Appendix D • Travel Demand Forecasting

Introduction

A key study tool used by MPOs is the travel demand software model. The model's main function is to produce long range traffic forecasts which are then used in a variety of ways to support the analysis of urban area and regional vehicular capacity needs and congestion issues. The results of these analyses are important in not only identifying potential highway network needs but also as a basis for identifying potential corridors where high capacity transit may need to be a consideration in the future.

Appendix D reports on the assumptions and traffic model specifications that were developed to support preparation of the 2045 Long Range Plan. For purposes of this Plan, updates of land use assumptions and future network links were completed to extend the target year for the model from 2040 to the year 2045. While ROCOG's model has historically been a simple Average Daily Traffic "three-step" model (trip generation, trip distribution, traffic assignment), the model has been modified to incorporate a mode choice element as well as parking allocation functionality. These changes occurred in conjunction with other studies that included Rochester's 2018 comprehensive plan update (P2S 2040) and the 2016-2018 Destination Medical Center (DMC) Integrated Transit Studies, to reflect the major planning assumptions brought forward in those studies:

- Significant growth in park and ride usage is expected to occur over the next 25 years
- Implementation of a Downtown Rapid Transit System with connections to transit villages and commuter parking reservoirs outside of but within a short transit ride of the central business district
- Implementation of a Primary Transit Network, expected to provide a spine of Bus Rapid Transit service along high ridership transit corridors extending out from Rochester's central business district

In addition, several enhancements were made to the model in 2019. The model inputs and assumptions were revisited and updated. The updated model was validated to 2015 observed traffic data available from MnDOT's Traffic Forecasting and Analysis website and travel patterns extracted from Census Transportation Planning Products (CTPP) data.

In addition to these elements, housing and employment forecasts were updated to reflect a modest redistribution of growth to reflect the transit-oriented development vision adopted in P2S 2040. The potential impact of enhanced transit service was also reflected in some adjustments to trip generation categories, and walk links were added as the first or last leg in the travel route to reflect that vehicle trips destinated to downtown are often directed to parking ramps and not to the block on which a person's eventual destination is located.

Preparation of the regional traffic forecasts were also completed, based primarily on study of historic traffic volume trends for arterial and major collector county and state roads outside of the planned growth area of Rochester and the small cities within the ROCOG Planning Area. The focus on only state and county highways in the regional area is consistent with that of the Plan, which is to consider improvement needs on those roads important to and which carry the vast majority of regional intercity traffic in the planning area.

Urban Area Travel Demand Model

Traffic forecasting for the ROCOG urbanized area focuses on roadways where the function is anticipated to be broader than solely servicing abutting property access. Freeways, expressways, and other arterial and collector roads are included in the model network, along with complementary facilities such as frontage roads. In developing the urban area travel demand model, a series of model input files were updated and/or developed to reflect the changes described earlier in this section and generate new long-range forecasts.

Key model inputs for the updated ROCOG Model included:

- Land use forecasts
- Traffic analysis zones
- Assignment of land use to traffic analysis zones
- Trip generation categories and trip rates
- Refinement of highway network
- Addition of downtown and commuter parking sites
- Addition of walk links
- Traffic model calibration

On the following pages, a brief synopsis of each of these data inputs is provided.

Updated Land Use Forecasts

For purposes of running the traffic model, employment and population projections are converted into equivalent land use units to serve as input to the traffic forecasting model. Table D-1 summarizes projected levels of growth by traffic model land use category.

Table D-1: ROCOG Urban Area Land Use Scenario

Land Use Category	Category Measure	2,015	2,045	Growth
Urban Single Family	Housing Unit	18,961	24,732	5,771
Suburban Single Family	Housing Unit	12,724	12,866	142
Suburban Multi-Family	Housing Unit	3,069	11,182	8,113
Urban Multi-Family	Housing Unit	8,154	14,036	5,882
Townhome Development	Housing Unit	4,558	9,723	5,165
General Business	Square Ft (1,000s)	4,608	7,868	3,260
Industrial	Square Ft (1,000s)	13,557	17,382	3,824
Office	Square Ft (1,000s)	5,492	8,409	2,916
Social and Recreational	Square Ft (1,000s)	764	764	0
Entertainment/Arenas	Seats	20,767	21,267	500
Secondary/Higher Education	Students	13,429	17,479	4,050
Elementary Ed / Day Care	Students	16,827	16,827	-
Hotels	Rooms	5,342	6,936	1,594
Hi-Int Retail	Square Ft (1,000s)	225	231	6
Drive Thru Bank	Square Ft (1,000s)	141	157	16
Active Recreation Parkland	Acres	3,262	4,883	1,622
Shopping Center	Square Ft (1,000s)	2,553	2,827	274
Big Box / Strip Mall	Square Ft (1,000s)	1,276	1,276	0
Nursing Home / Senior Apts	Residents	4,632	6,493	1,861
Mayo Medical Center	Square Ft (1,000s)	6,962	12,420	5,458
Hospital	Square Ft (1,000s)	3,850	5,093	1,243
Airport Terminal	Enplanements	463	945	482
Air Cargo	Square Ft (1,000s)	96	296	200
Mobile Homes	Housing Unit	1,263	1,263	-
BioTech Industry	Square Ft (1,000s)	-	1,020	1,020

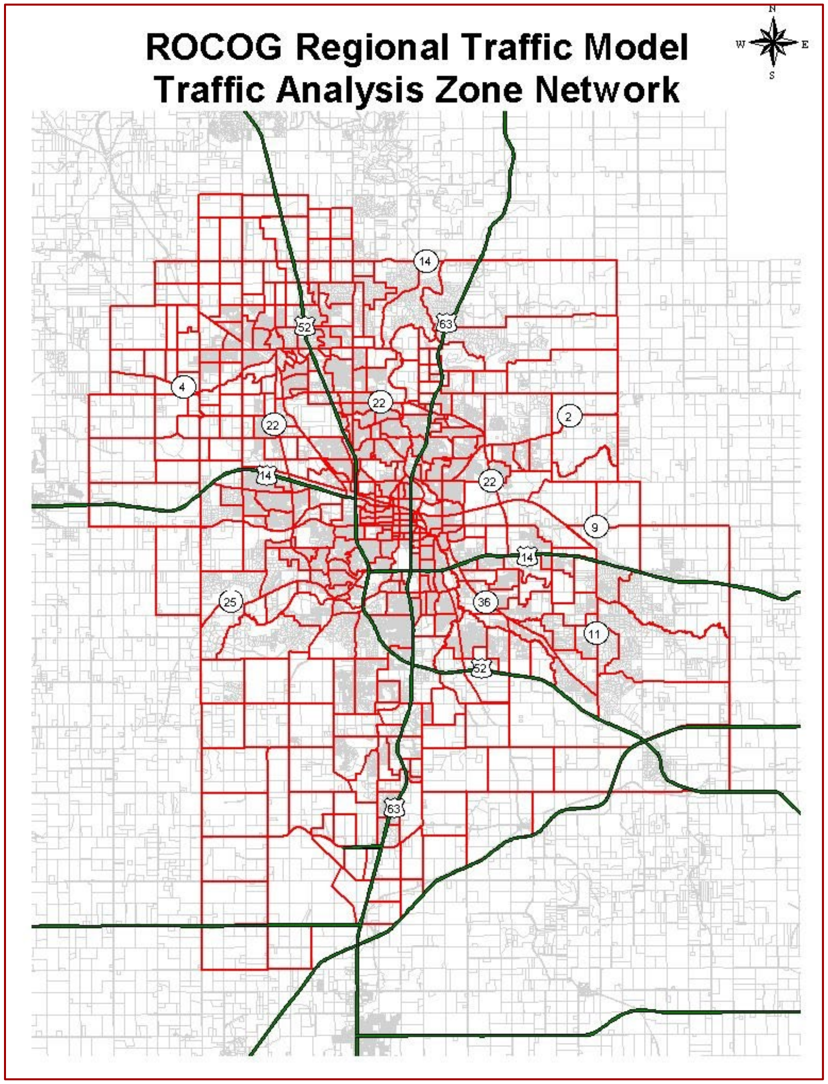
Chapter 2 reported on projected 2045 population forecasts and employment forecasts. For the Rochester urban area, population is expected to grow to approximately 176,000 by 2045, up from a current level of approximately 133,500 persons. Employment is expected to grow from a level of 119,000 jobs in 2019 to approximately 154,000 by the year 2045. Population forecasts are used to estimate growth in housing units by type, school enrollments and park needs. Job data is used to estimate the square footage of new development including retail, office, health care, and industrial development.

The regional population and employment forecasts and resulting land use totals were supplemented with information developed in the Destination Medical Center Plan completed in 2015. The DMC Plan provided projections of housing units as well as square footage of retail, health and education, and civic uses anticipated for development in the downtown area in the next 25 years. These were used as input into the land use forecasts.

Traffic Analysis Zones

Figure D-1 highlights the traffic analysis zone (TAZ) network for the Rochester urban area. It contains a total of 466 zones, with smaller zones resulting in a more finely grained network in the urban core and larger zones on the outer fringe, where development and traffic generation is less concentrated.

Figure D-1: Traffic Analysis Zone Network



While not used specifically for the Plan, a revised traffic analysis zone network has been developed for use in work related to the proposed Downtown Rapid Transit Network associated with the DMC plan. This network provides for block level detail within the central business district. This TAZ network will be incorporated into future ROCOG model work as part of the updated traffic forecasting model for the 2025 Metropolitan Plan Update.

Assignment of Land Use to Traffic Analysis Zones

Following estimation of total growth in terms of housing units and square footage of non-residential development, development must be allocated spatially across the urban study area in order to complete the traffic projections.

Figures D-2 and D-3 illustrate the general assumptions regarding the distribution of new growth for single family and multifamily residential development (Figure D-3) and for business and medical/education development (Figure D-4) through the year 2045. These assumptions give preference to undeveloped housing or non-residential acreage in general development plans that have been approved, but not built out, as the highest priority areas for future development. Secondary priority was assigned to areas which either have sewer and water service available and a high level of major road accessibility.

Figure D-2: Residential Growth Assumptions

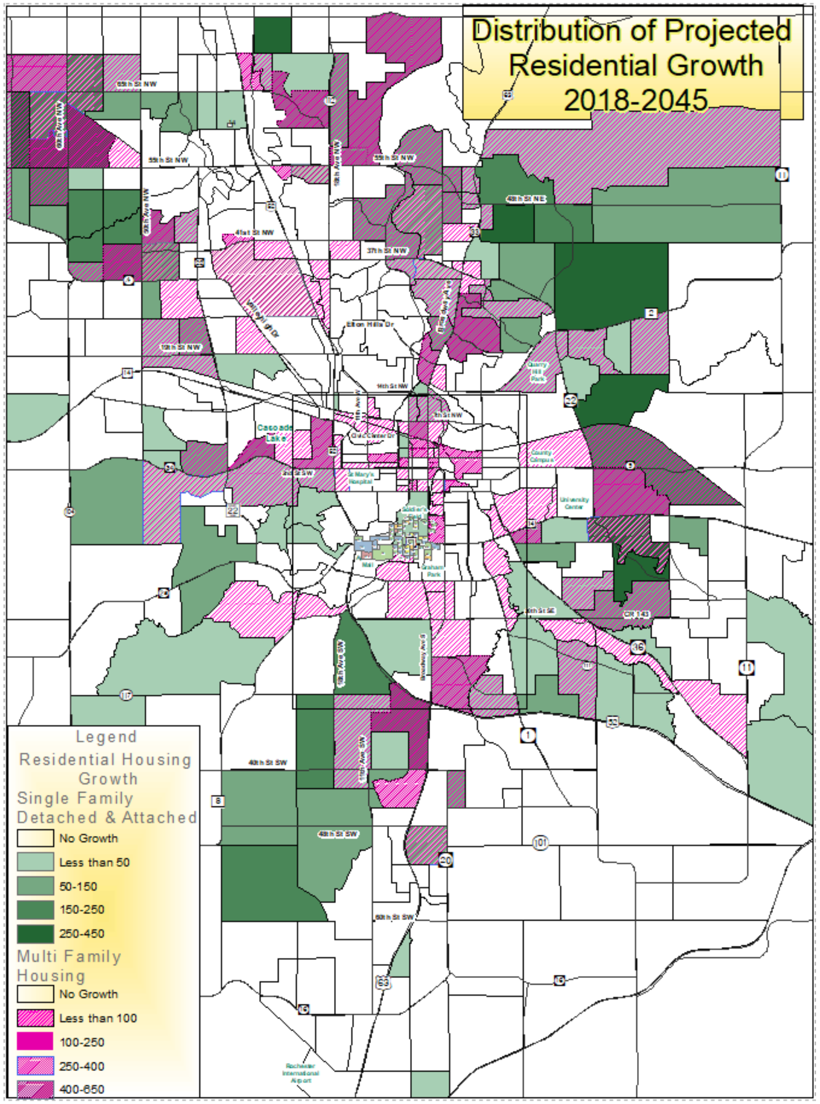
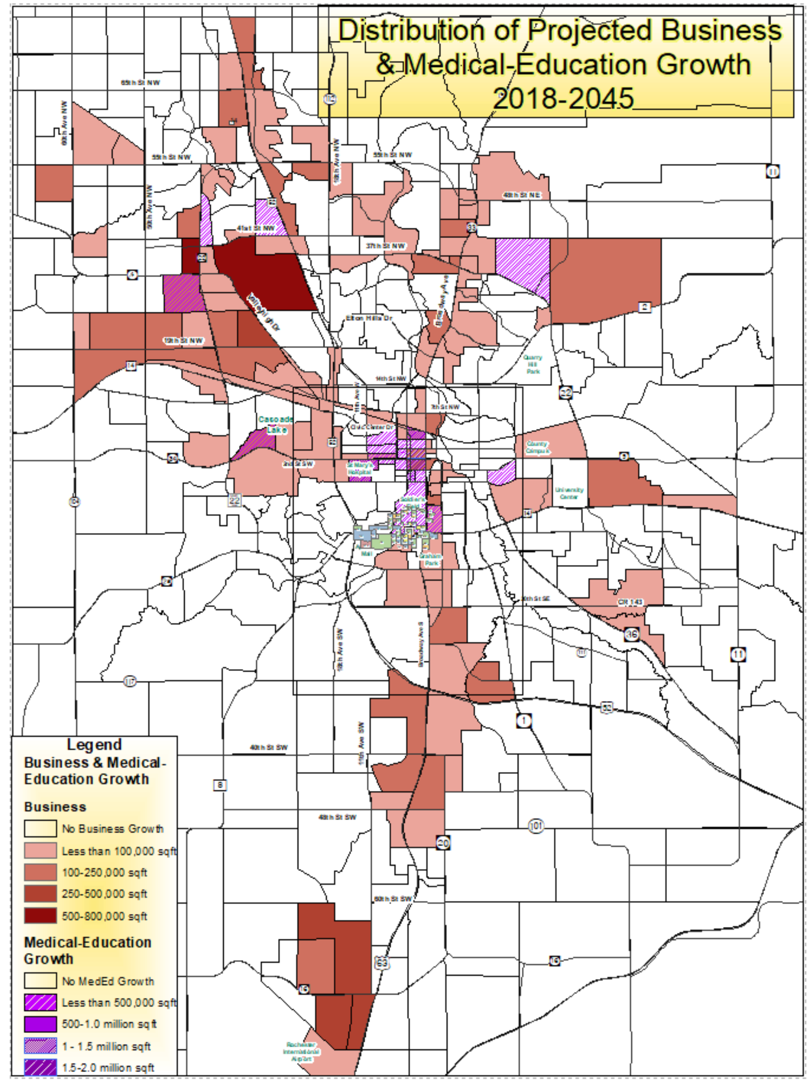


Figure D-3: Business and Medical/Educational Growth Assumptions



For the downtown Rochester area, assumptions regarding future land use distribution were derived by consulting the Rochester Downtown Master Plan, the Destination Medical Center Plan, and staff discussions with the Mayo Medical Center.

Trip Generation Categories

Each land use type is a assigned a trip rate which identifies the number of daily trips that are expected to be produced by each unit of development. Table D-2 summarizes the trip generation categories utilized in the Rochester urban area traffic model along with assigned daily trip rates and trip purpose breakdown. It uses a three-purpose model of "Home Based Work", "Home Based Other", and "Non-Home Based" trips.

No new trip generation categories were added to the model for use in the 2045 plan. Certain daily trip rates were adjusted to reflect newer information available from the Institute of Transportation Engineers Trip Generation Manual as well as newer trip generation studies from around Minnesota.

Traffic Model Network

The traffic model network is illustrated in Figure D-4 and consists of freeways, arterials and collector streets found in the Rochester urban area. Figure D-4 illustrates the base year network. Various alternative networks incorporating future committed or proposed improvement projects that would affect speed or capacity of a corridor

Table D-2: Trip Generation Rates

Land Use Type	Unit	Daily Trips	Home Based		Home Based		Non-Home	
			Prod.	Attr.	Prod.	Attr.	Prod.	Attr.
Suburban single family	DU	10.50	2.76	0.01	6.91	0.04	0.39	0.39
Urban single family	DU	9.52	2.47	0.1	6.2	0.03	0.36	0.36
Suburban multi-family unit	DU	8.01	2.08	0.09	5.21	0.03	0.3	0.3
Urban multi-family unit	DU	6.65	1.73	0.07	4.32	0.03	0.25	0.25
Twin and town homes	DU	8.90	2.1	0.12	5.27	0.25	0.58	0.58
General commercial	Sq FT (1000s)	30.00	0	3	0	16.78	5.11	5.11
Industrial	Sq FT (1000s)	5.50	0	2.2	0	2.32	0.49	0.49
Office	Sq FT (1000s)	15.40	0	5.39	0	6.59	1.71	1.71
Church and health clubs	Sq FT (1000s)	38.00	0	6.65	0	27.13	2.11	2.11
Public entertainment arenas	Seats	0.09	0	0.01	0	0.06	0.01	0.01
Secondary schools and college	Students	1.71	0	0.17	0	1.16	0.19	0.19
Elementary schools and day care	Students/ Child	1.29	0	0.14	0	0.87	0.14	0.14
Hotel motel	Lodging Units	6.20	0	0.62	0	3.46	1.06	1.06
High intensity commercial	Sq FT (1000s)	500	0	25	0	234.5	120.25	120.25
Drive through bank	Sq FT (1000s)	148.15	0	13.17	0	74.08	30.45	30.45
Developed parkland	Acres	8.00	0	0.8	0	5.42	0.89	0.89
Shopping center	Sq FT (1000s)	42.70	0	4.27	0	23.89	7.27	7.27
Big box retail	Sq FT (1000s)	90.00	0	9	0	50.56	15.22	15.22
FMC and senior city apartments and nursing homes	Residents	2.74	0.85	0	1.6	0.11	0.09	0.09
Mayo medical center	Sq FT (1000s)	9.66	0	3.86	0	3.86	0.97	0.97
St Mary's medical center	Sq FT (1000s)	13.22	0	5.29	0	5.29	1.32	1.32
Airport passenger terminal	Enplanements	3.00	0	0.45	0	1.53	0.51	0.51
Air cargo	Sq FT (1000s)	10.00	0	2	0	2.82	2.59	2.59
Mobile homes	DU	5.00	1.28	0.04	3.2	0.06	0.21	0.21
Biotech	Sq FT (1000s)	8.11	0	3.23	0	3.42	0.73	0.73

or would provide a new corridor were tested against future land use assumptions to determine the final improvement needs identified in the Plan.

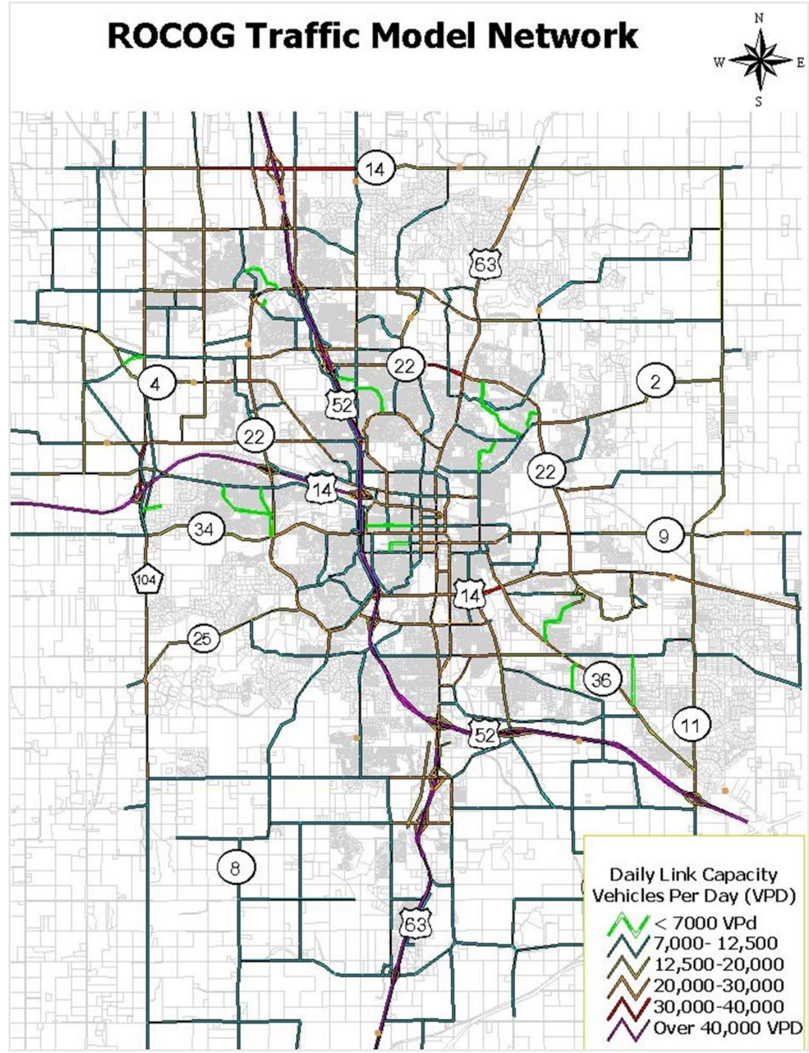
Free Flow Speeds

Free flow speeds are based on area type and facility class as shown in Table D-3. The free flow speeds were reviewed and updated and incorporated into the CUBE VOYAGER script.

Table D-3: Traffic Model Speeds

Class Name	Rural Area Type	Urban Area Type
Freeways	56	51
Narrow ramps	32	35
Wide ramps	37	37
Divided Arterials	37	31
Undivided	38	30
Centroid Connectors	15	15
Divided Expressways	42	36
Undivided Expressways	40	36
Arterials with turn lane	37	34
Parkways	26	26
Super Two	41	40

Figure D-4: Traffic Model Network



Calculation of Daily Capacity for rural-suburban expressway (TH 14)
880 veh/lane (x) 8.0 daily factor (x) 4 lanes = 28,160 AADT

Roadway Capacity

Like free flow speeds, the highway network link free flow capacities are based on area type and facility class. The free flow capacities were updated and now reflect peak hour free flow capacity per lane, adjusted for the total number of directional through lanes on a roadway facility. The capacities are shown in Table D-4.

With capacity factors now identified as the one-hour free flow capacity of a roadway, the ROCOG model has incorporated a set of scaling factors that allow the model to be used for different time periods. AM, mid-day, and PM peak periods, along with daily time periods, can be run using the model. A capacity scaling factor is set in the model run to reflect the appropriate analysis period and determine the total roadway capacity for a time period before trip assignment is completed. The factor for AM and PM periods is 2.5, for mid-day is 5.0, and daily traffic is set to 8.0.

Mode Choice and Parking Trips Diversions

A mode choice model is now incorporated in the ROCOG model. The mode choice module is comprised of the following three major components

- Estimation of walk trips
- Estimation of public transit (PT) trips
- Internal capture trips for high-density developments

Table D-4: Roadway Capacities

Rural Area Free Flow Capacity (per hour per lane)			
Class Name	**1 Lane**	**2 Lanes**	**3+ Lanes**
Freeways	1,750	1,750	1,750
Narrow ramps	1,000	1,000	1,000
Wide ramps	1,380	1,380	1,380
Divided Arterials	880	880	780
Undivided Arterials/Collectors	500	610	610
Centroid Connectors	9,999	9,999	9,999
Divided Expressways	880	880	780
Undivided Expressways	580	810	810
Arterials with turn lane	500	725	725
Parkways	530	530	530
Super Two	830	830	830
Urban Area Free Flow Capacity (per hour per lane)			
Class Name	**1 Lane**	**2 Lanes**	**3+ Lanes**
Freeways	1,920	1,920	1,920
Narrow ramps	1,000	1,000	1,000
Wide ramps	1,380	1,380	1,380
Divided Arterials	790	790	770
Undivided Arterials/Collectors	480	760	760
Centroid Connectors	9,999	9,999	9,999
Divided Expressways	780	780	770
Undivided Expressways	560	780	780
Arterials with turn lane	500	725	725
Parkways	530	530	530
Super Two	830	830	830

These trips are estimated and removed from the vehicle trip tables of the respective trip purpose.

In addition, morning commuter trips that use remote park-and-ride (PnR) lots and ride transit to work are calculated based on the number of parking spaces, the locations of the PnR lots, and the likely trip origins. Information on the number of parking spaces and lot locations is direct input provided by ROCOG. Trip origins for the vehicular portion of the trip are estimated by the model using assumptions regarding which land use districts are served by which PnR lots.

It is assumed that the workplaces of the PnR commuter trips are in downtown Rochester. The numbers of commuter trips that use PnR lots are calculated as the demands of work trips from the likely trip origins to downtown and scaled to the numbers of parking spaces. The destination zones are replaced with the TAZ IDs that are assigned to the PnR lots. The commuter trips to downtown are then removed from the AM HBW trip table and replaced with the trips to the PnR lot TAZs.

The PM returning commuter trips is a mirror image of AM commuter trips. The morning commuter trips and PnR lot trips are transposed and used to adjust the PM HBW trip table in a similar way to the AM calculations.

Utilization of the parking facilities in downtown is estimated based on the type of parking facility (on street, parking ramp, parking lot, or PnR lot), the type of parking utilization (employee-only, visitors, or shared), and the number of parking spaces allotted to employees and visitors. Using this information, the primary TAZ(s) served by parking facilities in the parking data file, the parking trip rates, and the number of parking trips are calculated. In trip assignment, the parking trips must travel through the nodes that represent the parking facilities, then walk from the parking facilities to their respective downtown destination zone.

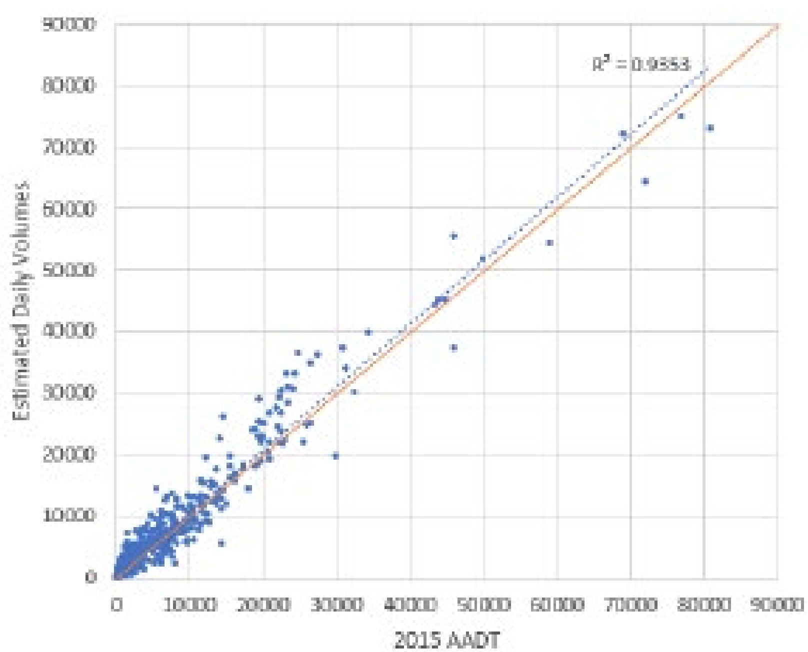
Model Calibration

A final model building step prior to generating new forecasts is the calibration phase, in which base year land use (2015 in this case) is used in the model to see how well existing traffic counts are replicated by the model. The goal of calibration is to match within certain tolerances traffic flows generated by the model with existing traffic flows on different classes of streets. As shown in Figure D-5, the deviation in corridors flows generated by the model when compared to existing counts was well within desired guidelines for all classes of roadways.

Trip Assignments

Seven trip tables (two sets of trip tables by trip purpose and EE trips) are assigned to the highway network. For

Figure D-5: Calibration Goodness of Fit



each of the trip purposes:

- Parking and non-parking trips are estimated and assigned separately. The parking facilities are represented by parking nodes in the network.
- Non-parking trips are loaded directly to their destination zones and are prohibited from travelling through parking nodes.
- Parking trips must travel through parking nodes and "walk" to their destination zones as the last leg of travel.
- HBW parking trips are assigned to parking facilities that are either designated as employee-only lots or lots shared with visitors. In the return trips, the walk-to-parking-node becomes the first leg of travel.
- HBO and NHB parking trips are prohibited from using employee-only parking facilities. Using the parking information provided by ROCOG, the non-work parking trips are assigned to the parking facilities that are designated to serve the destination zones. If the parking facilities is "full", the parking trips will be routed to other parking facilities that are closest to the destination zones in terms of travel time. This is achieved by using walk time. The walk time between the TAZ and the designated parking facilities are much shorter.

Urban Travel Demand Forecasts

Figures D-6 through D-8 illustrate the various outputs from the 2045 ROCOG traffic model incorporating the various changes and adjustments described on the previous pages. This includes:

- Figure D-6, which illustrates traffic volumes estimated for the year 2018 based on existing land use and used in Figure D-5 to estimate the goodness of fit of the model to existing traffic counts collected in the field

- Figure D-7, which reports projected traffic volumes for the year 2045 using the land use assumptions and model refinements described previously
- Figure D-8, which illustrates the projected growth in traffic between the base year model and 2045

Forecasts were analyzed to determine where 1) added capacity may be needed on major streets and highways, 2) where future congestion can be anticipated, 3) lane needs on arterial/collector streets in new development areas, and 4) intersections that may need future geometric or operational improvements. Improvement needs based on this analysis are discussed in Chapter 10.

Urban Congestion Analysis

The traffic forecasts illustrated in Figure D-7 were also used to analyze future congestion needs as reported in Chapter 14 of the plan. The congestion analysis provides a different perspective on projected traffic conditions than the lane needs/capacity analysis discussed in the previous section. While lane needs analysis focuses on identifying whether corridors are projected to be over or under-capacity based on threshold cutoff value, the congestion analysis provides results that suggest how severe, on a qualitative scale, future congestion conditions may be. This analysis better helps to identify where there may be corridors as opposed to individual

Figure D-6: Existing/Base Year Modeled Traffic Volumes

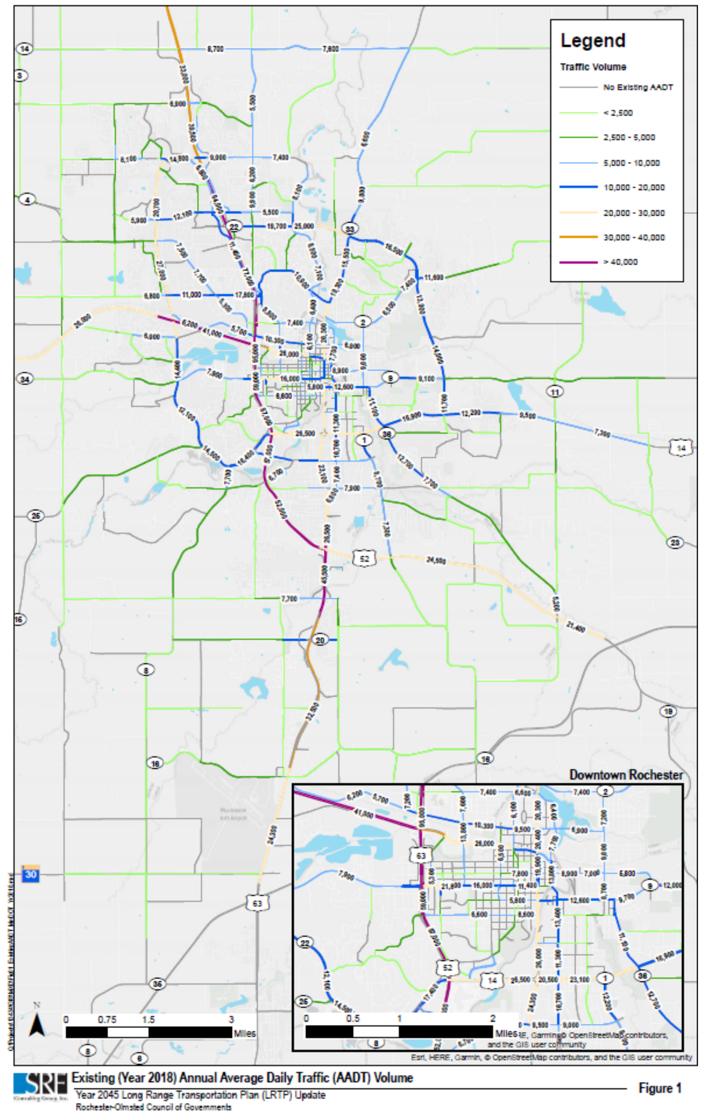


Figure D-7: Projected 2045 Traffic Volumes

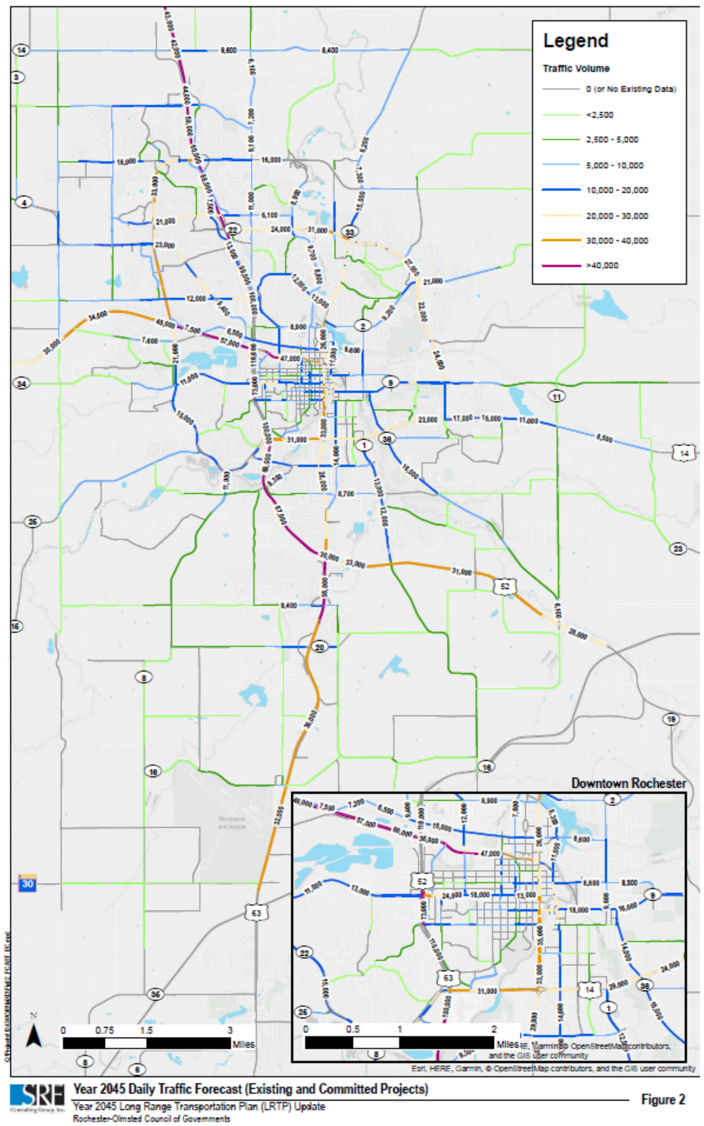
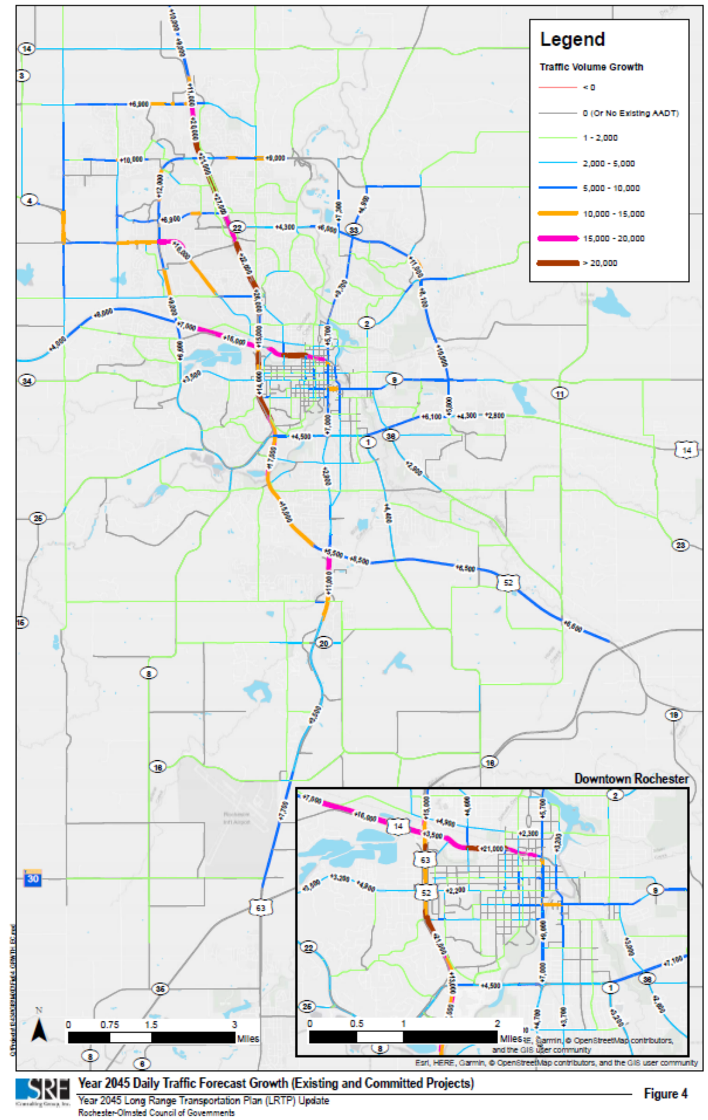


Figure D-8: Projected Traffic Growth 2018-2045



segments or intersections that may warrant consideration for future TSMO improvements.

The measure of congestion used is traffic density per lane, and it is taken from the methodology used by the Texas Transportation Institute in their annual Urban Mobility Report on congestion in major cities across the country. The thresholds are straight-forward and reported in terms of Not Congested, Infrequent, Periodic, Frequent, and Severe congestion levels, based on the traffic density shown in Table D-5.

Table D-5: Urban Traffic Congestion Thresholds in Vehicles Per Day Per Lane (vpdpl)

Facility Type	Freeway	Arterial
Conditions not Congested (vpdpl)	<15,000	< 5,500
Infrequent Congestion (vpdpl)	15,000-17,500	5,500-7,000
Periodic Congestion (vpdpl)	17,500-20,000	7,000-8,500
Frequent Congestion (vpdpl)	20,000-25,000	8,500-10,000
Severe Congestion (vpdpl)	>25,000	>10,000

This analysis was applied to both baseline traffic forecasts and projected 2045 traffic forecasts. Figures D-9 and D-10 highlight projected existing and future congestion levels for major roads in the urban area. The results of this analysis and recommendations for future strategies are discussed in Chapter 14.

Figure D-9: Modeling Base Year Congestion

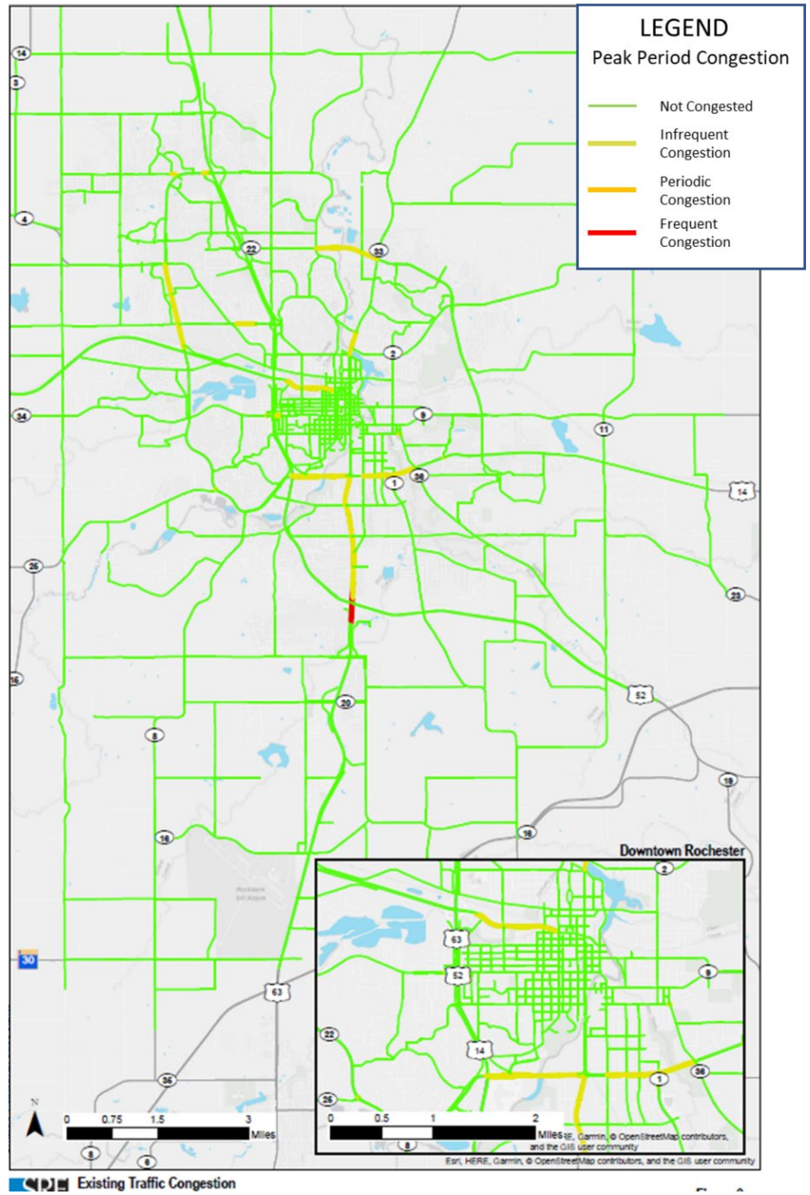
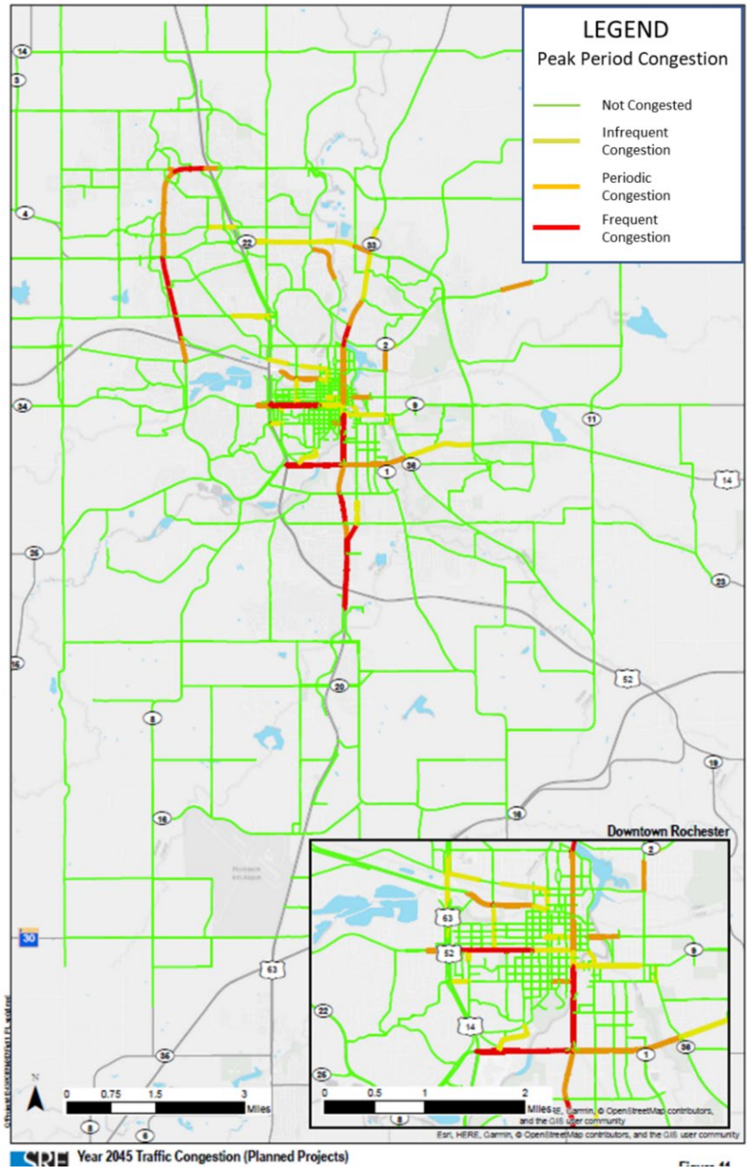


Figure D-10: Projected 2045 Congestion Levels



Regional Area Traffic Forecasts

Preparation of traffic projections for the regional study area relied primarily on evaluating historic traffic growth rate trends to estimate future traffic flows. This process involved looking at growth rates over different time frames (5, 10, and 15 years), with a bias given towards using more recent growth rate trends as a guide to future growth in areas where additional development is anticipated, while using the longer term growth rates in areas of more stable land use. The analysis looks at growth both in absolute terms as well as on a percentage basis. The forecast process, however, generally relies on using absolute growth trends since the application of percentage growth rates can lead to illogical results. This is due to the fact that relatively small changes in historic traffic levels on low volume roads can result in high percentage growth rates, which if applied over a planning horizon of 30 years going forward, can lead to unrealistically high projected volumes.

Figure D-11 illustrates the results of the regional traffic forecasting work.

Figure D-11: Projected 2045 Regional Traffic Volumes