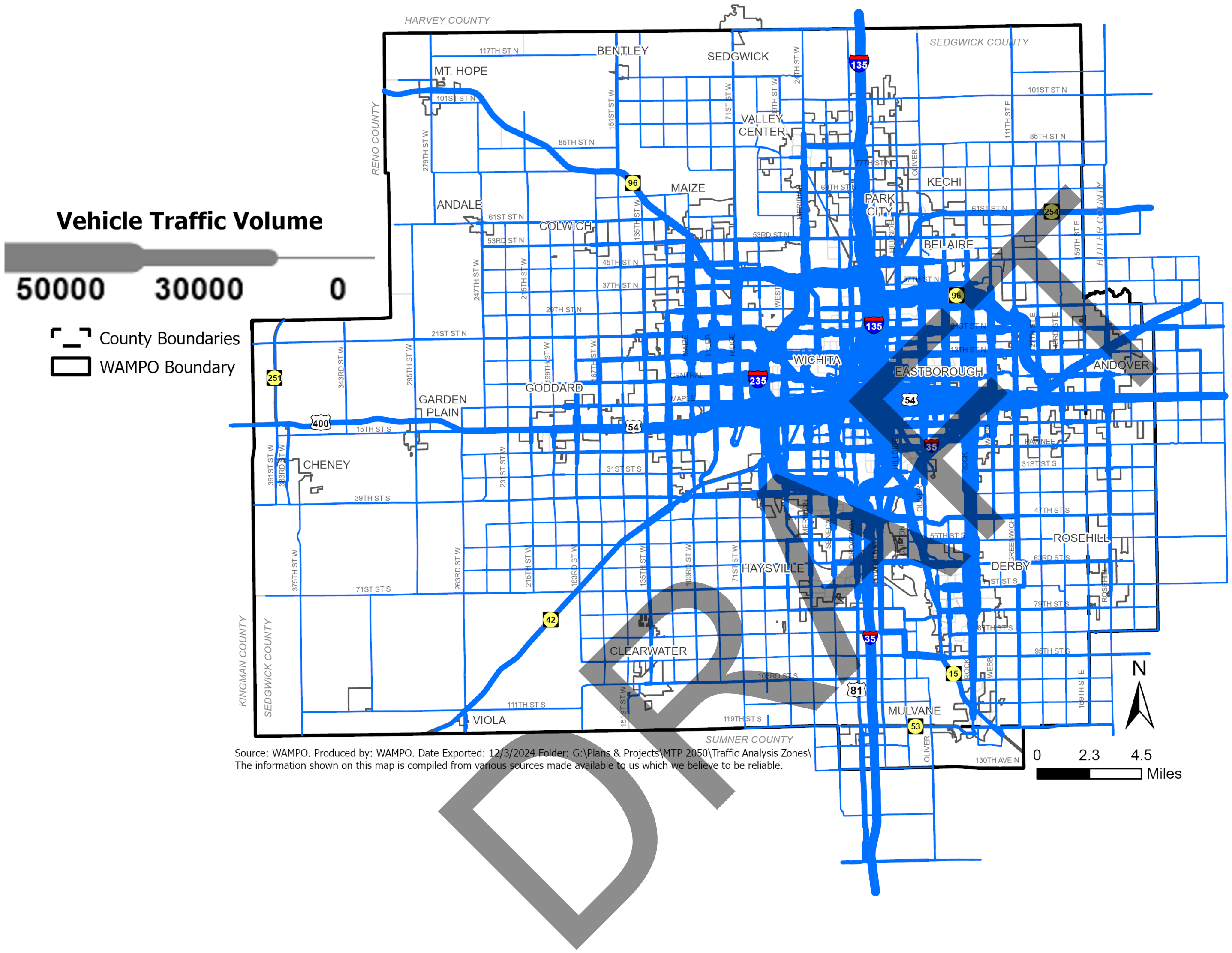
Map I.2 and Map 1.3 show forecast daily traffic volumes on the modeled roadway network in the 2022 Base Scenario and 2050 Build Scenario, respectively, with thicker lines corresponding to more heavily traveled roadways. Unsurprisingly, Interstates and freeways (e.g., I-35, I-135, I-235, US-54/400, K-96) are forecast to experience more vehicle traffic than are roadways with lower functional classifications. Also unsurprisingly, traffic volumes are forecast to be higher on roadways closer to central Wichita and on major connectors between population/commercial centers (e.g., Rock Road between Wichita and Derby).

Map 1.4 and Map 1.3 show forecast traffic volumes and congestion levels on the modeled roadway network in the 2022 Base Scenario and 2050 Build Scenario, respectively, during the AM peak travel period (defined in the model as 7:00 AM-9:00 AM). Traffic congestion is represented as the ratio of traffic volume to roadway capacity, such that a roadway segment with a ratio greater than one can be interpreted as congested. The roadway segments forecast to be the most congested during peak travel periods are those near interchanges between major thoroughfares (e.g., between I-135 and US-54/400, between I-135 and I-235).

Map I.2: WAMPO TDM 2022 Base Scenario Daily Traffic Volumes

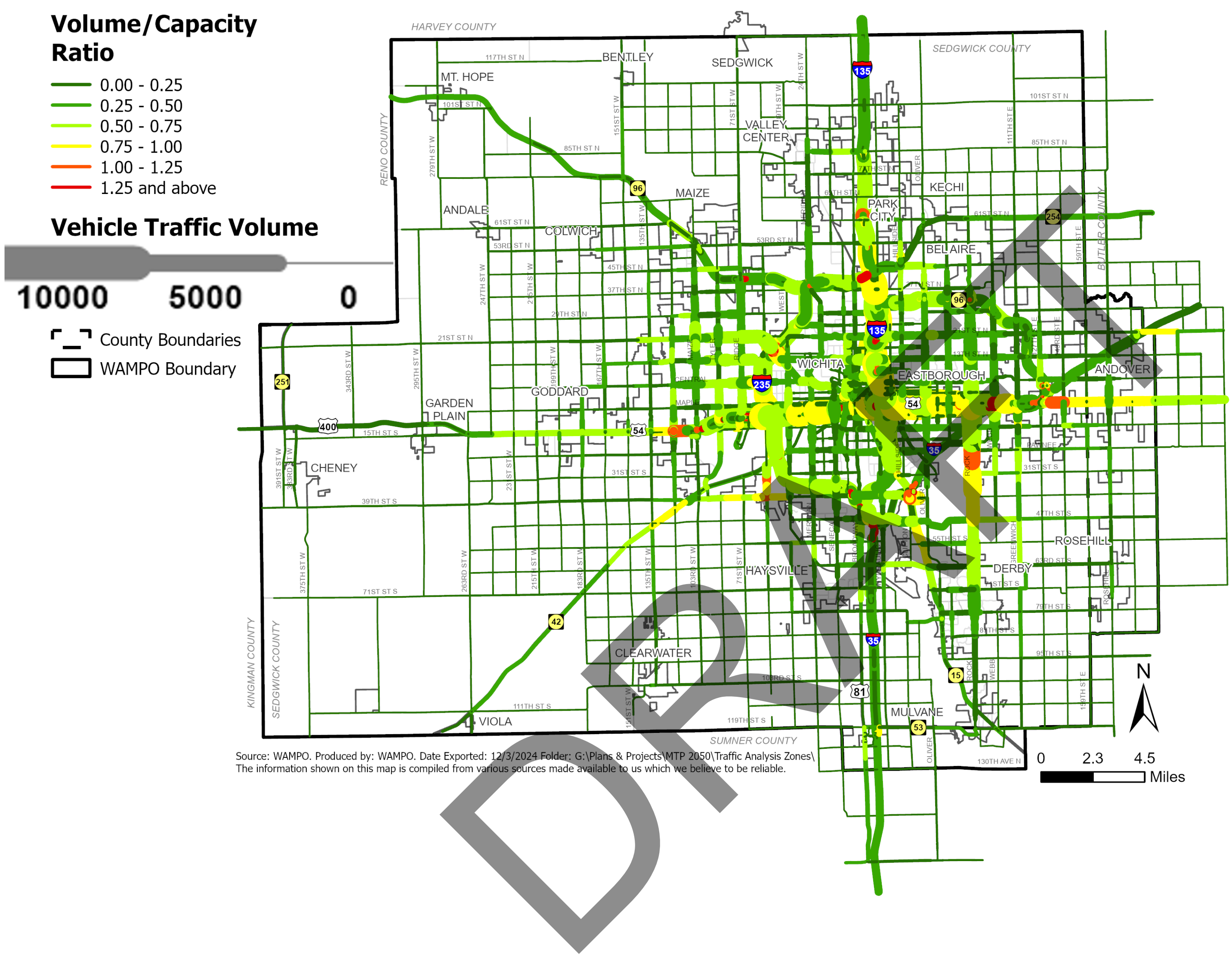


Map I.3: WAMPO TDM 2050 Build Scenario Daily Traffic Volumes



Source: WAMPO. Produced by: WAMPO. Date Exported: 12/3/2024 Folder: G:\Plans & Projects\MTP 2050\Traffic Analysis Zones\
The information shown on this map is compiled from various sources made available to us which we believe to be reliable.

Map I.4: WAMPO TDM 2022 Base Scenario AM-Peak Traffic Volumes and Congestion Levels



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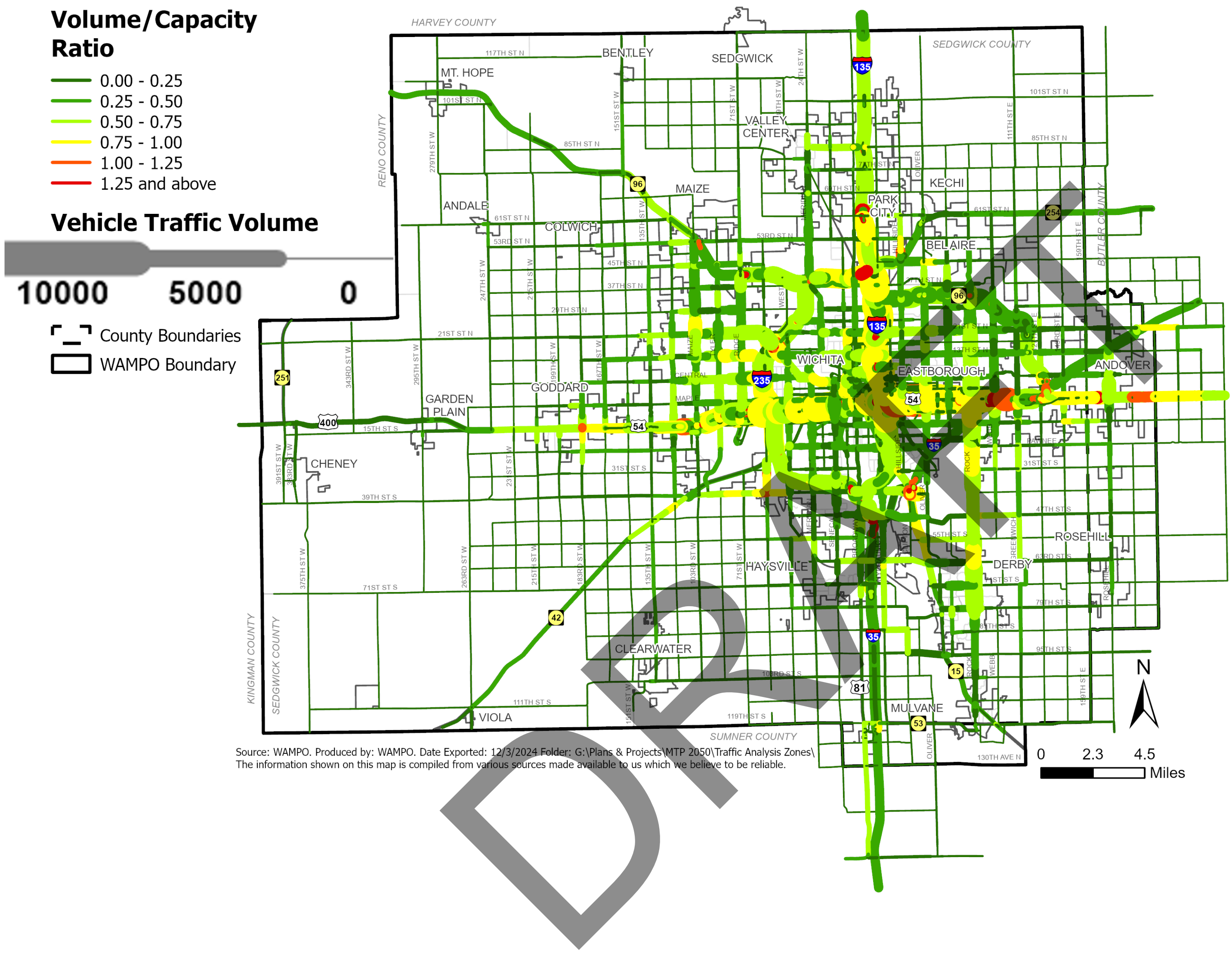
The information shown on this map is compiled from various sources made available to us which we believe to be reliable.

Map I.5: WAMPO TDM 2050 Build Scenario AM-Peak Traffic Volumes and Congestion Levels



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The information shown on this map is compiled from various sources made available to us which we believe to be reliable.

Table I.4 summarizes projected person-trip mode shares in the 2022 Base Scenario and 2050 Build Scenario. The most common travel mode is single-occupant motor vehicle, followed by multiple-occupant motor vehicle, with smaller numbers of trips made by bus or by nonmotorized modes. Not much change in mode shares is forecast between 2022 and 2050.

Table I.3: 4: Summary of 2022 Base Scenario and 2050 Build Scenario Person-Trip Mode-Share Outputs from the WAMPO Travel Demand Model

Mode	Scenario		Difference
	2022 Base	2050 Build	
Single-Occupant Vehicle	47.87%	47.86%	-0.01%
Multiple-Occupant Vehicle	38.97%	38.90%	-0.07%
School Bus	5.33%	5.30%	-0.03%
Pedestrian	4.97%	5.04%	0.07%
Bicycle	1.59%	1.59%	0.00%
Public Transit	0.64%	0.67%	0.03%
Other	0.63%	0.65%	0.02%
Total	100.00%	100.00%	0.00%