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MEMORANDUM

TO: Scott Pedersen, MINNESOTA DEPARTMENT OF TRANSPORTATION
Jim Gates, CITY OF BLOOMINGTON
Bob Vorpahl, METROPOLITAN AIRPORTS COMMISSION

FROM: Steve Wilson, Principal
Paul Morris, Engineer

DATE: June 24, 2008

SUBJECT: I-494 & TH 77 CORRIDOR FORECASTING AND CONCEPT DEVELOPMENT
FORECAST TECHNICAL MEMORANDUM

The purpose of this memorandum is to document the travel demand forecasts for the I-494 & TH 77 Corridor Forecasting and Concept Development Study. This memorandum includes a summary of the forecast modeling process, model validation information, transportation facility and socioeconomic data assumptions, and forecast results.

DESCRIPTION OF STUDY AREA AND DATA COLLECTION

Study Area

The study area for this forecasting effort includes the I-494 corridor in the City of Bloomington from East Bush Lake Road to the Minnesota River. This corridor includes system interchanges with TH 100, I-35W, TH 77, and TH 5. The following freeways are also part of the forecasting study area to the following extents: TH 100/Normandale Boulevard between 84th Street and 70th Street, I-35W between 90th Street and 66th Street, TH 77 between East Old Shakopee Road and 66th Street, and TH 5 north of I-494 to Glumack Drive. All of the arterial roadways with access to the freeways within the study area are included, as well as key arterials in the Bloomington Central Station and Mall of America areas.

Data Collection

Hourly freeway counts were obtained through Mn/DOT loop detector counts on all of the freeway segments in the study area. The loop detector data was retrieved from April 2007.

THE PURPOSE OF TRAVEL DEMAND FORECASTS

Travel demand models estimate the amount of travel on transportation facilities with specific development and transportation system assumptions. The forecasts provide estimates of facility use identified by roadway volumes and generalized travel impacts identified by peak period congestion. Travel demand forecasts are also used as inputs to other areas of study, such as traffic operations analysis. The travel demand forecasts assume vehicle operating costs remain constant over the long term, such that increased fuel costs would be offset by improved vehicle efficiency between 2005 and 2030.

Models provide an estimation of traffic forecasts that include many future year assumptions. However, with lack of certainty regarding future-year conditions, the model results should be considered estimates with some margin of error. Mn/DOT currently considers long-range forecasts to have a precision of +/- 15 percent. Decision-makers and designers should be aware of the uncertainty in long-range forecasts and whether that uncertainty would affect outcomes related to forecast volumes.

MODEL MODIFICATIONS

The Twin Cities regional travel demand model, developed by the Metropolitan Council in 2004, was used to develop these forecasts. A number of modifications were made as part of developing and running the travel demand model for this study. These modifications are discussed below and are consistent with Mn/DOT's *Travel Demand Forecast Model Guidelines* (April 2006).

Transportation Analysis Zone (TAZ) Splits

Metropolitan Council TAZs were subdivided in the study area to better characterize trip patterns. Zonal boundaries were drawn to reflect greater levels of detail in the Cities of Bloomington, Richfield, and Edina and in the Fort Snelling/MSP Airport area. The TAZ refinement process expanded the 56 original zones in the study area to 244 zones, increasing the total number of zones in the seven-county area from 1,201 to 1,389.

Highway Network

The roadway network was also expanded to include more detail in the study area, including the Cities of Bloomington, Richfield, and Edina and in the Fort Snelling/MSP Airport area. This level of detail was used to accommodate the refinement of subdivided TAZs and to include lower volume roadways in the model to better estimate local travel patterns.

Highway Assignment Process

The default regional highway assignment process uses a 2.0 percent "gap" closure, wherein the model is assumed to reach equilibrium if the difference in travel time between iterations is less than 0.5 percent. In some cases, this may take more than 30 iterations to achieve, which is the default maximum number of iterations. To ensure that this degree of closure was achieved in this study, the number of iterations during the peak period was increased to 50, to reduce the gap and thereby increase the stability of individual link volumes.

Temporal Distribution

Vehicle trips in the final iteration of the model are allocated to subdivided TAZs based on the socio-economic data for each TAZ, using a simplified trip generation process. In doing so, inbound and outbound trips are allocated based on time of day.

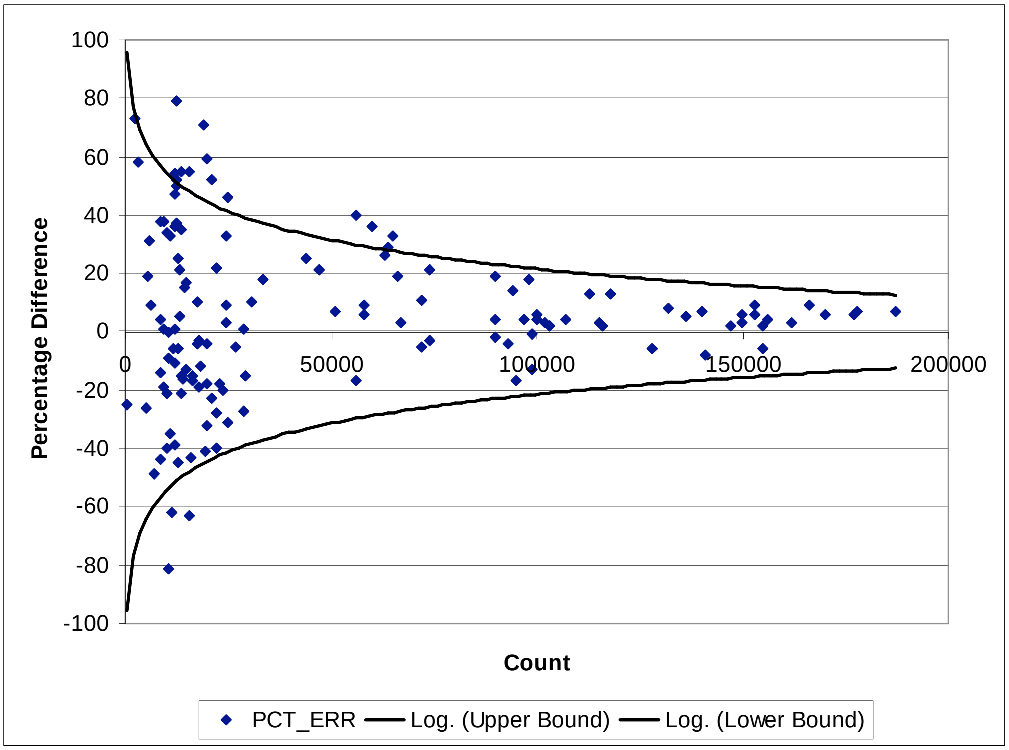
MODEL VALIDATION

Model validation describes the process of comparing the applied model to external data to evaluate the goodness of fit of the model. The I-494 & TH 77 Corridor Forecasting Study model generally used existing model parameters, calibration of new parameters where necessary and appropriate, and variety of available data sources to verify the accuracy of the model. This includes the Metropolitan Council's 2001 Travel Behavior Inventory datasets, socio-economic data provided by the cities in the study area and current available traffic counts.

Study Area Traffic Volume Validation

The travel demand forecasting model daily traffic volumes were validated using daily traffic counts (ADT) obtained from Mn/DOT for 2005/2006. The resulting model assignment compared to existing counts is shown in Figure 1. The model validates with an overall root mean squared error (RMSE) of 16 percent for an average link volume of 50,300 vehicles per day (vpd). The correlation statistic, indicating the ability of the model to capture observed conditions, was 0.98. A higher percentage of error can be tolerated on lower volume roadways where the numeric difference is lower. An acceptable RMSE (10 percent) was achieved for study-critical freeways and expressways with current ADT values exceeding 100,000 vpd. Sixty-four percent of counts in the study area fall within the FHWA percent difference targets shown as the black lines in Figure 1.

Figure 1
Comparison of Model Error to 2005 Ground Counts



MODEL ADJUSTMENT

While the Twin Cities Regional Model is validated to base year (2005) counts, there is always a base-year discrepancy in each link or residual error in the model. To account for this discrepancy, forecast year volumes are adjusted on a link-by-link basis. This practice was used consistently with the methods described in NCHRP 255 (Highway Traffic Data for Urbanized Area Project Planning and Design) based on:

- The difference between model and count volume
- The ratio of the model to count volume
- The magnitude of growth between existing and future volume

Three calculations are used in making adjustments to the link volumes produced by the model. These are the Ratio Method, the Difference Method, and the Average Method. The calculations for each of these are given below.

- Ratio Method: *AdjustedVolRatio = AssignedVolume * (BaseCount / BaseAssignedVolume)*
- Difference Method: *AdjustedVolDifference = AssignedVolume + (BaseCount - BaseAssignedVolume)*
- Average Method: *AdjustedVolDifference = 0.5 * (AdjustedVolDifference + AdjustedVolRatio)*

Table 1 shows the conditions under which each of these adjustment methods is appropriate. In general, the ratio method provides potentially volatile and unstable adjustments, where the travel demand model is extremely different than the counts, or where growth is proportionately high. Consequently, this method is never used independently. In most cases, the average method is used.

Table 1
Model Adjustment Process

Condition	Implications of Condition	Method Used
$\frac{FutureVolume}{BaseVolume} > 3$	High model growth may cause the ratio method to result in unreasonably high adjusted volumes.	Difference Method
$\frac{BaseCount}{BaseVolume} > 1.5$	A large underestimation by the model in the base year may cause the ratio method to result in unreasonably high adjusted volumes.	Difference Method
$\frac{BaseVolume}{BaseCount} > 1.5$	A large overestimation by the model in the base year may cause the ratio method to result in unreasonably low adjusted volumes.	Difference Method
All Other Cases		Average Method

There are cases where none of these methods are appropriate. For example, on a facility which is experiencing a major change in capacity in the future, the adjustment method may be applied across a screenline instead of on a specific link. Reasonable engineering and planning judgment should be used for any adjustment technique, or in using unadjusted future volumes. The modeling process as developed includes a field to identify locations where additional manual adjustments were made.

FUTURE NETWORK ASSUMPTIONS

Following are the transportation network assumptions that were used in the travel demand forecasts for the I-494 & TH 77 Corridor Forecasting Study. The forecasting analysis years included 2020 and 2030. The assumptions are consistent with currently adopted plans, not including unfunded future improvements on the regional and local roadway network. Specifically, the *Mn/DOT Metro District Transportation Systems Plan 2008-2030* and Capital Improvement Plans (CIP) for the Cities of Bloomington, Richfield, and Edina were referenced. Additional improvements identified in the Bloomington Central Station and Mall of America area for the *Mall of America: Phase II Traffic Study* dated September 2006 were assumed. These improvement areas are depicted in Appendix A, Figure A-1. Descriptions of the specific improvements are as follows:

Year 2020 Roadway Network Changes (Assumed to be in place)

- *Mn/DOT Facilities*
  1. I-35W/TH 62 Crosstown interchange reconstruction
  2. I-494/TH 169 interchange reconstruction
- *Local Facilities*
  3. Construction of the American Boulevard bridge over I-35W[(1)]
  4. Reconstruction of the I-494/Lyndale Avenue interchange to a single-point urban interchange configuration
  5. Reconstruction of the 76th Street bridge over I-35W
  6. Improvements to the I-35W/82nd Street interchange
  7. Construction of the 77th Street tunnel under TH 77 with 77th Street access from southbound TH 77 and to northbound TH 77
  8. Realignment of Bloomington Avenue in the northeast corner of Richfield
- *Airport South Area*
  9. Access modifications to the TH 77 northbound/I-494 eastbound collector-distributor (CD) road including new access at Thunderbird Road and access revision at Lindau Lane to and from northbound TH 77 relocated to the Mall of America parking area
  10. Conversion of American Boulevard to a one-way westbound roadway between 34th Avenue and 28th Avenue
  11. Corridor improvements to East Old Shakopee Road, Killebrew Drive, 24th Avenue, 28th Avenue, and American Boulevard

(1) Project complete at time of development of forecasts, but not included in Mn/DOT 2005 AADT volumes.

Year 2030 Roadway Network Changes (Assumed to be in place)

- *Mn/DOT Facilities*
  12. Reconstruction of I-494 between TH 100 and the Minnesota River including systems interchange improvements at TH 100, I-35W, and TH 77
  13. Access restrictions in the “Big Box” area including Penn Avenue and Lyndale Avenue to/from I-35W and 82nd Street to/from I-494
  14. Additional capacity on I-35W between 90th Street and TH 62
  15. Reconstruction of TH 100 between 36th Street and I-394
- *Local Facilities*
  16. Access closure of the I-494/Nicollet Avenue interchange ramps

17. Consolidation of the split diamond interchange between Portland Avenue and 12th Avenue to a single-point urban interchange configuration at Portland Avenue

- *Airport South Area*

18. Reconstruction of the I-494/34th Avenue interchange including improved connections to TH 5 and I-494 to the east
19. Additional capacity on 34th Avenue from American Boulevard to the Humphrey Terminal

FUTURE YEAR DEVELOPMENT ASSUMPTIONS

Socio-Economic Data Assumptions

The forecast of future-year development in the model area is a primary determinant of the amount and characteristics of travel. Socioeconomic data for the entire region was provided by the Metropolitan Council. Subdivided TAZs located in the project area were assigned data received from the cities along the corridor. The 2020 and 2030 land use data used in these areas was verified for consistency with Metropolitan Council control totals for each municipality and was determined to be within the acceptable range (five percent). The population and employment totals for the study area communities and the MSP Airport are shown in Table 2.

Table 2
Population and Employment Estimates by Community

	2005		**2020**		**2030**	
Community	Pop	Emp	Pop	Emp	Pop	Emp
Bloomington	85,830	110,380	92,600	131,810	96,390	139,750
Richfield	36,160	16,210	42,700	17,600	47,100	18,100
Edina	46,460	49,410	50,000	60,000	51,500	62,400
MSP Airport	910	28,530	0	37,200	0	40,350

Significant locations of commercial redevelopment in the City of Bloomington include the Bloomington Central Station, Mall of America Phase II, and Normandale Lakes Office Park. The City of Richfield has outlined redevelopment plans to replace all existing residential land uses between 17th Avenue and TH 77 with commercial land uses. The City of Edina provided the socio-economic TAZ data used in the recent update of the City’s Comprehensive Plan. All of the household growth in the study area is shown in Appendix A, Figure A-2. Similarly, employment growth is depicted in Appendix A, Figure A-3.

Airport South Development Assumptions

This forecasting study has resulted in future traffic volumes that differ from the recent *Mall of America*, *Phase II Traffic Study* (September 2006) completed by SRF Consulting Group, Inc. This difference can be attributed to four reasons: 1) the regional model is constrained versus all ITE trips generated for the *Mall of America*, *Phase II Traffic Study* were distributed to the supporting roadway system. 2) Land use assumptions differed between the *Mall of America, Phase II Traffic Study* and the current study. For example, higher densities were assumed for future development in the Mall of America area and lower densities were assumed for future development east of 28th Avenue. 3) Future improvements differed between the *Mall of America, Phase II Traffic Study* and the current study. For example, the southbound off-ramp from TH 77 to 77th Street and the Thunderbird connection to eastbound I-494 were not included in the *MOA Study* but are assumed in this study. 4) The regional travel demand model uses trip rates from the 2000 regional travel behavior inventory that are generally lower than those found in the *ITE Trip Generation* manual, which is widely used for smaller area traffic studies.

MSP Airport Development Assumptions

The MSP Airport introduces an additional complexity to this forecasting study that required an understanding of how airport use translates into traffic demand. The amount of air travel at the MSP Airport is a function of the population of the Twin Cities metropolitan area and outlying areas that are dependant on air travel. As described in the modeling process presented in Appendix C, this number is quantified through a special generator input. This input is in units of passenger originations and was developed based on Federal Aviation Administration (FAA) forecasts of enplanements through year 2025. The Metropolitan Council was consulted in the development of this special generator input. The input for each of the modeled timeframes is shown in Table 3.

Table 3
MSP Airport Special Generator Input

Year	**2005**	**2020**	**2030**
Special Generator Input (passenger originations)	25,736	39,031	50,339

Source: Metropolitan Council

The Metropolitan Airports Commission (MAC) has proposed expansion of parking facilities at MSP Airport. The majority of new parking facilities are planned to be constructed near the Humphrey Terminal. The timing and magnitude of these new facilities is summarized in Table 4.

Table 4
MSP Airport Parking Expansion Summary

Location	**Lindbergh Terminal**	**Humphrey Terminal**	**Total Airport**
Timeframe	*Number of Spaces*		
Current Total	**11,200**	**1,800**	**13,000**
2009	0	5,500	5,500
2010	0	1,400	1,400
2015	0	8,000[1]	8,000
2016	3,000[2]	0	3,000
2020	0	6,300	6,300
2020 Total	**14,200**	**23,000**	**37,200**
2023	0	8,000	8,000
2030 Total	**14,200**	**31,000**	**45,200**

Source: Metropolitan Airports Commission *Parking Progression Development Summary* dated August 31, 2007.
Note: Current spaces represent total parking demand and may not correspond with current physical parking spaces.
(1) 2,000 of 8,000 spaces to be added in 2015 are replacement of existing surface parking spaces.
(2) 3,000 spaces to be added in 2016 are conversion of existing rental car spaces to public parking.

In addition to changes in parking facilities at the MSP Airport, the split of air traffic operations between terminals is also expected to change in the future. Specifically, as gate space at the Lindbergh Terminal reaches capacity, a greater share of the air traffic is expected to operate at the Humphrey Terminal. The combined effect of these changes has an impact on the traffic volumes traveling to/from each of these terminals. Using average length-of-stay data provided by MAC and the expected parking expansion information, the distribution of airport trips between terminals was computed for each of the modeled timeframes. The current ratio of trips is approximately 90 percent to the Lindbergh Terminal and 10 percent to the Humphrey Terminal. In the future, the distribution is estimated to be 66 percent Lindbergh and 34 percent Humphrey in the year 2020 and 60 percent Lindbergh and 40 percent Humphrey in the year 2030. The results of these computations are detailed in Table 5.

Table 5
MSP Airport Trip Distribution Summary

		Existing	Estimated/ Assumed 2020	Estimated/ Assumed 2030
Parking Stalls	Lindbergh	11,200	14,200	14,200
	Humphrey	1,800	23,000	31,000
Lindbergh Terminal Daily Trips	General/Long-term	1,300	2,600	2,600
	Short Term	10,500	18,600	18,600
	Rental*	3,700	0	0
	Curb Drop	18,500	23,200	26,300
	Total	*34,000*	*44,400*	*47,500*
Humphrey Terminal Daily Trips	General/Long-term	400	6,600	8,900
	Short Term	1,500	9,000	12,000
	Curb Drop	1,800	7,500	11,300
	Total	*3,700*	*23,100*	*32,200*
Summary	Total Airport Trips**	37,700	67,500	79,700
	Lindbergh Percent	90%	66%	60%
	Humphrey Percent	10%	34%	40%

*Rental parking is assumed to move out of the Lindbergh Terminal parking ramps to a location near 24th Avenue and Airport Lane.

**Each "Total Airport Trip" represents a round trip both in and out of terminal, such that ADT = 2 x "Total Airport Trips".

FORECAST RESULTS

Daily forecast volumes for years 2020 and 2030 are shown in Appendix A, Figures A-4 and A-5.

Year 2020 Forecasts

Daily forecast volumes for the year 2020 were developed for segments of all freeways and arterials with freeway access in the study area. The maximum daily traffic volume forecasted on I-494 is 193,000 vpd on the segment located between 24th Avenue and 34th Avenue. Since no improvements are assumed on this segment by year 2020, significant levels of congestions are expected.

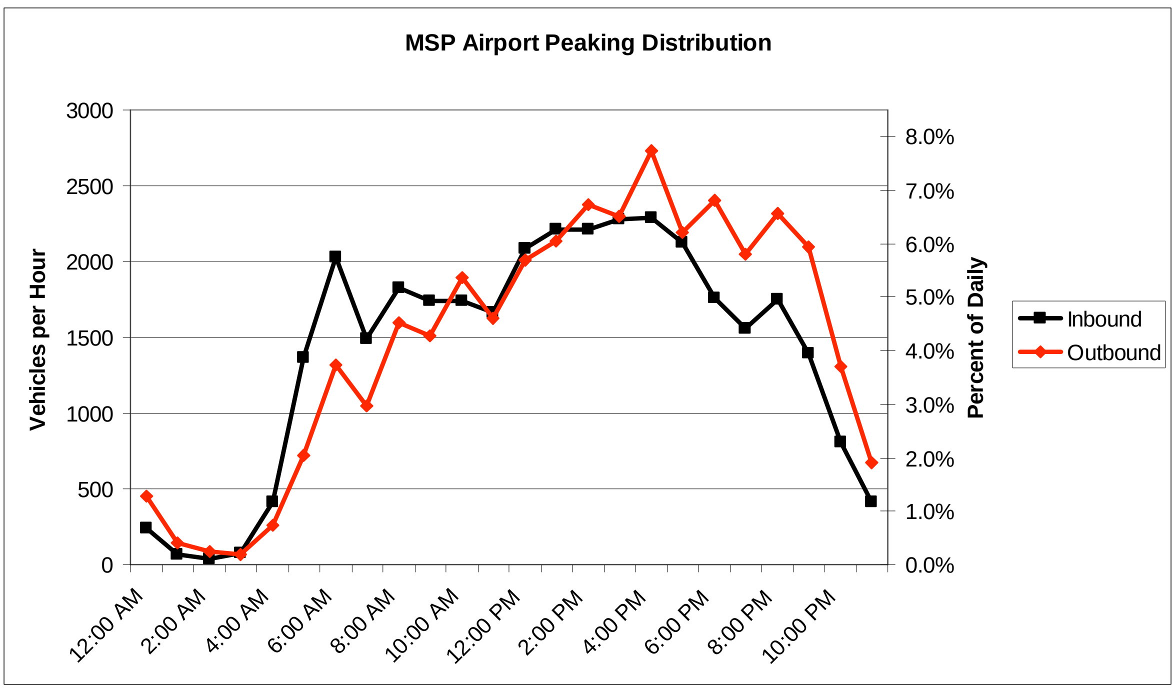
The segment of 34th Avenue north of I-494 is expected to have the largest rate of growth of all arterials in the study area, increasing from 25,000 vpd to 52,000 vpd.

Year 2030 Forecasts

Traffic volumes on I-494 are expected to exceed 200,000 vpd on most segments in the study corridor. This indicates that the ten-lane and twelve-lane cross sections assumed on I-494 will be necessary to carry the demand volume.

The daily traffic volume on 34th Avenue north of I-494 is expected to experience an additional increase to 64,000 vpd by the year 2030. This segment is anticipated to have temporal peaking characteristics that differ from other roadways in the study area. The percentage of the daily traffic in the a.m. and p.m. peak hours is expected to be approximately six percent and eight percent, respectively. These percentages are consistent with existing conditions at the Lindbergh Terminal ramps to and from TH 5, which are shown in Figure 2. Despite these peaking characteristics, this volume is likely to exceed the capacity of this roadway, considering the assumed expansion to a six-lane divided facility.

Figure 2
MSP Airport Peaking Distribution



Forecast Reasonableness Checks

The guidelines for *Twin City Travel Demand Forecasts Prepared for Mn/DOT Metro* (dated 5/10/2006) describes four checks to be made to ensure that traffic forecasts are reasonable. Each of these checks is discussed in detail below. Table D-1 in Appendix D illustrates the volumes discussed in each of the reasonableness checks.

The first check is the percentage of daily traffic in the peak hours. In most cases, this is expected to decrease as roadways become increasingly congested. In this study, however, significant capacity is being added to I-494, and some of the current demand not served during the peak hour should be able to be met in the future.

The second check is the directional split of peak hour traffic. The directional split is generally expected to become more balanced into the future as a corridor becomes more developed. I-494 is almost completely developed already, illustrated by nearly equal directional splits. In some locations, the directional split actually becomes less balanced by 2030. This is due to an increased demand being served in the peak hour, similar to the first check, which results in directional splits returning to the demand ratio.

The third check is to ensure that traffic entering the study area is within the capacity of those roadways. Assuming a 2,200 vehicle per hour (vph) capacity on I-494, this condition is met for eastbound traffic between France Avenue and Penn Avenue on the west side of the corridor and for westbound traffic east of TH 5 on the east side of the corridor.

The fourth check is a comparison of the daily traffic forecasts to historical traffic volume growth. Annual average daily traffic (AADT) volumes were obtained from Mn/DOT flow maps for years from 1990 to 2006. Using these volumes, a linear growth rate was established for each major segment of I-494. In three of four locations, the 2030 forecast is less than the linear extrapolation of the historical volumes. The one location in exception is the segment of I-494 between France Avenue and Penn Avenue. This segment has experienced substantial congestion during much of the past 10 years, which has limited the growth. Thus when new capacity is added by 2030, the daily growth is expected to exceed the extrapolated factor.

Year 2017, 2027 and 2037 Forecasts

Daily forecast volumes were developed for years 2017, 2027 and 2037. Tabular results of these forecast volumes are summarized in Appendix B. Year 2017 forecasts were developed based on "straight-line growth" from years 2005 to 2020. These forecasts include additional consideration of roadway network improvements assumed in year 2020, namely that the I-35W/TH 62 Crosstown Reconstruction and the American Boulevard Bridge over I-35W are assumed to be complete. However, no improvements are assumed for I-494 in the study area. Year 2017 forecast volumes were generally found to be five percent lower than year 2020 forecast volumes, which would result in a 1.5 percent annual growth rate.

Year 2027 and 2037 forecasts were developed based on “straight-line growth” from years 2020 to 2030, however reconstruction of I-494 in the study area is assumed to be complete by 2027. Therefore, a scenario was analyzed that included reconstruction of I-494 in the year 2020. These results were used with the “straight-line growth” method to develop forecasts for years 2027 and 2037 that account for a reasonable increase of traffic on I-494 due to the reconstructed roadway.

Conclusions

Currently, the study segment of I-494 is congested during the a.m. and p.m. peak periods. Traffic volumes for year 2020 are expected to increase by 10 to 25 percent over current conditions. Therefore, year 2020 daily forecasts indicate that the I-494 corridor will be significantly congested in the study area. Since no capacity improvements are assumed in this area, peak period congestion will spread to hours before and after the current peak periods, which will result in more hours of congestion throughout the day.

Year 2030 daily forecasts increase by an additional 10 to 25 percent over year 2020 volumes, assuming major capacity improvements on I-494. This indicates that the capacity added between years 2020 and 2030 will serve a large previous unmet travel demand in the study area. Improvements to the I-494 corridor will result in a higher demand being met during the peak periods, with fewer hours of congestion throughout the day.

The growth in airport trips and the shift in terminal distribution between current and year 2030 conditions will result in significant increases in traffic near the Humphrey terminal. Despite improvements to 34th Avenue north of I-494 and the I-494/34th Avenue interchange, congestion is still expected between the years 2020 and 2030.

cc: Jim Henricksen, Mn/DOT
Brian Isaacson, Mn/DOT
Mark Filipi, Metropolitan Council
Don Demers, SRF Consulting Group, Inc.

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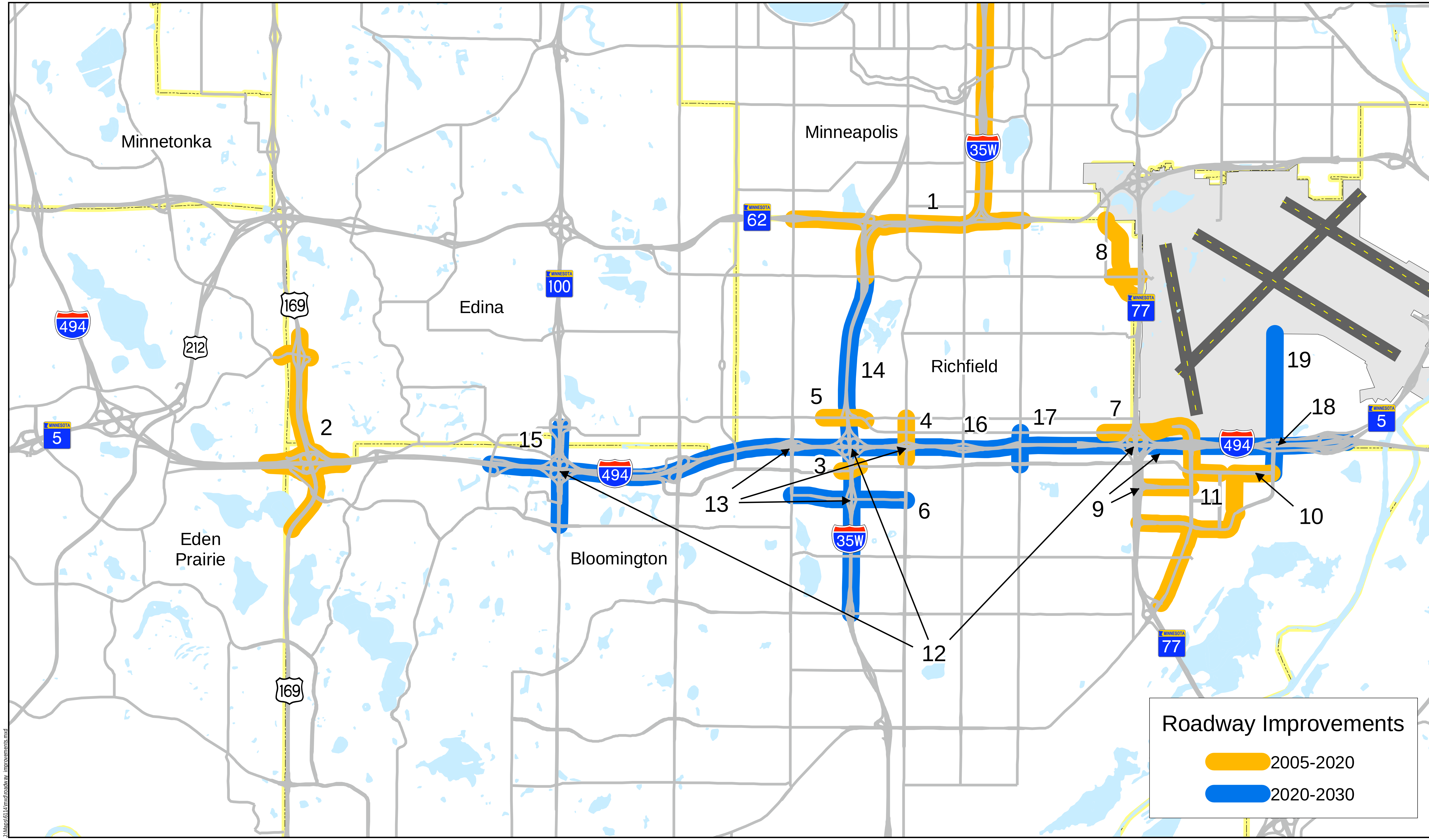
APPENDIX A: FIGURES

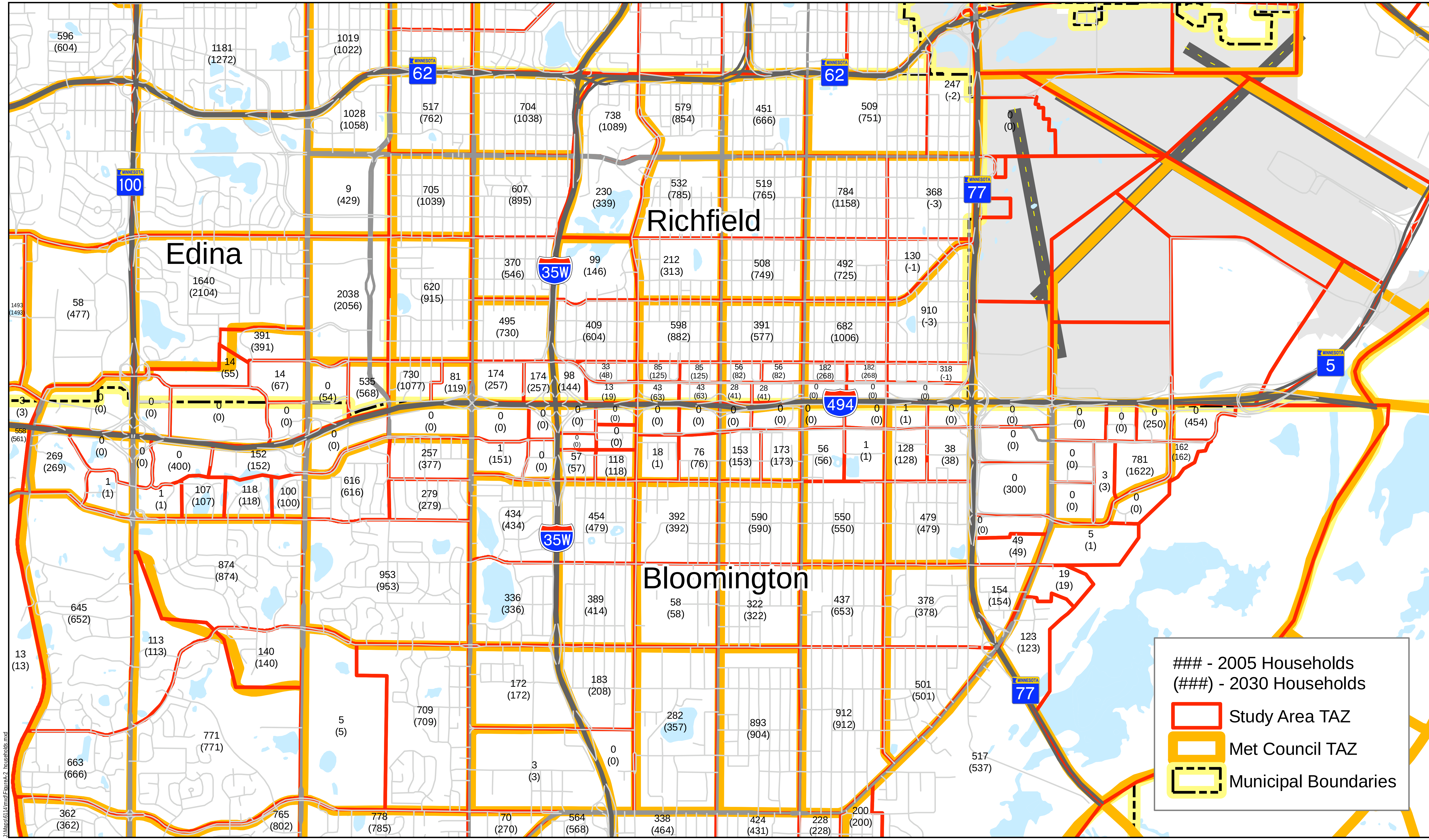


Roadway Improvements

Forecasting & Concept Development I-494 & TH 77

Mn/DOT

Figure A-1

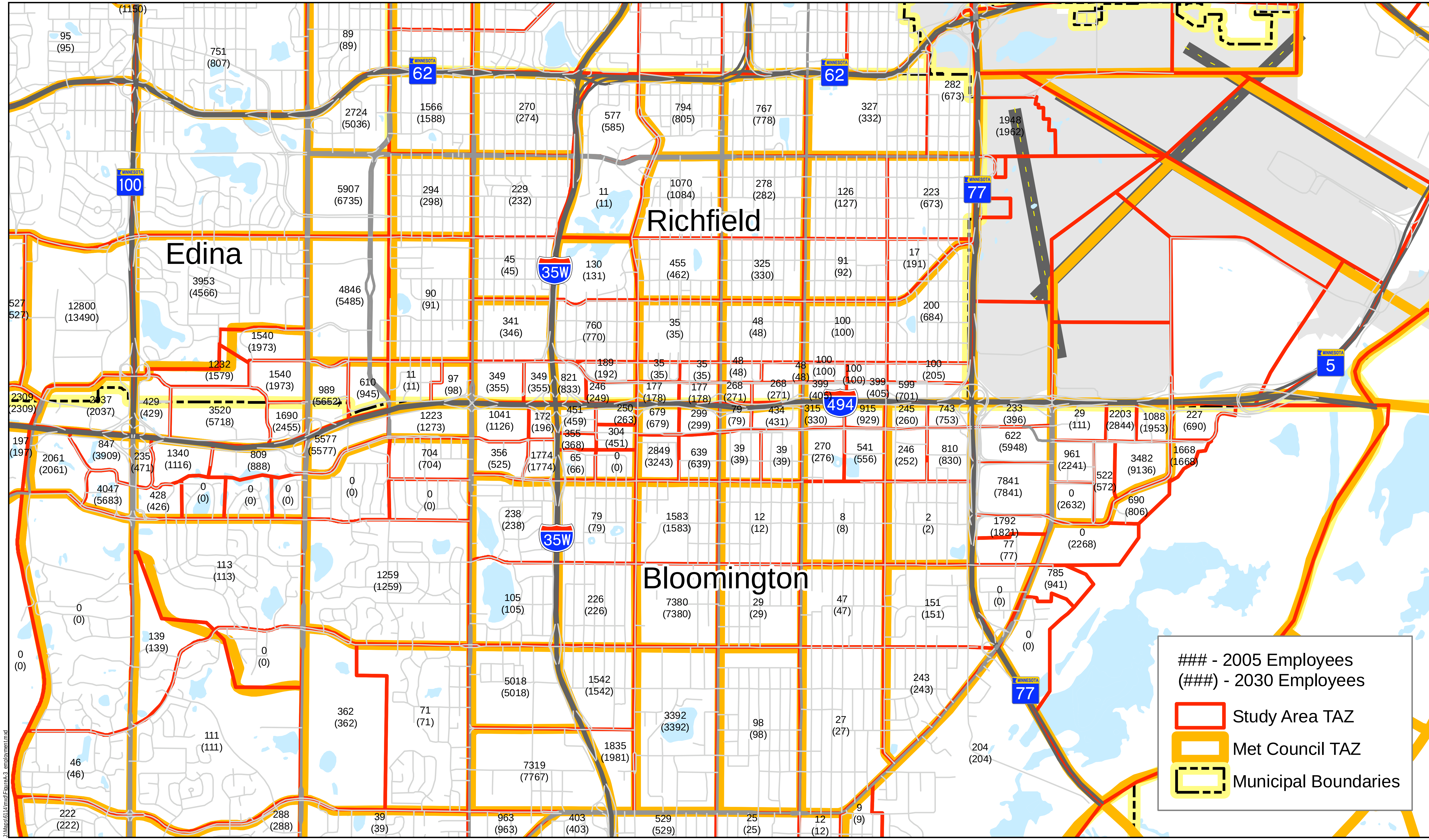


2005 Households and 2030 Households

Forecasting & Concept Development I-494 & TH 77

Mn/DOT

Figure A-2

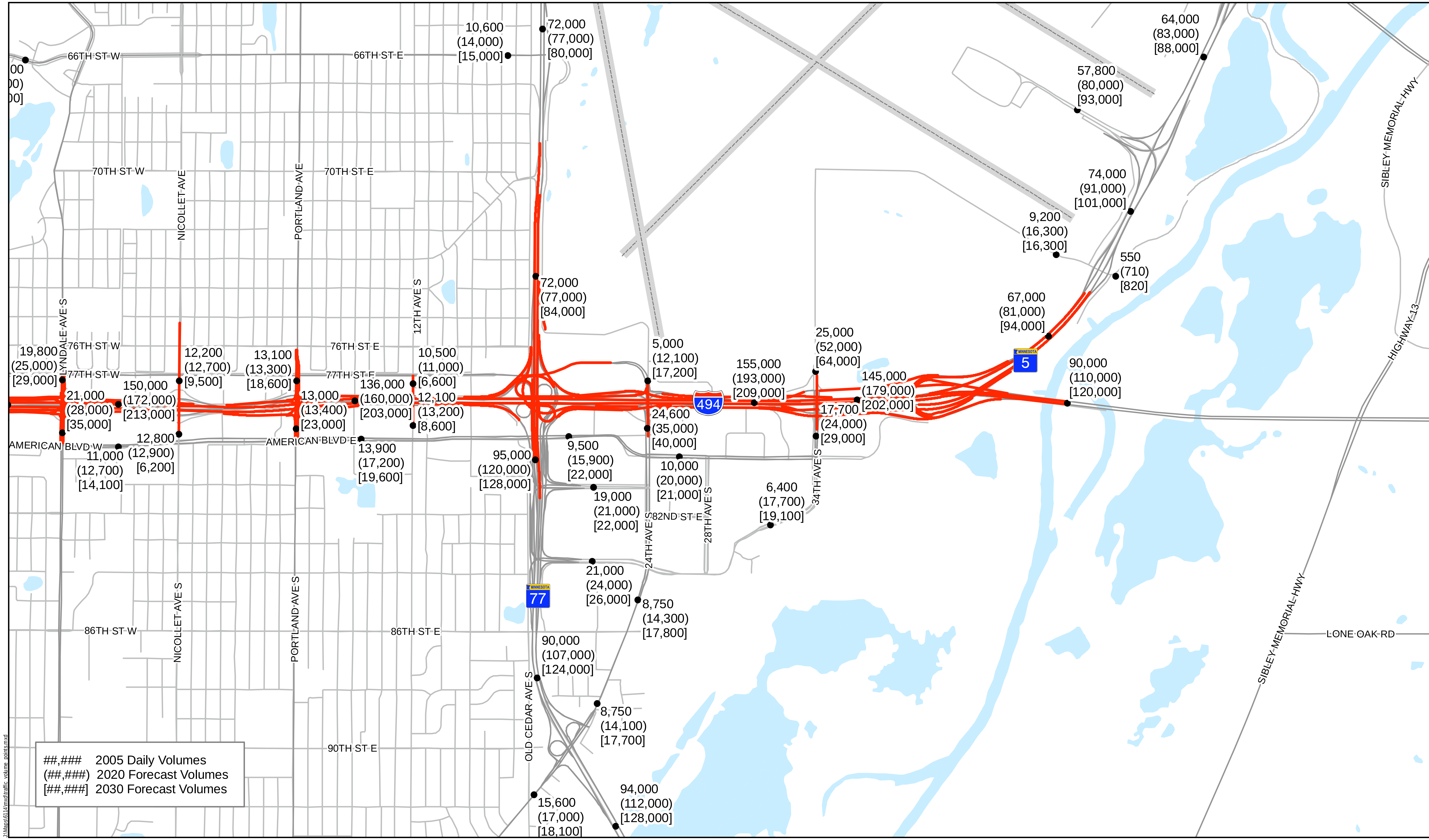


2005 Employment and 2030 Employment

Forecasting & Concept Development I-494 & TH 77

Mn/DOT

Figure A-3

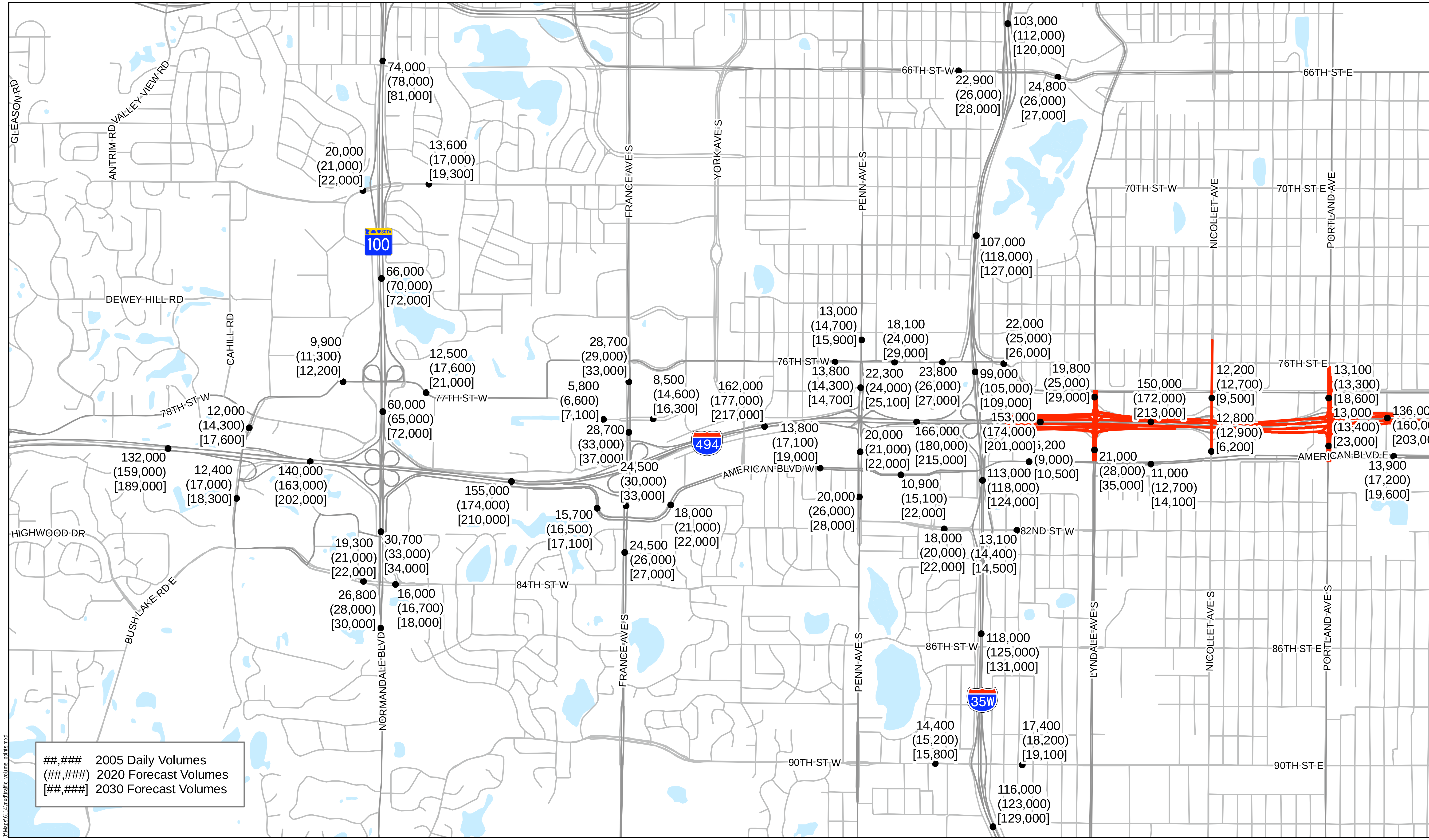


2020 and 2030 Forecast Daily Traffic

Figure A-4

Forecasting and Concept Development I-494 & TH 77

SP 2785-349 Mn/DOT



2020 and 2030 Forecast Daily Traffic

Figure A-5

Forecasting and Concept Development I-494 & TH 77

SP 2785-349 Mn/DOT

APPENDIX B: DAILY TRAFFIC VOLUME SUMMARY

Appendix B

Daily Traffic Volume Summary

Facility	Segment	Year					
		2005	2017	2020	2027	2030	2037
Regional Facilities							
I-494	TH 169 to East Bush Lake Rd	132,000	154,000	159,000	186,000	189,000	195,000
	East Bush Lake Rd to TH 100	140,000	158,000	163,000	200,000	202,000	208,000
	TH 100 to France Ave	155,000	170,000	174,000	207,000	210,000	216,000
	France Ave to Penn Ave	162,000	174,000	177,000	214,000	217,000	223,000
	Penn Ave to I-35W	166,000	177,000	180,000	211,000	215,000	223,000
	I-35W to Lyndale Ave	153,000	170,000	174,000	197,000	201,000	210,000
	Lyndale Ave to Nicollet Ave	150,000	168,000	172,000	210,000	213,000	219,000
	Portland Ave to 12th Ave	136,000	155,000	160,000	201,000	203,000	208,000
	TH 77 to 24th Ave	141,000	162,000	167,000	186,000	192,000	207,000
	24th Ave to 34th Ave	155,000	185,000	193,000	207,000	209,000	213,000
	34th Ave to TH 5	145,000	172,000	179,000	186,000	202,000	239,000
	East of TH 5	90,000	106,000	110,000	118,000	120,000	126,000
I-35W	94th St to 90th St	116,000	122,000	123,000	126,000	129,000	136,000
	90th St to 82nd St	118,000	124,000	125,000	128,000	131,000	139,000
	82nd St to I-494	113,000	117,000	118,000	122,000	124,000	128,000
	I-494 to 76th St	99,000	104,000	105,000	108,000	109,000	112,000
	76th St to 66th St	107,000	116,000	118,000	126,000	127,000	129,000
	66th St to TH 62	103,000	110,000	112,000	119,000	120,000	122,000
TH 5	I-494 to Post Rd	67,000	78,000	81,000	92,000	94,000	99,000
	Post Rd to Glumack Dr	74,000	88,000	91,000	100,000	101,000	104,000
	Glumack Dr to TH 55	64,000	79,000	83,000	87,000	88,000	89,000
TH 77	South of E Old Shakopee Rd	94,000	108,000	112,000	124,000	128,000	137,000
	E Old Shakopee Rd to Killebrew Dr	90,000	104,000	107,000	118,000	124,000	137,000
	Lindau Ln to I-494	95,000	115,000	120,000	128,000	128,000	129,000
	I-494 to Diagonal Blvd	72,000	76,000	77,000	80,000	84,000	92,000
	Diagonal Blvd to 66th St	72,000	76,000	77,000	78,000	80,000	84,000
TH 100/ Normandale Blvd	South of 84th St	26,800	28,000	28,000	29,000	30,000	31,000
	84th St to I-494	30,700	33,000	33,000	34,000	34,000	35,000
	I-494 to 76th St	60,000	64,000	65,000	69,000	72,000	79,000
	76th St to 70th St	66,000	69,000	70,000	71,000	72,000	74,000
	North of 70th St	74,000	77,000	78,000	80,000	81,000	82,000
Local Facilities							
12th Ave	South of I-494	12,100	13,000	13,200	8,400	8,600	9,000
	North of I-494	10,500	10,900	11,000	6,500	6,600	6,900
24th Ave	South of I-494	24,600	33,000	35,000	39,000	40,000	44,000
	North of I-494	5,000	11,500	12,100	16,100	17,200	19,700
34th Ave	South of I-494	17,700	23,000	24,000	28,000	29,000	32,000
	North of I-494	25,000	47,000	52,000	64,000	64,000	64,000
66th St	West of I-35W	22,900	25,000	26,000	27,000	28,000	29,000
	East of I-35W	24,800	26,000	26,000	27,000	27,000	28,000
	West of TH 77	10,600	13,300	14,000	14,700	15,000	15,700
70th St	West of TH 100	20,000	21,000	21,000	22,000	22,000	23,000
	East of TH 100	13,600	16,300	17,000	17,900	19,300	23,000

Facility	Segment	Year					
		2005	2017	2020	2027	2030	2037
76th St	West of TH 100	9,900	11,000	11,300	11,900	12,200	12,800
	East of TH 100	12,500	16,600	17,600	19,600	21,000	24,000
	West of Penn Ave	13,800	14,200	14,300	14,400	14,700	15,300
	East of Penn Ave	18,100	23,000	24,000	28,000	29,000	30,000
	West of I-35W	23,800	26,000	26,000	27,000	27,000	28,000
	East of I-35W	22,000	24,000	25,000	26,000	26,000	27,000
82nd St	West of I-35W	18,000	19,600	20,000	21,000	22,000	23,000
	East of I-35W	13,100	14,100	14,400	14,500	14,500	14,600
84th St	West of Normandale Blvd	19,300	21,000	21,000	21,000	22,000	23,000
	East of Normandale Blvd	16,000	16,600	16,700	17,700	18,000	18,800
90th St	West of I-35W	14,400	15,000	15,200	15,400	15,800	16,800
	East of I-35W	17,400	18,000	18,200	18,800	19,100	19,900
American Blvd	West of France Ave	15,700	16,300	16,500	17,000	17,100	17,400
	East of France Ave	18,000	20,000	21,000	22,000	22,000	23,000
	Xerxes Ave to Penn Ave	13,800	16,400	17,100	18,100	19,000	21,000
	Penn Ave to I-35W	10,900	14,300	15,100	19,300	22,000	28,000
	I-35W to Lyndale Ave	5,200	8,600	9,000	9,100	9,500	10,300
	Lyndale Ave to Nicollet Ave	11,000	12,400	12,700	13,500	13,700	14,100
	Portland Ave to 12th Ave	13,900	16,500	17,200	16,300	16,600	17,400
	TH 77 to 24th Ave	9,500	14,600	15,900	21,000	22,000	25,000
	24th Ave to 28th Ave	10,000	19,000	20,000	21,000	21,000	22,000
East Bush Lake Rd	South of I-494	12,400	16,100	17,000	18,000	18,300	18,900
	North of I-494	12,000	13,800	14,300	17,400	17,600	18,000
East Old Shakopee Rd	West of TH 77	15,600	16,700	17,000	17,900	18,100	18,700
	East of TH 77	8,750	13,000	14,100	17,300	17,700	18,600
	South of Killebrew Dr	8,750	13,200	14,300	17,300	17,800	19,000
	28th Ave to 34th Ave	6,400	16,800	17,700	18,600	19,100	20,000
France Ave	South of American Blvd	24,500	26,000	26,000	27,000	27,000	28,000
	American Blvd to I-494	24,500	29,000	30,000	31,000	33,000	39,000
	I-494 to Minnesota Dr	28,700	32,000	33,000	36,000	37,000	38,000
	North of Minnesota Dr	28,700	29,000	29,000	33,000	33,000	34,000
Glumack Dr	West of TH 5	57,800	76,000	80,000	89,000	93,000	102,000
Killebrew Dr	East of TH 77	21,000	23,000	24,000	26,000	26,000	27,000
Lindau Ln	East of TH 77	19,000	21,000	21,000	21,000	22,000	24,000
Lyndale Ave	South of I-494	21,000	27,000	28,000	34,000	35,000	36,000
	North of I-494	19,800	24,000	25,000	29,000	29,000	30,000
Minnesota Dr	West of France Ave	5,800	6,400	6,600	7,000	7,100	7,500
	East of France Ave	8,500	13,400	14,600	15,900	16,300	17,100
Nicollet Ave	South of I-494	12,800	12,900	12,900	6,000	6,200	6,600
	North of I-494	12,200	12,600	12,700	9,300	9,500	9,900
Penn Ave	South of American Blvd	20,000	25,000	26,000	27,000	28,000	29,000
	American Blvd to I-494	20,000	21,000	21,000	22,000	22,000	23,000
	I-494 to 76th St	22,300	24,000	24,000	24,000	25,100	27,000
	North of 76th St	13,000	14,400	14,700	15,500	15,900	16,700
Portland Ave	South of I-494	13,000	13,300	13,400	23,000	23,000	24,000
	North of I-494	13,100	13,300	13,300	18,300	18,600	19,200
Post Rd	West of TH 5	9,200	14,900	16,300	16,300	16,300	16,300
	East of TH 5	550	680	710	790	820	900

APPENDIX C: TRAVEL DEMAND MODELING PROCESS

APPENDIX C: TRAVEL DEMAND MODELING PROCESS

Travel forecasts were prepared using a modified version of the travel demand models developed and approved by the Metropolitan Council and the Minnesota Department of Transportation. These models are computerized procedures for systematically predicting travel demand changes in response to development and transportation facility changes.

These models, used primarily for major project planning efforts, are calibrated and validated at a level of accuracy sufficient for planning regional facilities such as freeways and major arterials. This provides sufficient accuracy for most regional and corridor-level planning. The models were completed in 2004 using data from an extensive Regional Travel Behavior Inventory (TBI) conducted by the Metropolitan Council and Mn/DOT in 2001. These forecasts include modifications made by the Metropolitan Council as of November 2005.

The procedure used to simulate and forecast travel patterns is a complex battery of input data and computer processes that transform data into representations of travel. The process uses the standard “four-step” approach to travel forecasting with sequential generation, distribution, mode choice, and assignment models. The models use stand-alone FORTRAN-language modules developed for the Twin Cities as well as the Cube Voyager travel forecasting software.

The main components of the travel forecasting process are shown in Figure C-1 and are described below. Detailed documentation of the model parameters is available from the Metropolitan Council.

Highway Network Representation

All of the freeways, expressways, and major arterial roadways in the Twin Cities area are compiled into a computer representation of the region’s highway system. In addition, most minor arterials, many collector roads and other local streets are included. The attributes of the roadways are described in terms of area type, facility type, distance, free-flow speed, number of lanes, and capacity.

The regional network was prepared using values for speed and capacity by area type and facility type based, in part, on speed studies conducted as part of the 2001 Regional Travel Behavior Inventory. These values are shown in Table C-1.

Transit Network Representation

All regional transit routes are included in a computer representation of the transit system. The transit network defines the transit system in terms of links (which represent the highway system) and lines (which define a transit route’s frequency and path). Data in the transit network include link speed, link distance, route frequency, and route type.

FIGURE C-1
TRAVEL DEMAND FORECASTING PROCESS

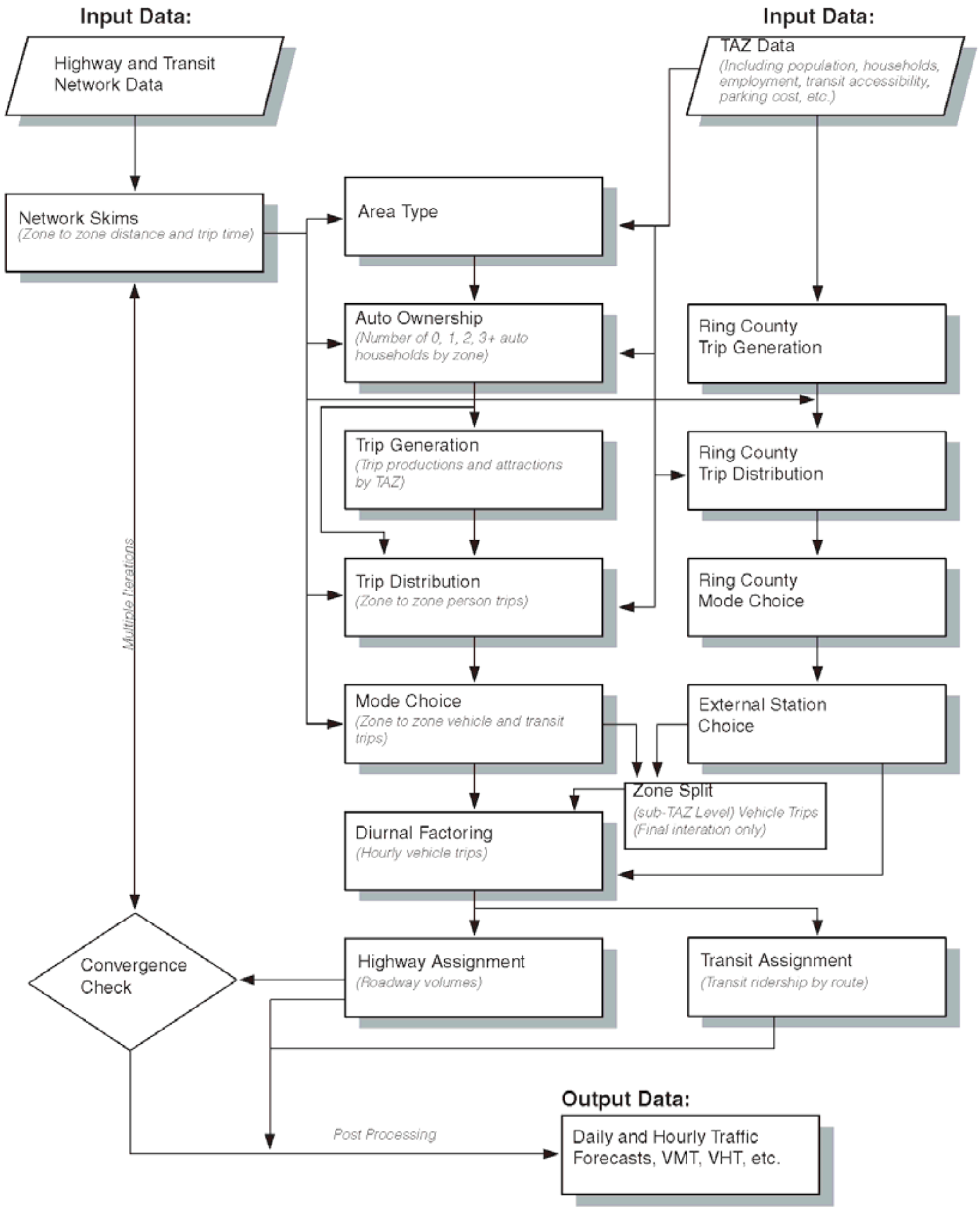


TABLE C-1
REGIONAL MODEL DEFAULT SPEEDS AND PER-LANE CAPACITIES

Facility Type		Area Type					
		Rural	Developing	Developed	Residential Core	Business Core	Outlying Business District
Metered Freeway	Capacity	1950	1950	1950	1950	1950	1950
	Speed	110 Percent of Posted Speed					
Unmetered Freeway	Capacity	1750	1750	1750	1750	1750	1750
	Speed	110 Percent of Posted Speed					
Metered Ramp	Capacity	750	725	675	625	600	600
	Speed	37	37	36	35	35	39
Unmetered Ramp	Capacity	1500	1450	1350	1250	1200	1200
	Speed	37	37	36	35	35	39
Divided Arterial	Capacity	1000	950	850	750	700	700
	Speed	59	42	33	27	23	31
Undivided Arterial	Capacity	900	850	750	650	600	600
	Speed	55	39	31	24	22	30
Collector	Capacity	600	550	500	450	400	400
	Speed	51	34	30	23	22	28
HOV Lane	Capacity	1400	400	1400	1400	1400	1400
	Speed	110 Percent of Posted Speed					
HOV Ramp	Capacity	NA	1450	1350	1250	1250	1250
	Speed	37	37	36	35	35	39
Centroid Connector	Capacity	NA	NA	NA	NA	NA	NA
	Speed	23	23	23	23	23	23

Source: Metropolitan Council

Zonal Data Representation

The regional models divide the seven-county Twin Cities Metropolitan area into 1,201 geographic transportation analysis zones (or TAZs). The thirteen ring counties are divided into 365 TAZs. Various demographic and socioeconomic data are allocated into these zones for the purposes of the forecast models. The main exogenous data are population, household, retail employment, and non-retail employment. The zones also serve as the beginning and end locations of travel in the region. In addition to the 1,566 zones, the 35 most important interface points between the seven-county core and the thirteen-county ring are identified and included as “external” zones. The 31 most important points of entry into the twenty-county region are included as “perimeter” zones. The zonal system was determined primarily on the basis of physical boundaries and major roadways.

Socioeconomic inputs for the regional model are currently developed outside the travel demand forecasting process. Documentation on the methodology used to generate these inputs is available from the Metropolitan Council. Modifications to the base zonal data are discussed in a subsequent section.

Trip Generation

Trip generation is the process by which the number of trips attributed to a zone is estimated based on the amount and type of activity in that zone. Trips are either "produced" by or "attracted" to a zone, depending on the type of trip. Each trip has two ends. Trips either beginning at a household or ending at a household are considered to be produced by that household. Trips are attracted to non-residential activities such as workplaces, shopping areas, universities, or airports.

The end result of trip generation estimation is a total number of trips produced by and attracted to each zone. The trips at this point are called "person-trips" and do not have any association with a given mode of travel.

The determinants of household trip production are household size, household income, the number of automobiles owned, and location. Several factors contribute to trip attractions, depending on the trip purpose. The main factors are retail employment, non-retail employment, and the amount of activity within a given proximity and area type.

The trip generation phase of the forecasting process uses trip rates (i.e., number of trips per person, household, or employee) based on the 2001 regional TBI applied to each zone to calculate the number of trips taken, by purpose (home-based work, shopping, grade school, work-related, and other, and non home-based work and other). Trip generation in the ring counties employs only three trip purposes (home-based work, home-based other, and non home-based).

Within the trip generation model are two socio-economic sub-models: an employment density-based parking model and an income/household size related auto ownership model.

Destination Choice

The destination choice process converts the person-trips estimated in the generation step to movements between pairs of zones based on the amount of travel activity in a zone and the generalized travel time proximity of the producing zone to other zones. The resulting trip tables provide the number of trips between zones. Trip tables are calculated for each trip purpose (stratified by auto-ownership and also by income for home-based work trips) for both peak and off-peak travel.

A discrete choice model is the backbone of the destination choice process. This process distributes trips from each production zone to attraction zones based on the relative utility, or attractiveness of each attraction zone. Attractiveness is a function of the number of attractions in the zone, level of service (distance, travel time by different modes, travel cost of different modes, parking cost), and location (area type).

The generic destination choice model does not fully account for all trip distribution patterns. Other factors influence destination selection such as reluctance to cross a geographic barrier, tax-favorable residential area, or a "prestigious" shopping district. The Twin Cities destination choice model is calibrated to include adjustment coefficients, or "K-factors" to account for these other factors between forty-three internal districts in the seven-county area.

Certain major destinations (such as universities, colleges, MSP airport, and regional malls) have different distribution patterns than other internal trips. Trips are distributed to these “special generator” locations first in the trip generation step, and the productions associated with these trips are removed from their respective zones before trip distribution.

Mode Choice

The mode choice phase of the regional model uses a nested discrete choice model to identify the number of person-trips between each pair of zones and determine whether the trips are made by single-occupant vehicles, carpools, priced lane users, or transit riders. The model is further used to determine if a trip is a candidate for a high-occupancy vehicle lane or a tolled lane.

External Station Choice

The external-station choice model connects trips between the core seven-county area and the ring county area. It uses a discrete choice model to identify an external station for each trip that enters, exits, or passes through the seven-county area. It then splits each trip into a ring county trip (between the external station and either a ring county TAZ or a perimeter station) and a core county trip (between the external station and a core county TAZ).

Temporal Distribution

The time-of-day or temporal distribution model takes the estimated daily vehicle trips and distributes them across periods of time in order to accurately reflect peaking conditions on the roadway system. The basis for the temporal distribution is the 2001 regional TBI. Twenty-four time periods ranging in length from 30 to 120 minutes have been established to represent a 24-hour day. Differentiation among peak hours results in better estimates of congested conditions throughout the day and more accurate assignment of highway volumes (discussed in the next section).

Highway Assignment

The highway assignment model selects the route between zones for each trip. The process identifies routes based on travel times that reflect the appropriate traffic volume, roadway capacity, and speed relationship. This is known as a user-equilibrium model, where multiple iterations are used to balance demand with capacity, thereby reflecting the impacts of capacity constraints on routes and travel times.

The model will permit a demand in excess of capacity. Capacity in the Twin Cities area is generally defined at Level of Service D, therefore assignment of demand above capacity indicates Level of Service E or F. The delay functions in the model are link-based, meaning the effect of intersection delays and long backup queues are not fully represented.

Trips for each of the twenty-four previously mentioned time periods were assigned separately, and later combined to produce a peak-period and daily highway assignment.

Model Iterations

The regional model is run under an iterative process. Congested highway travel times are estimated by the highway assignment process, and then cycles back through the previous steps of the model. Congested travel times affect trip generation, destination choice, and mode choice and adjustments are made to successive iterations.

The method of successive averages (MSA) technique was used to estimate congested travel times for each iteration. This technique involved taking the weighted volumes from previous iterations for each link, calculating a new weighted average including the current iteration, recalculating congested travel times, then using those times in the subsequent iteration. The model is run until acceptable convergence is reached, which was set to two percent for this study.

APPENDIX D: FORECAST REASONABLENESS CHECKS

Table D-1

Traffic Forecast Reasonableness Checks

AM Peak Hour Percentage and Directional Distribution Comparison

Facility	Segment	Existing (2005)							2030							Growth Factor	
		Two Way			EB		WB		Two Way			EB		WB			
		Daily	Peak	% of Daily	Peak Hour	Dir %	Peak Hour	Dir %	Daily	Peak	% of Daily	Peak Hour	Dir %	Peak Hour	Dir %	Forecast	Historic
I-494	France Ave to Penn Ave	175,000	13,185	7.5%	6,515	49%	6,670	51%	217,000	16,920	7.8%	8,420	50%	8,500	50%	1.24	1.29
	Lyndale Ave to Nicollet Ave	150,000	11,080	7.4%	5,700	51%	5,380	49%	213,000	15,890	7.5%	7,910	50%	7,980	50%	1.42	1.37
	24th Ave to 34th Ave	165,000	12,440	7.5%	6,095	49%	6,345	51%	209,000	13,150	6.3%	6,770	51%	6,380	49%	1.27	1.66
	East of TH 5	90,000	7,350	8.2%	3,020	41%	4,330	59%	120,000	10,460	8.7%	4,480	43%	5,980	57%	1.33	1.89

PM Peak Hour Percentage and Directional Distribution Comparison

Facility	Segment	Existing (2005)							2030							Growth Factor	
		Two Way			EB		WB		Two Way			EB		WB			
		Daily	Peak	% of Daily	Peak Hour	Dir %	Peak Hour	Dir %	Daily	Peak	% of Daily	Peak Hour	Dir %	Peak Hour	Dir %	Forecast	Historic
I-494	France Ave to Penn Ave	175,000	12,135	6.9%	5,585	46%	6,550	54%	217,000	21,230	9.8%	9,810	46%	11,420	54%	1.24	1.29
	Lyndale Ave to Nicollet Ave	150,000	11,830	7.9%	6,085	51%	5,745	49%	213,000	19,910	9.3%	9,510	48%	10,400	52%	1.42	1.37
	24th Ave to 34th Ave	165,000	13,010	7.9%	6,075	47%	6,935	53%	209,000	17,400	8.3%	7,760	45%	9,640	55%	1.27	1.66
	East of TH 5	90,000	7,210	8.0%	3,665	51%	3,545	49%	120,000	13,370	11.1%	6,870	51%	6,500	49%	1.33	1.89