Appendix C: Travel Demand Modeling for the Norman CTP

Overview

The City of Norman is developing a Comprehensive Transportation Plan to provide the framework for the planning and implementation of an efficient and comprehensive multi-modal transportation system within Norman, as shown in Figure 1 below. The Comprehensive Transportation Plan (CTP) will assess and address transportation deficiencies and needs, recommend a prioritized list of capital improvements, and identify policies and programs to assist in the implementation of needed projects. To help with the identification of roadway deficiencies and the assessment of proposed improvements, one of Alliance's tasks was to refine and apply the Oklahoma City Area Regional Transportation Study (OCARTS) travel demand model. The resulting Norman subarea model network was used to forecast year 2035 traffic demand, pinpoint anticipated system deficiencies, and quantify the mobility benefits of proposed roadway improvement scenarios.

The memorandum describes the steps taken to determine the validity of the model, ensure model forecasts are reasonable, and confirm the model could be utilized as a useful planning tool. The memorandum also serves as documentation for coding error corrections and all build-scenario related network improvements.

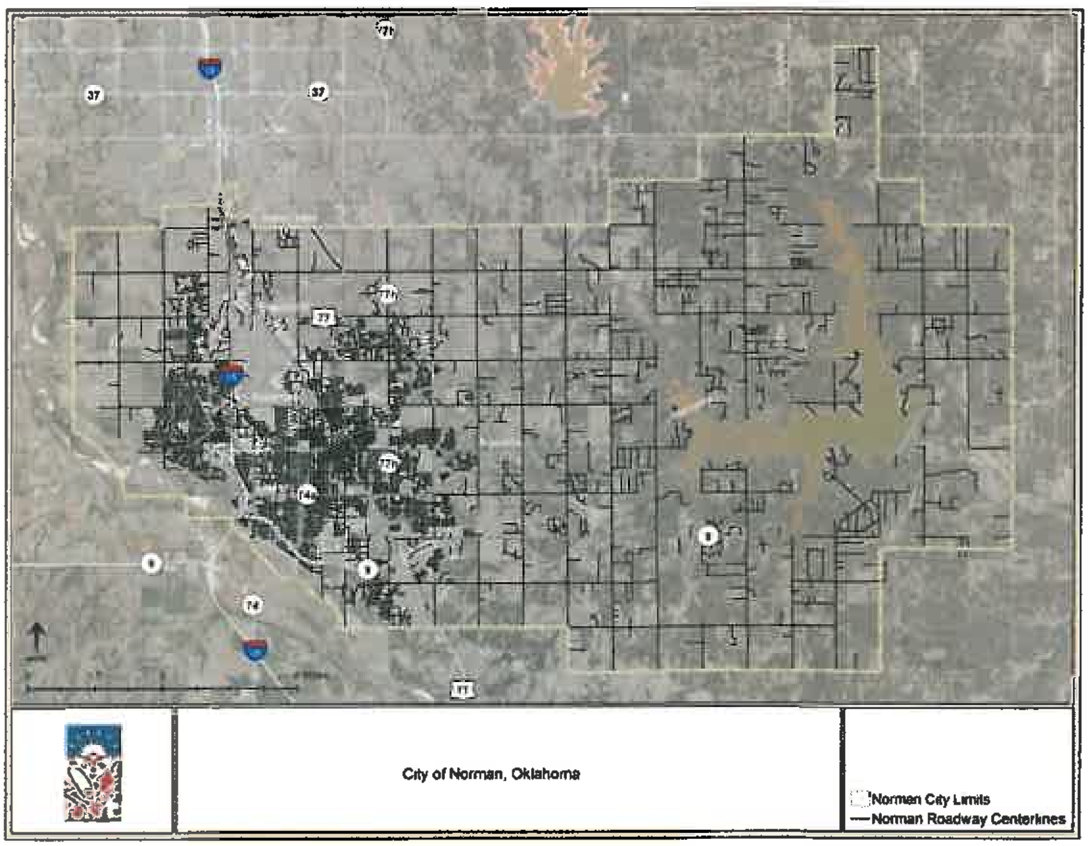


Figure 1: Map of City of Norman - Study Area

Model Setup

In order for a travel demand model forecast to be judged as plausible, the model must be able to produce reasonable traffic volumes. The processes and techniques used to determine the reasonableness of traffic volumes for a model's base year are termed model calibration and validation. They are data heavy processes, and the quality of the traffic counts used in the calibration and validation steps largely influence the validity of and confidence in the modeled volumes. However, since the Norman-specific subarea model was based on an already calibrated and validated regional travel demand model, the validation process for the Norman CTP project was limited in scope.

Source Materials

The City of Norman is located within the Oklahoma City metropolitan area, where the Association of Central Oklahoma Governments (ACOG) is the agency responsible for the planning and programming of regionally significant and federally funded transportation improvements. As the Metropolitan Planning Organization (MPO) for the region, ACOG had developed and utilized a travel demand model that encompasses portions of four central Oklahoma counties - Canadian, Grady, Logan, and McClain, all of Oklahoma County, as well as the full extent of Cleveland County, where the City of Norman is located.

Travel Demand Model Structure

A travel demand model forecasts traffic volumes based upon the relationship between socioeconomic characteristics, including population, (demand) and the transportation system (supply). The same general four steps are found in most travel demand models developed for an urban area: Trip Generation, Trip Distribution, Mode Share, and Multi-Modal Traffic Assignment, which can have a feedback loop for trip distribution through assignment.

Trip Generation

Trip Generation is the first of the four primary steps in the travel demand model process. By definition, a person trip is a person traveling from one place to another for a defined purpose. Consequently, trip generation is closely related to both the characteristics of a place and a person. Socioeconomic attributes of each traffic analysis zone (TAZ), including the population and employment counts, are utilized by the Trip Generation model to determine the number of trips produced by and attracted to each TAZ. The result of the Trip Generation step is a set of trip productions and trip attractions for each TAZ by trip purpose. These productions and attractions are used to populate a seed matrix that is passed to the trip distribution step.

Trip Distribution

Trip Distribution is the second step of the traditional four step model, which identifies the production zone and attraction zone of a trip generated in the Trip Generation Model based on the trip length frequency distribution.

The ACOG TDM applies the trip length frequency distribution through the use of a traditional Gravity Model that distributes trips according to characteristics of land use and the transportation system in the study area. Trip distribution is expressed as the number of trips traveling between any zone pair as a function of the magnitude of the total productions and attractions in the two zones and the travel impedance between them, which included a generalized cost component that applied a composite impedance based on travel time, travel cost, and other factors. The roadway network attributes describe the transportation system characteristics used to measure travel impedance (e.g. distance, travel time, etc.). The model can be mathematically stated as:

$$T_{ij} = P_i \times \frac{A_j \times F_{ij}}{\sum_k A_k \times F_{ik}}$$

Where:

T_{ij} = forecast flow produced by zone i and attracted to zone j

P_i = the forecast number of trips produced by zone i

A_j = the forecast number of trips attracted to zone j

F_{ik} = friction factor between zone i and zone k (F-Factors)

Travel time is used as the measurement of separation between zones for the purposes of applying the Gravity Model, with trip lengths measured in minutes.

Mode Share

Mode Share is the third step in the travel demand modeling process. Mode Share (sometimes also called Mode Choice) models are used to separate the various person trips identified in the trip distribution step into different modes based upon fixed proportions derived from available survey data, which identified nine different modes (Drive Alone, Shared Ride with 2 people, Shared Ride with 3+ people, Walk to Local Bus, Walk to Premium Bus, Walk to Street Car, Drive to Local Bus, Drive to Premium Bus, and Drive to Street Car). The Mode Choice estimation in the ACOG model was based on the specifically designed household travel and onboard transit surveys that collected information on household income, number of vehicles, and number of persons with driver's licenses. For the transit mode, origin-and-destination information, in-vehicle transit time, access time, wait time, transfer time, and different transit fares were also taken into account. The final Mode Share estimation was further broken out by trip purpose.

Assignment

The Assignment of traffic to the highway network is the final step in the traditional modeling process. It estimates the flow of traffic on a network. The roadway assignment methodology employed by the ACOG TDM is an Equilibrium Assignment model. The procedure incorporates the use of a generalized cost function to address composite time and economic factors, such as the treatment of toll facilities. The transit assignment procedure estimates transit ridership for all available transit routes and was calibrated against known passenger-mile statistics, boarding, alighting, and transfer activities.

The ACOG TDM includes six passenger trip purposes and two commercial vehicle and freight truck trip purposes. The passenger trip purposes are stratified by four household sizes and five income groups. These stratifications result in multiple separate matrices to be assigned in the traffic assignment step.

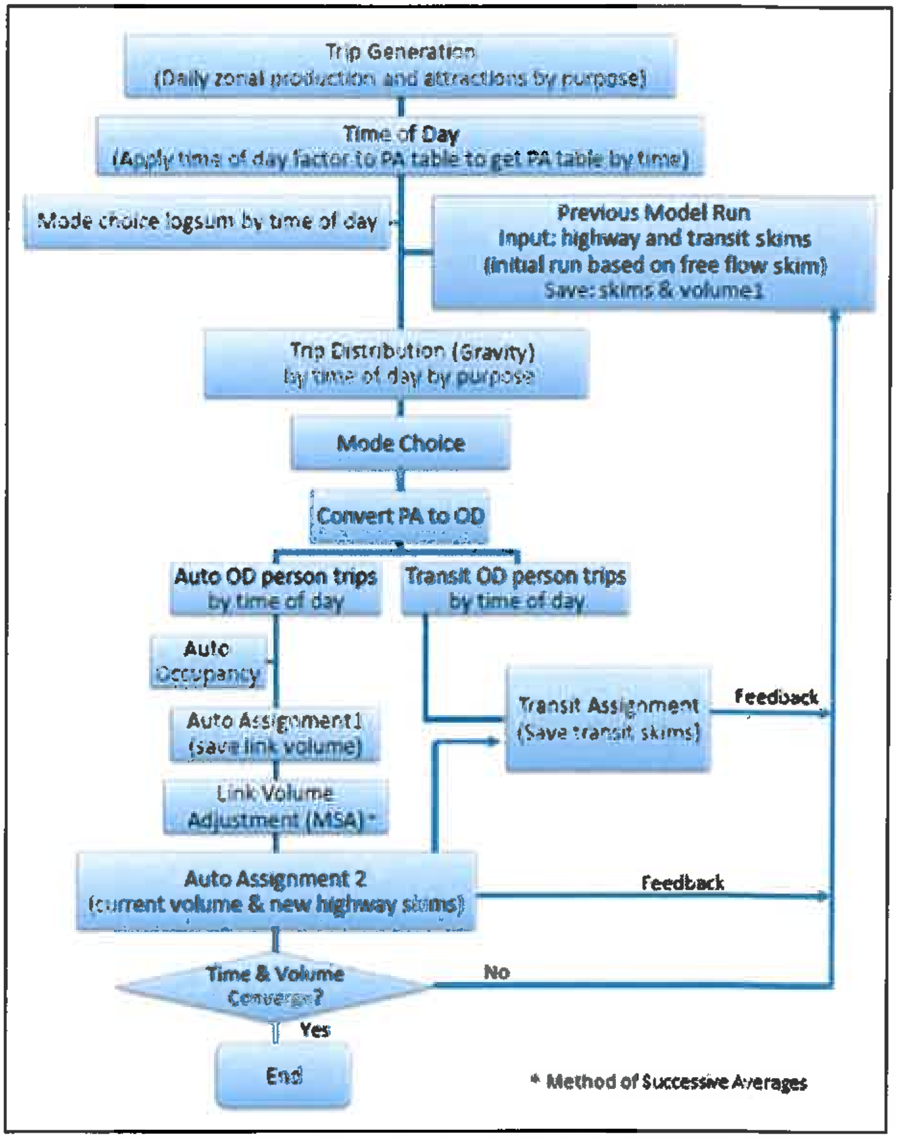
Feedback Loop – The ACOG model contains a feedback loop from traffic assignment to trip distribution. The purpose of a feedback loop is to take congested travel times from the assignment process and supply them for the next iteration of trip distribution to better replicate actual travel conditions for each time period analyzed in the model, which increases the speed and reliability of traffic assignment. During each iteration, a comparison of assigned traffic volumes to previous iterations is performed using the Method of Successive Averages (MSA). The feedback loop will iterate until the convergence criterion is met.

Time of Day

Urban area models commonly produce trips by time of day to increase accuracy. Typical time of day stratifications include either two time periods (a peak and an off-peak period) or four time periods, as used in the ACOG model, where trip distribution was separated into the following four time-of-day periods:

AM – Morning Peak – 7 to 9 a.m.
MD – Midday Off-Peak – 9 a.m. to 3 p.m.
PM – Evening Peak – 3 to 6:30 p.m.
NT – Nighttime Off-Peak – 6:30 p.m. to 7 a.m.

To summarize the overview of the model design, **Error! Reference source not found.** depicts the model flow chart, which shows how passenger trips go through trip generation, distribution, mode choice, and subsequent assignment. The feedback loop from assignment back to trip distribution is also depicted.



PA = Production/Attraction; OD = Origin/Destination

Model Data

The two basic model data building blocks of any travel demand model are the transportation system networks and the socioeconomic data by traffic analysis zones (TAZ).

- The networks represent the multimodal transportation system, and account for different categories of roads (such as freeways, arterials, collectors, ramps, etc.), along with their respective information on facility speed, capacity, travel time from zone to zone, and user cost expressed as tolls or operating cost.
- The TAZs are the geographical areas that link socioeconomic data and land uses with the transportation system. The demographic characteristics of the TAZs are tied to the transportation system using zonal centroids and their associated centroid connectors.

The network and zonal densities should be consistent in order to produce realistic loading of traffic onto the model network. (For additional information regarding the review of the TAZ structure and the base year model network, please refer to the copy of the initial Technical memorandum on the subject, placed at the end of this appendix.)

Networks

The ACOG model did not use a multiyear network for the analysis of travel demand in the Central Oklahoma area; instead, the MPO developed a 2005 base and several 2035 horizon year alternate transportation networks to assist with the forecasting of various transportation scenarios. ACOG's 2005 base year network was provided and subsequently tested in Alliance's dedicated travel demand model lab to ensure that the model processes performed as expected. (Validation information is listed in the following subchapter.) ACOG's Alternate 4, also called 'Encompass 2035' network, is the approved long-range transportation scenario, which was used as a benchmark for comparison with the anticipated Norman-specific model runs.

Alternate 2, ACOG's 'Updated Existing-Plus-Committed (E+C)' network was chosen as the base for City of Norman-specific build scenarios for the 2035 forecast year. Alternate 2 included all regional projects either built, under construction, or with committed funding by September 2010, which provided the ideal starting point for the development of an up-to-date E + C model network for the City of Norman, containing all projects either built, under construction, or with funding committed by April 2013.

Socioeconomic Data

Apart from the roadway and transit networks included in the regional model, another key input to travel demand modeling is socioeconomic data, which for the Norman CTP included 2005 estimates and 2035 projections for population, household, school enrollment, and employment data by traffic analysis zone. Employment estimates and projections were divided into retail and non-retail categories to better capture trip patterns associated with different employment sites. This socioeconomic information was provided by traffic analysis zone, which serves as the primary geographic layer. The ACOG model works with a total of 2450 TAZs, of which 230 are used to describe the City of Norman demographics.

The ACOG-provided socioeconomic 2035 forecast data was analyzed for reasonableness and compared to additional information obtained from the City of Norman. A workshop, which was attended by staff from the consultant team, ACOG, and the City, the Norman, was conducted early in the project in order to evaluate the socioeconomic input data. Future land use was determined to have been adequately represented in the projected ACOG socio-economic data, with the exception of the University North Park development. Specifically, the forecasted employment growth of the University North Park development prompted further analysis, and ultimately resulted in an adjustment of underlying employment and population data for TAZ 2154. (For details, please refer to the description of the development of the "Enhanced E+C" network contained in a later section of this report.)

Model Calibration and Validation

The ability of the travel demand model to forecast future year traffic and other travel behaviors is based on their ability to estimate "known" traffic volumes and travel patterns under base year conditions for which extensive data is available. There are two components to the process of matching model results to the observed base year travel data - calibration and validation.

Calibration

During the model calibration, parameter values are adjusted until the predicted travel matches the observed travel within the region for the base year. Parameters usually addressed during calibration are as follows:

- Trip attraction function, which matches trip attractors, i.e. retail and non-retail establishments, households, or schools with their appropriate number of trips by purpose using the socioeconomic variables as parameters and calibrating coefficients from the household travel survey; the trip attractions are also balanced to the trip productions for each trip purpose;
- Trip distribution, utilizes a gravity-based distribution methodology, which matches trip purpose distribution and modeled trip length to observed trips; and
- Volume delay function, which accounts for roadway and intersection delays by facility class and area type (i.e. CBD, urban, suburban, and rural), taking into account available roadway capacity and intersection control, to best simulate traffic assignments on the model network.

Alliance Transportation Group (Alliance) was instrumental in the original calibration and validation of the base-year network when the regional travel demand model was developed. At that time, Alliance used specifically designed and collected household travel surveys, onboard transit surveys, and regionally collected traffic counts to ensure that the highway and transit assignments were within acceptable ranges of reasonableness in comparison to observed traffic and ridership.

In the absence of TAZ changes or significantly different count volumes, coupled with the fact that no household travel or onboard transit surveys had been conducted since the initial model development in 2010, the ACOG model was determined to still be calibrated. Therefore, a recalibration of the model was not undertaken as part of the Norman Comprehensive Transportation Plan.

Validation

Following the model calibration, model validation is undertaken to further ensure the forecasting ability of a regional travel demand model. The Federal Highway Administration (FHWA) advises that the results of the travel assignment portion of a travel demand model should "tell a coherent story" about how the network behaves. Two methods essential to validating the model and ensuring that the travel assignments are 'coherent' are reasonableness checking and sensitivity testing.

Validation generally refers to the process of using a calibrated model to estimate travel assignments for the base year and comparing these travel assignments to observed travel data. The typical comparison, when sufficient data is available, is between roadway traffic assignments and actual traffic volumes derived from traffic count data. Extensive traffic counts must be available to validate a model. Validation of the model to counted traffic flows is important to the model effort for two reasons: First, it shows whether the calibration tools used in the model process and the assumptions made were reasonable; and second, the validation shows what level of confidence the user can have in the forecast results.

Reasonableness Checking

While not standard, the Federal Highway Administration (FHWA) and many states have developed targets that can be used to help determine the validity of a travel demand model. Validation measure can be tested against facility type (functional classification), area type, volume ranges, and screen lines. For example, Table 1 shows the percentage target for daily traffic volumes by functionally classified roadway type.

Table 1: Percent Difference Target for Daily Traffic Volumes by Functional Class

Functional Class	FHWA Recommendation
Freeways/Expressways	±7%
Principal Arterials	±10%
Minor Arterials	±15%
Collectors	±25%

Table 2 below shows how well the ACOG model replicates 2005 base year count data by functional classification of the roadway, as analyzed with the following equation.[1]

$$Percent\ of\ Count = \frac{\sum_{j=1}^{n} Modeled_j}{\sum_{j=1}^{n} Counted_j}$$

Table 2: Difference between Observed Counts and Modeled Volumes by Functional Class

Functional Class	Observed Links	Average Observed Count	Aggregate Observed Counts	Average Modeled Volume	Aggregate Modeled Volumes	Difference	FHWA
Freeways/Expressways	188	40,419	7,598,717	41,282	7,761,066	2.14%	±7%
Principal Arterials	1,834	9,420	17,276,460	9,712	17,810,90[illegible]	3.09%	±10%
Minor Arterials	4,054	4,364	17,691,588	4,302	17,440,427	-1.42%	±15%
Collectors	1,181	2,567	3,031,708	2,722	3,214,715	6.04%	±25%
Total			45,598,47[illegible]		46,227,11[illegible]	1.38%	

Source: 2005 Base Year model run results

[1] *j* represents the individual network link with count, *n* is the total number of links with counts in the network for the specific categories.

As mentioned earlier, the targets listed in the table above provide guidance to evaluate the travel demand model. Reviewing the ACOG Base Year model run results, the percent errors for all facility types are within the target ranges, and observed count values and modeled traffic volumes correlate well, which is indicative of the reasonable and reliable traffic forecasting ability of the ACOG model.

Sensitivity Testing

Sensitivity testing refers to using alternative demographic or network data input in order to yield information about the overall behavior of the model. Sensitivity testing is not used to determine whether the model is correct, but rather to assess whether the response from the model in the form of scenario outputs are reasonable based on the inputs provided to the model before further forecasting activities are undertaken. When the model was first developed, Alliance subjected the base year model network to sensitivity testing to ascertain whether or not it would perform as expected when the 2035 forecast year socio-demographic data set was used.

To demonstrate the validated forecasting ability of the travel demand model, staff installed the model components into Alliance's dedicated travel demand model lab and initiated activities related to interpretation and analysis of the provided 2005 and 2035 model alternatives. For that purpose, Alliance tested the assignment procedure for complete functionality of the networks and volume-delay-function components. In particular, Alliance analyzed the Alternative 4 ('Encompass 2035') and Alternate 2 (ACOG's 'Updated E+C') future year scenarios, and prepared several preliminary maps for preliminary review. These maps depicted transportation system characteristics and capacity deficiencies for both alternatives for direct comparison, before beginning with the customization and refinement of the Norman subarea-specific network for the CTP. Figure 2 through Figure 5 on the following pages show the peak-period volume-to-capacity (V/C) ratios for both alternatives.

Alliance staff also compared Encompass 2035 model run results that were produced for sensitivity testing to those received from ACOG, in order to determine that the model performed as originally employed by ACOG, as sometimes differences in model results are introduced by the use of a different travel demand model computer set-up. However, no significant differences were found, which again confirmed that the model performed as desired.[2]

As shown in Figure 6 and Figure 7, Alliance staff also prepared 2005 (Base Year) and 2035 (Alternative 4) starburst diagrams, which show overall trips to and from the Norman subarea to all other parts within the Central Oklahoma region. These diagrams were used to help stakeholders better understand regional travel patterns.

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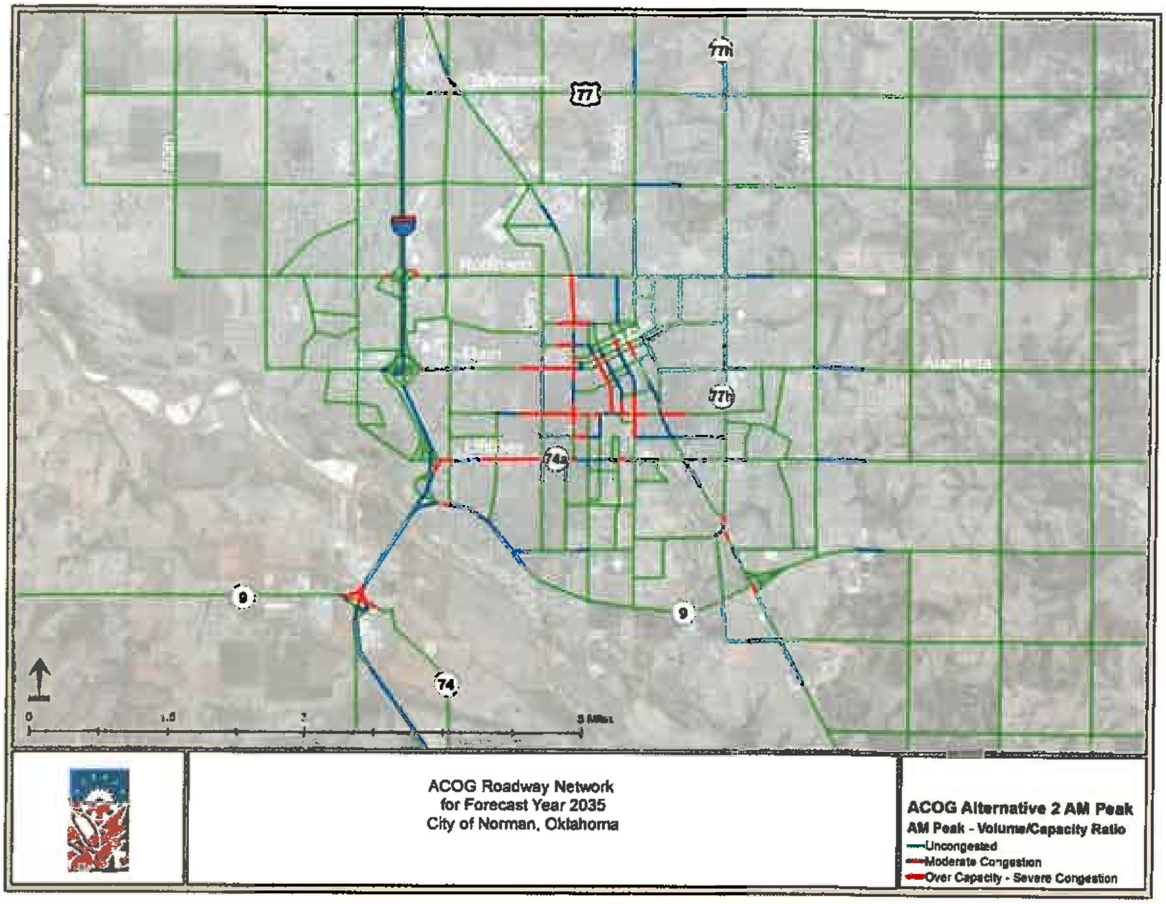
2 Please note: The Alliance-run Encompass 2035 model results were shared with City of Norman staff familiar with the ACOG model. The V/C ratios were depicted separately for the morning and evening peak period, as opposed to showing the post-processed 24-hour V/C ratios that ACOG generally shared with its member entities. This difference in graphic output prompted discussion of the 2035 run results, as well as the ACOG-applied post-processing calculations. These different graphical representations are in no way indicative of differences in the traffic assignment results between the ACOG and Alliance model results. It was determined that using the morning and evening peak-period V/C ratios (instead of 24-hour V/C ratios) would be more helpful in identifying specific roadway deficiencies and improvement needs.

Figure 2: ACOG Alternative 2 – AM Peak Congestion Levels



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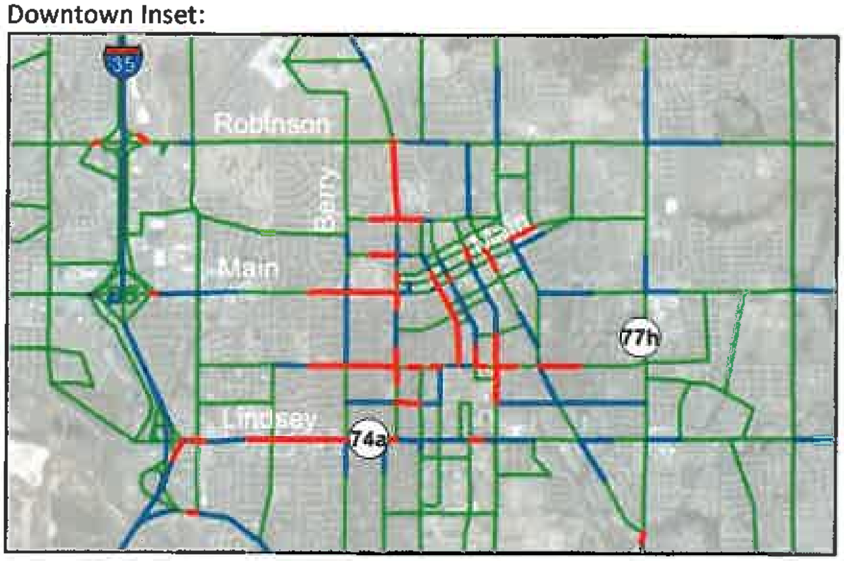
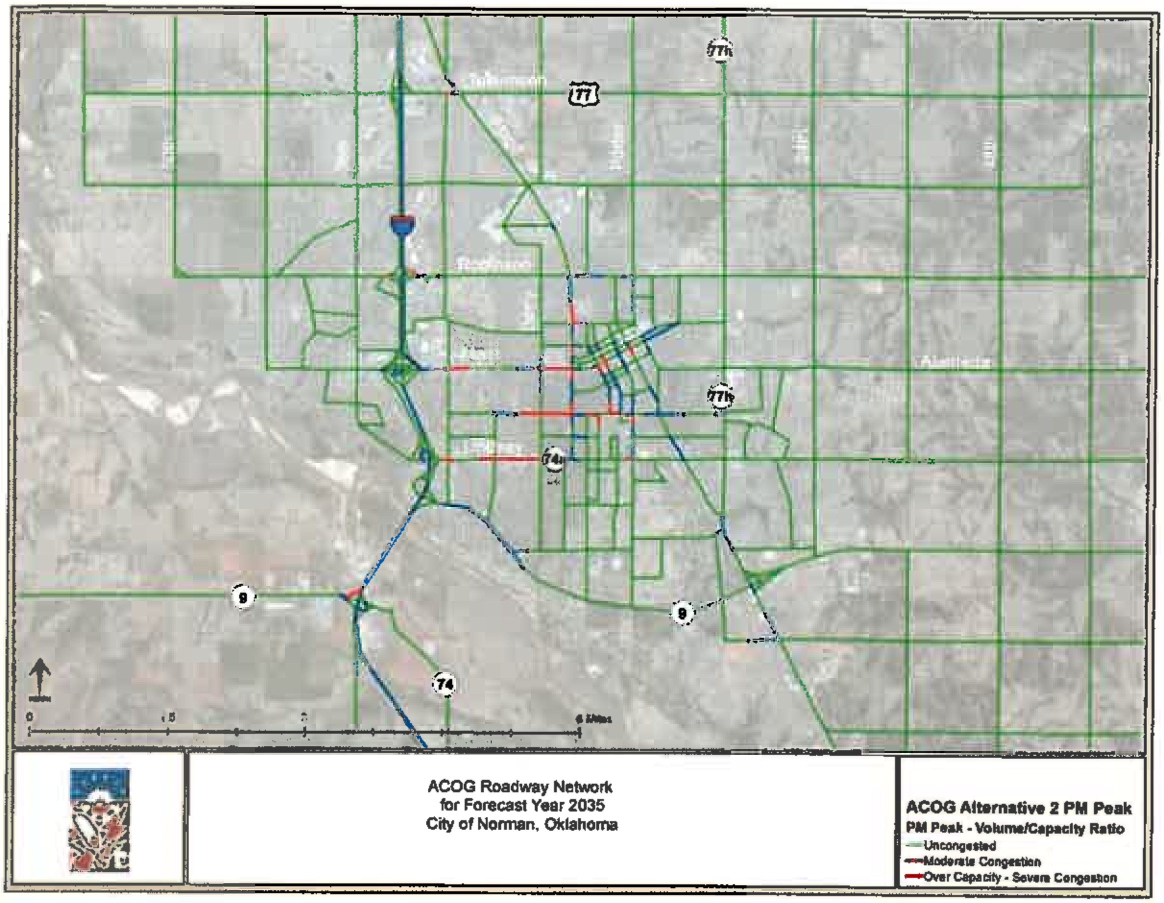


Figure 3: ACOG Alternative 2 – PM Peak Congestion Levels



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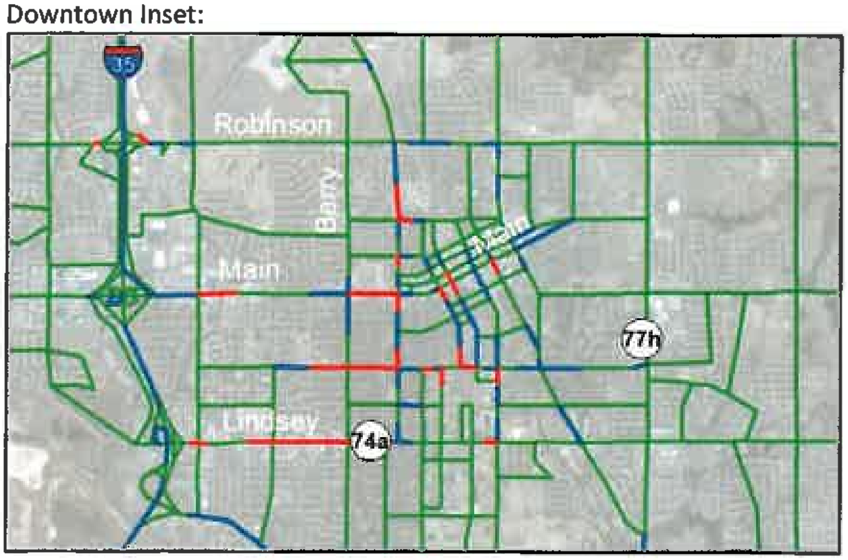
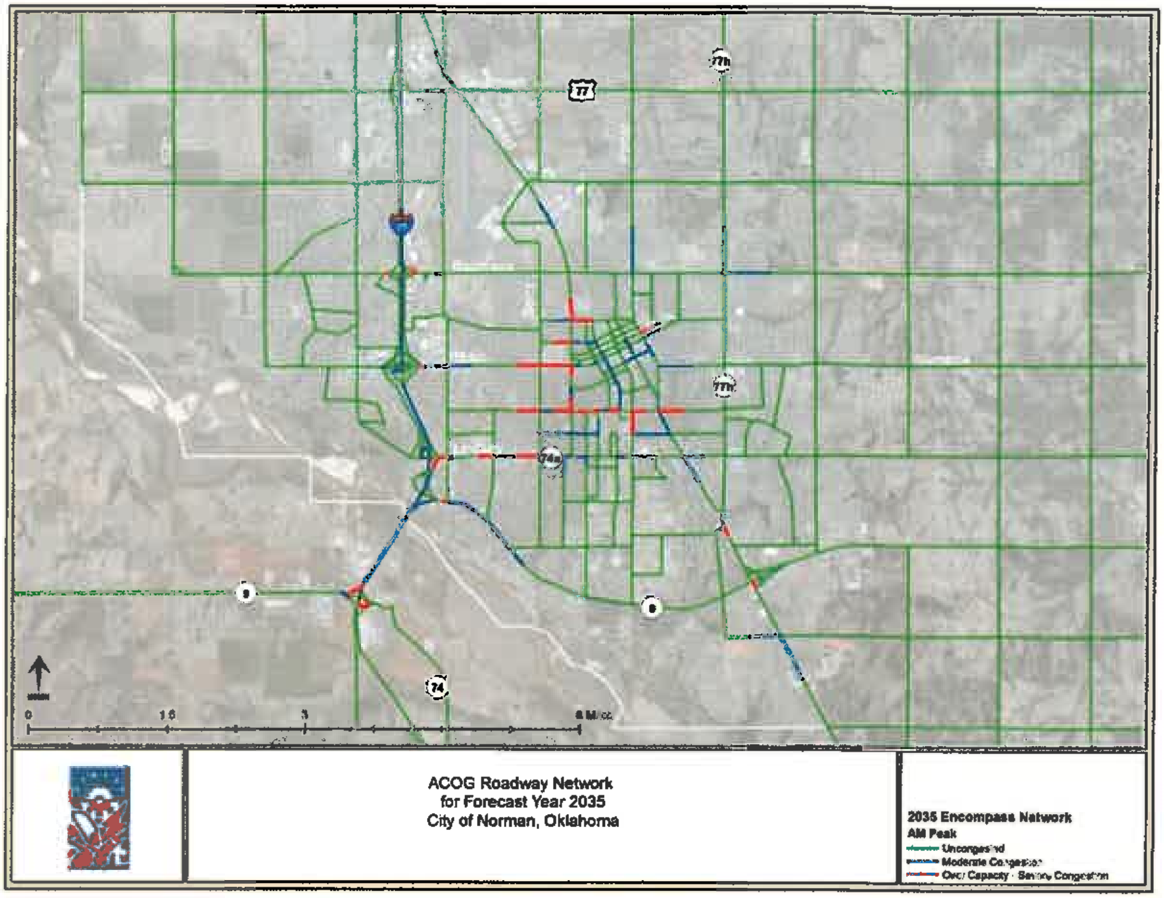


Figure 4: ACOG Encompass 2035 – AM Peak Congestion Levels



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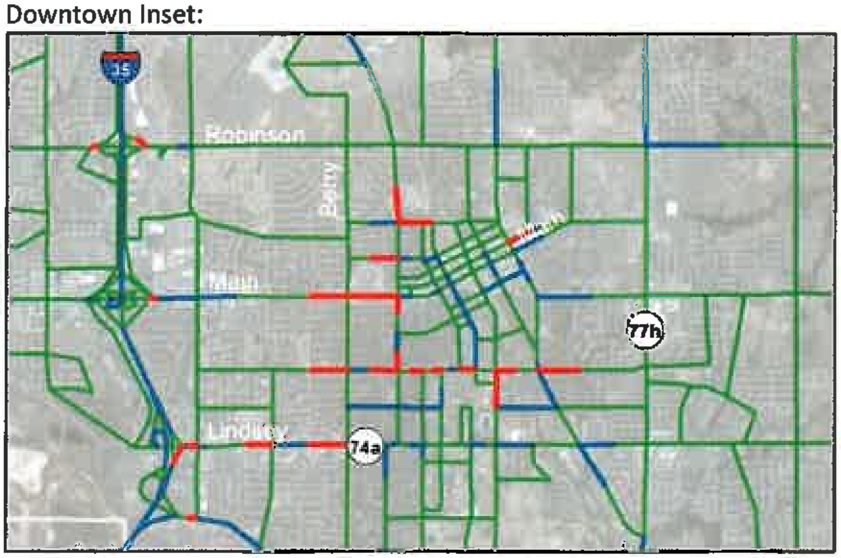
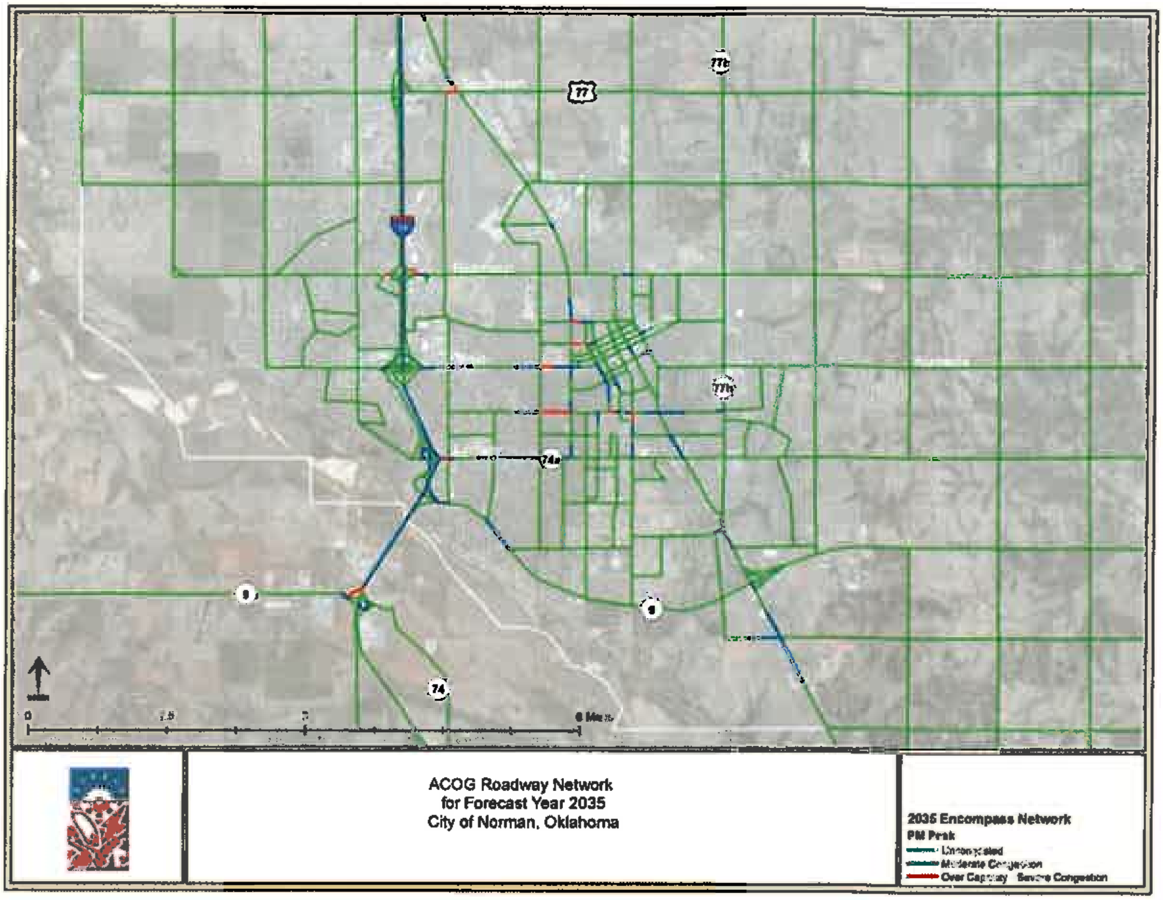


Figure 5: ACOG Encompass 2035 – PM Peak Congestion Levels



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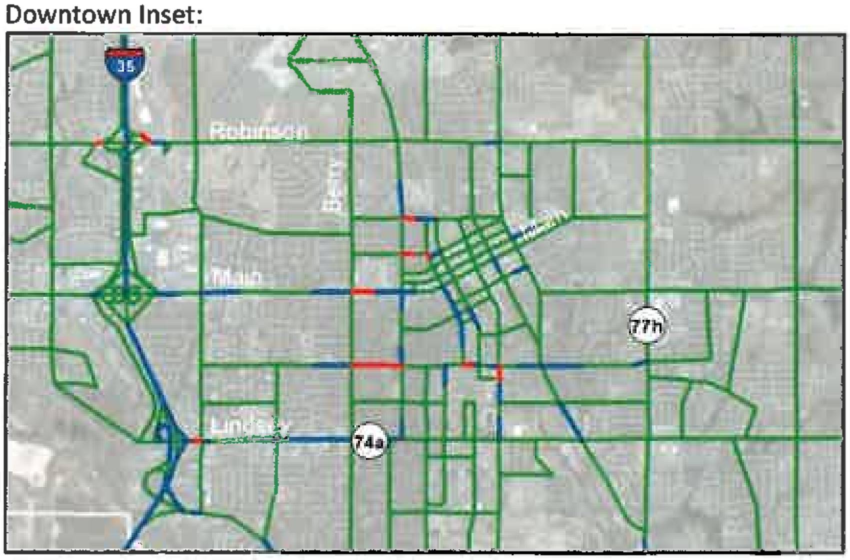


Figure 6: 2005 Regional Travel Patterns to and from the City of Norman

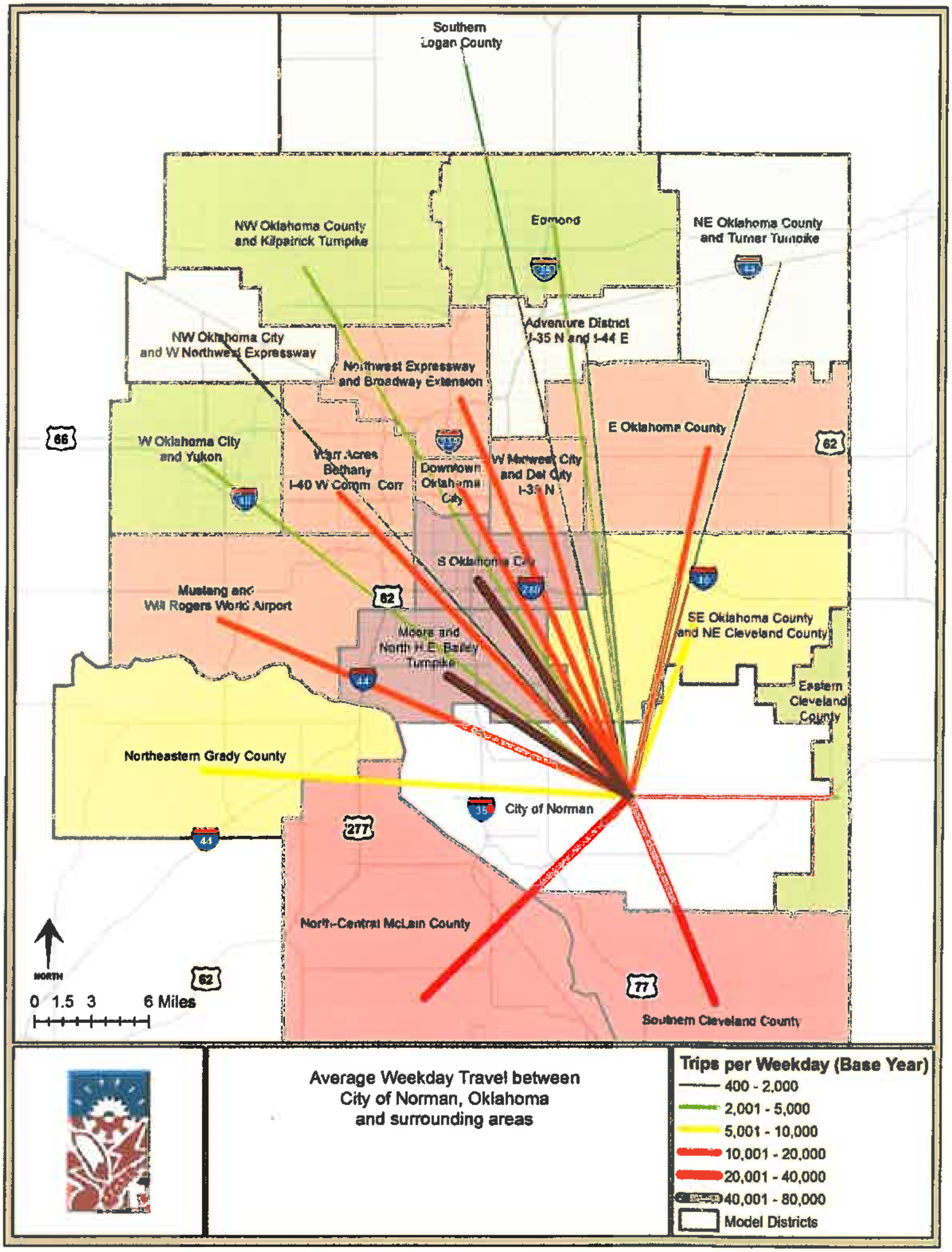
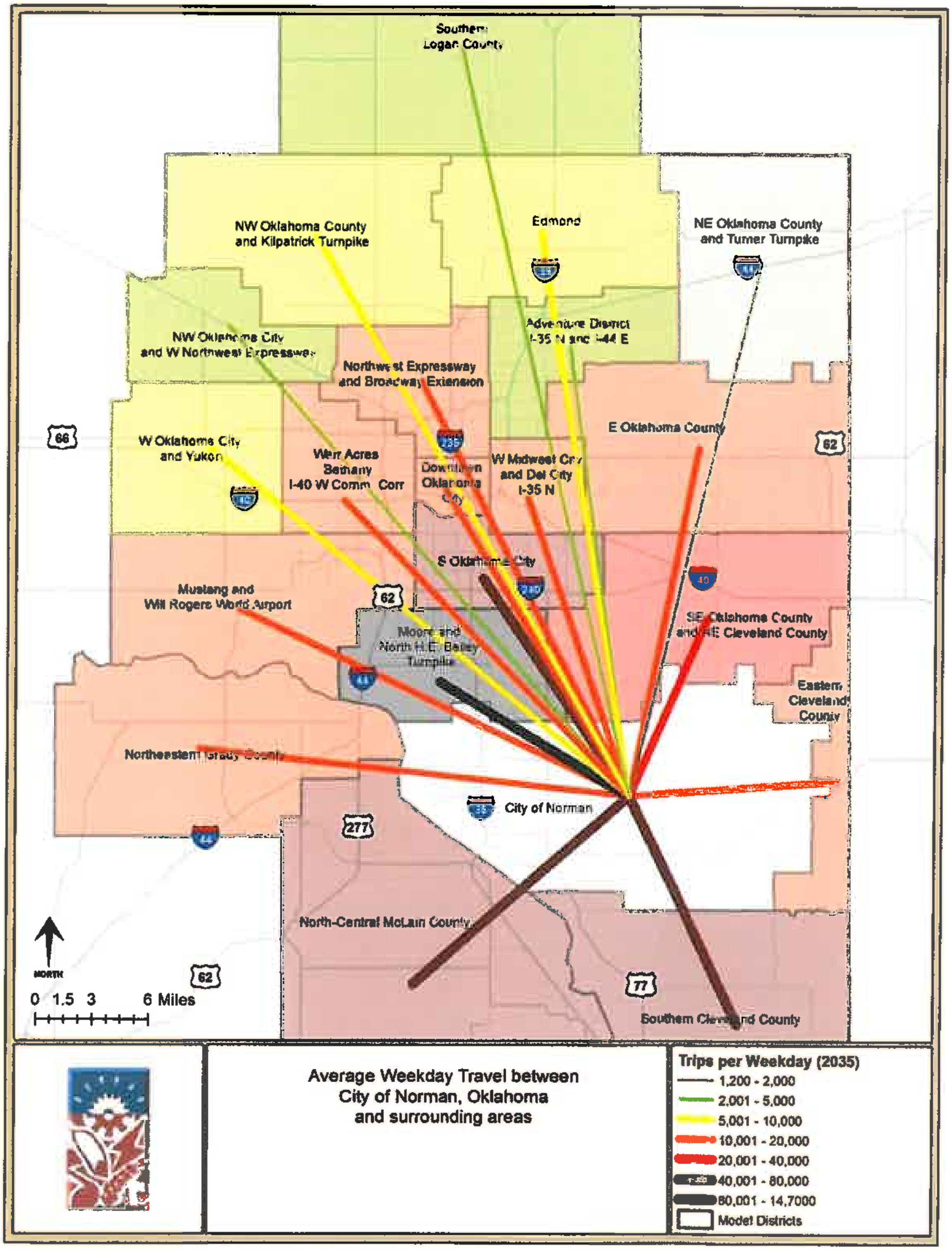


Figure 7: 2035 Regional Travel Patterns to and from the City of Norman



Network Refinements

As discussed in the Validation Section, the ACOG-supplied 2035 model network was deemed to produce a reasonable travel forecast, and the actual network refinement to capture City of Norman-specific projects began.

During a travel demand model update, it is often necessary to update the model network to include changes that may have occurred after the model was originally developed. Modifications to transportation infrastructure are made necessary by the recent addition or removal of projects as outlined in the regional Transportation Improvement Program (TIP), addition of projects receiving bond funding, or completion of transportation infrastructure previously in progress. Additional updates might be necessitated when coding errors are found upon close examination of the network for a particular subarea.

The model used in this effort was originally developed by ACOG in 2010, as part of the development of the OCARTS area long-range transportation plan 'Encompass 2035'. The specific alternative chosen as the starting point for network updates was ACOG's Alternate 2 ('Updated E+C'), which included all regional projects that had either been built, were under construction, or had committed funding in September 2010.

The following subsections describe error correction and project specific model refinements, which were made in order to first provide the most realistic and up-to-date E+C network for the Norman subarea model, which was then used as the basis for the analysis of the future travel patterns within the City of Norman.

Network Errors

An 'error' modification occurs whenever it is necessary to correct mis-coded links. During the research of recently completed projects, and those which would be built in the near-term, several errors were discovered in the ACOG network. Table 3 displays a list of the required network modifications.

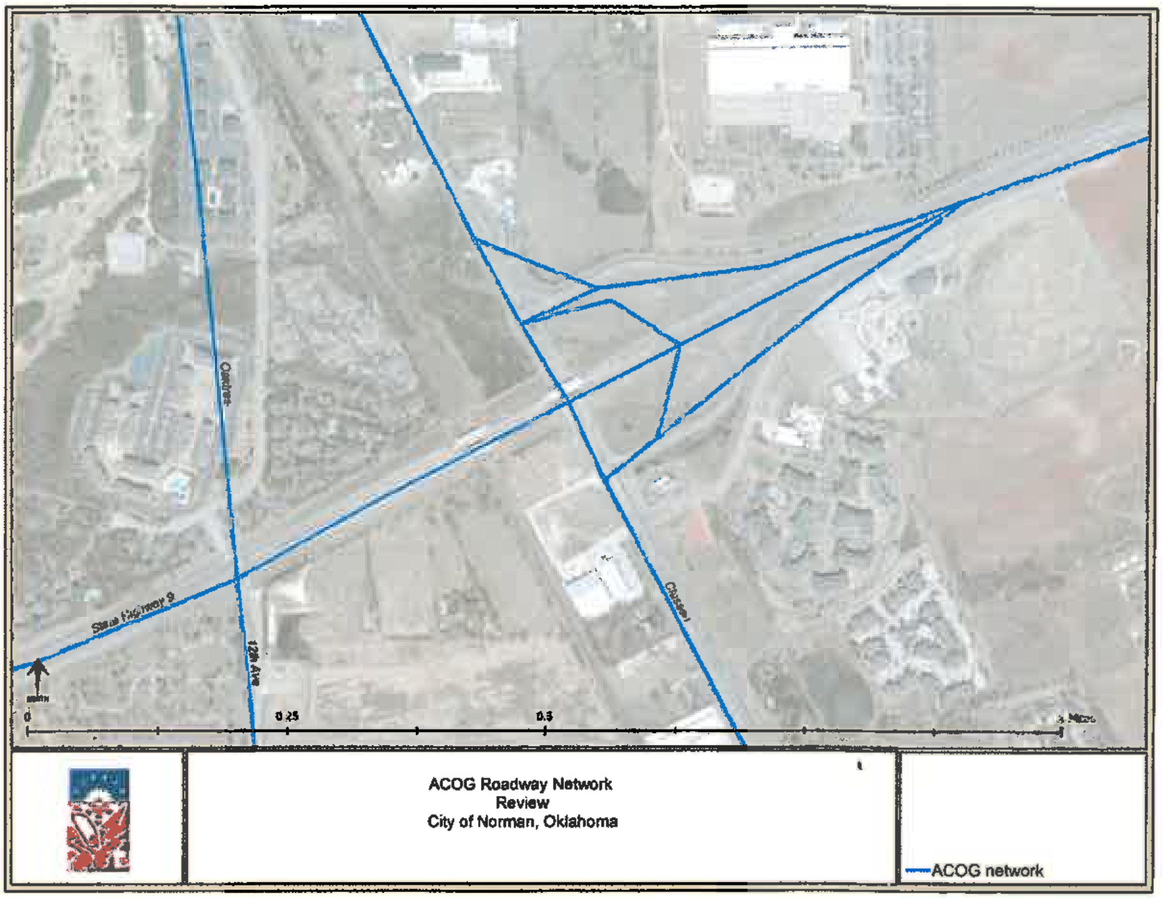
Table 3: Corrected Network Errors

Street	From	To	Shown as	Corrected to	Changed in	Reason
12th Ave SE	E Alameda St	E Boyd St	4	5	Enhanced	Existing configuration
36TH Ave SW	Shadowridge Dr	Ed Noble Pkwy	5	4	Enhanced	Existing configuration; no project pending
E Alameda St	Classen Blvd	Ridge Lake Blvd	4	5	Enhanced	Existing configuration
Chautauqua Ave	W Timberdell Rd	W Imhoff Rd	4	3	Enhanced	Existing configuration; no project pending
Chautauqua Ave	W Imhoff Rd	SH 9	2	4	Enhanced	Existing configuration
Classen Blvd	SH 9	Ash St (Noble)	4	5	Enhanced	Existing configuration
Imhoff Rd	Classen Blvd	1,400 ft east of Classen	3	4	Enhanced	Existing configuration

Street	From	To	Shown as	Corrected to	Changed in	Reason
		Blvd				
Lindsey St	Oakhurst Ave	24th Ave E	4	5	Build	Existing configuration
W Main St	24th Ave W	S University Blvd	4	5	Enhanced	Existing configuration
W Robinson St	Interstate Dr	24th Ave W	4	6	Enhanced	Existing configuration
W Robinson St	Crossroads Blvd	Interstate Dr	2	4	Enhanced	Existing configuration
	60th Ave NW	48th Ave NW	4	2	Enhanced	Existing configuration; no project pending
W Rock Creek Rd	½ mile west of 36th Ave W	36th Ave W	4	2/3	Enhanced	Existing configuration; no project pending
Stubbeman Ave	W Rock Creek Rd	E Robinson St	2	4	Enhanced	Existing configuration
W Tecumseh Rd	I-35	N Flood Ave	2	4	Enhanced	Existing configuration

Furthermore, an error was fixed early on to correct where State Highway (SH) 9 and Classen Boulevard (U.S. Highway [US] 77) had previously been coded with a full interchange instead of a grade separated interchange as shown in the aerial image below.

Figure 8: State Highway 9 and Classen Boulevard – Grade Separation Corrected Network



Not necessarily a coding error, but nonetheless important, was the update of three interstate interchanges. At the time of the original model development took place, interchange project design information needed to code the following projects was not yet available:

- I-35, Main Street Interchange – single-point urban interchange (SPUI)
- I-35, Lindsey Street Interchange – single-point urban interchange
- I-35, SH 9 Interchange – addition of a southbound I-35 off-ramp to SH 9

Figure 9 and Figure 10 show the new and previous interchange coding in comparison for the Main Street and the Lindsey and SH 9 interchanges, respectively.

Figure 9: Main Street Interchange Coding

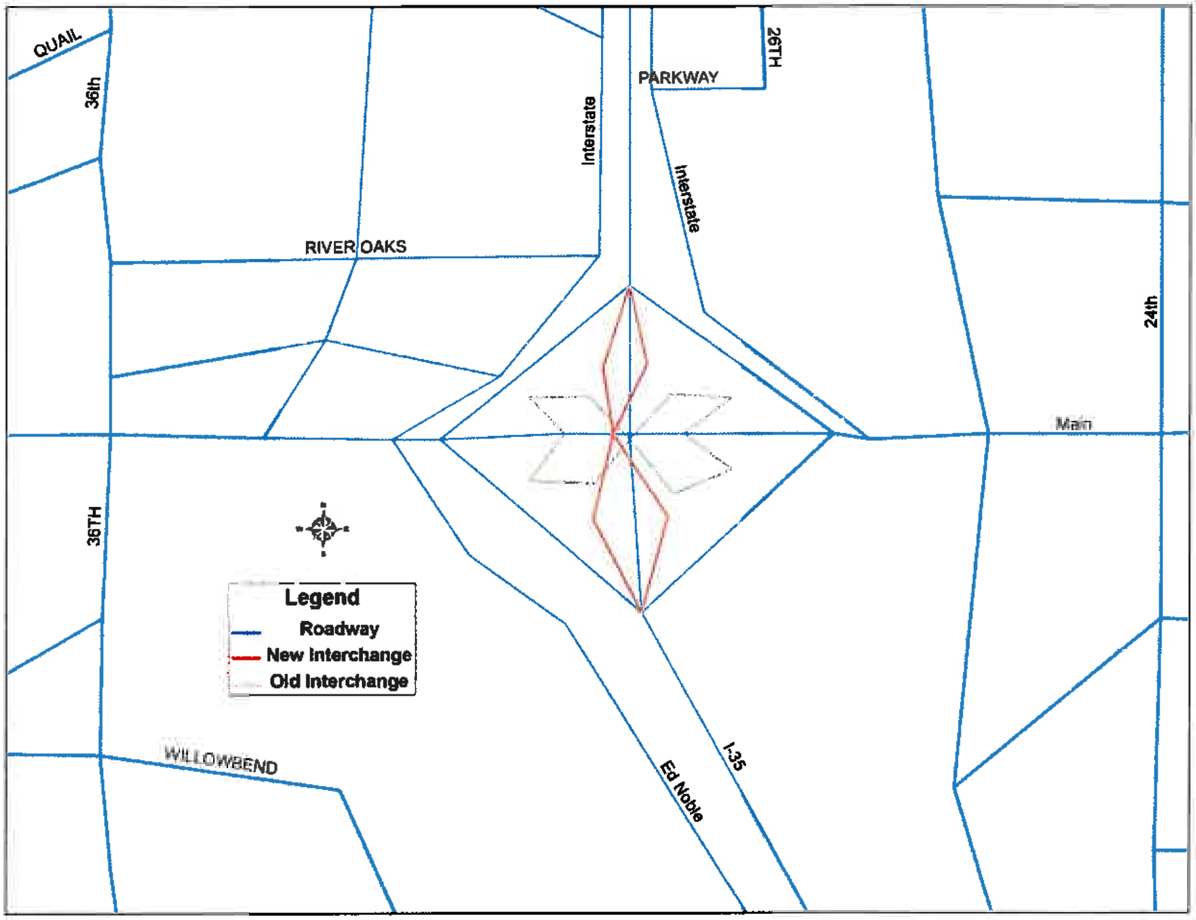
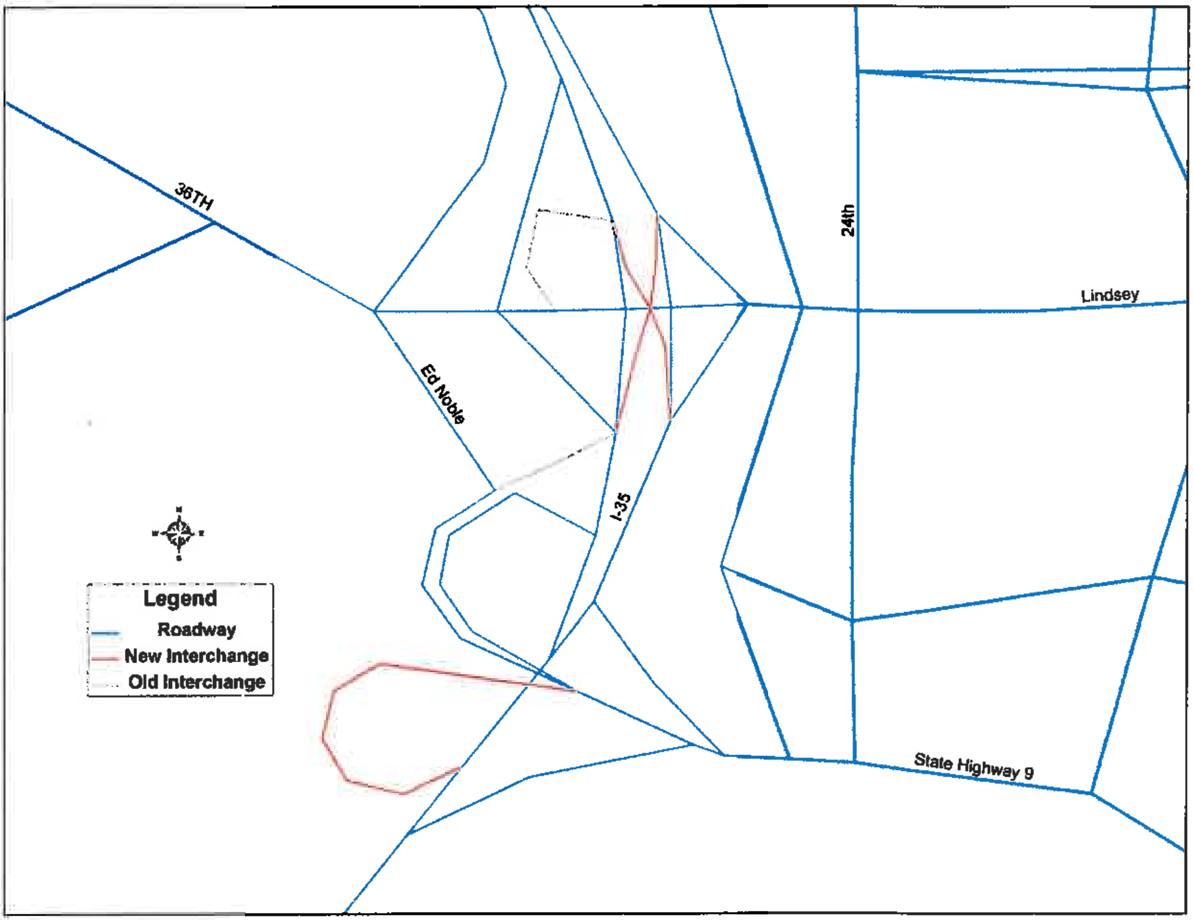


Figure 10: Lindsey Street and State Highway 9 Interchange Coding



Also corrected was the irregular placement of a centroid connector that erroneously crossed 36th Avenue W and connected to Ed Noble Parkway instead. As can be seen in the upper left corner of Figure 10 above, the centroid connector now ties into 36th Avenue W just west of the parkway.

Project-specific Network Updates

Existing-Plus-Committed

ACOG's Alternative 2 network served as the basis for the Norman subarea network, since it included all roadway improvement projects either built, under construction, or with committed funding by September 2010.

The following list of roadway projects was developed in collaboration with City of Norman staff, and includes all of the projects built or committed to be built between 2010 and 2013.

Table 4: Norman Subarea – 2013 E+C Improvements

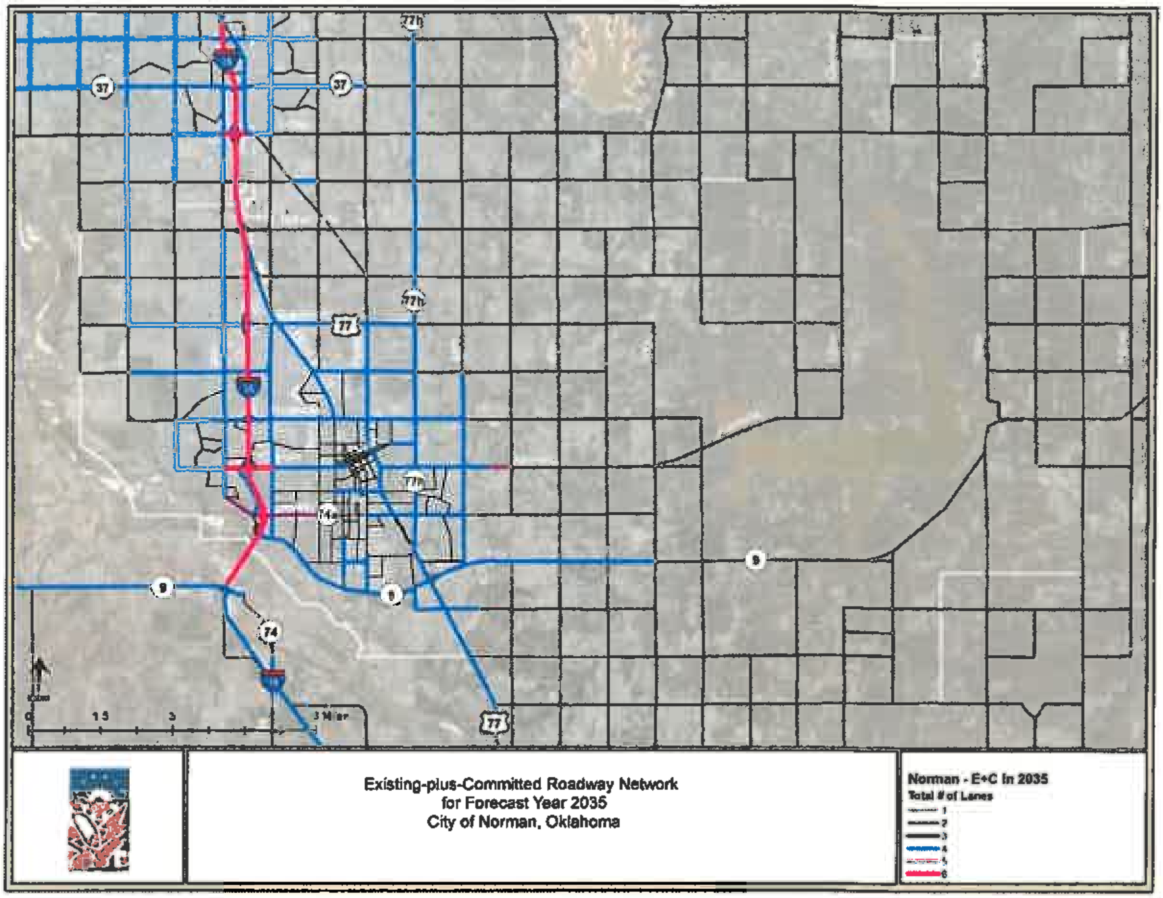
Street	From	To	Improvement
12th Ave E	SH 9	Cedar Lane Rd	Widening from 2 to 4 lanes
24th Ave E	Robinson St	Lindsey St	Widening from 2 to 4 lanes
36th Ave W	Indian Hills Rd	Tecumseh Rd	Widening from 2 to 4 lanes
60th Ave W	Indian Hills Rd	Tecumseh Rd	Widening from 2 to 4 lanes
Alameda St	Ridge Lake Blvd	36th Ave E	Widening from 2 to 5 lanes
I-35	1/2 mile north of Main St	1/2 mile south of Main St	Widening from 4 to 6 lanes
Lindsey St	Jenkins Ave	Classen Blvd	Widening from 2 to 4 lanes
Porter Ave	Tecumseh Rd	Rock Creek Rd	Widening from 3 to 4 lanes
Rock Creek Rd	36th Ave W	24th Ave W	Widening from 2 to 4 lanes
Rock Creek Rd	Porter Ave	12th Ave E	Widening from 2 to 4 lanes
SH 9	24th Ave E	72nd Ave E	Widening from 2 to 4 lanes

These projects were coded into the Norman subarea Existing-plus-Committed (E+C) network.

Model Results

Figure 11 through Figure 14 show the Norman subarea E+C network and associated TDM run results for the 2035 horizon year. Figure 13 and Figure 14 show high levels of peak period congestion occurring on Flood, University, Main, Boyd, and Lindsey.

Figure 11: Norman E+C Network – Number of Lanes



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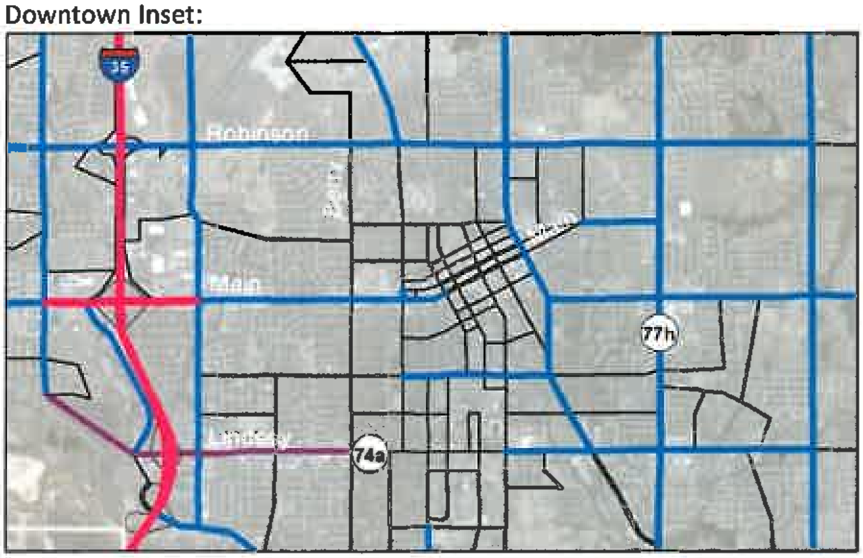
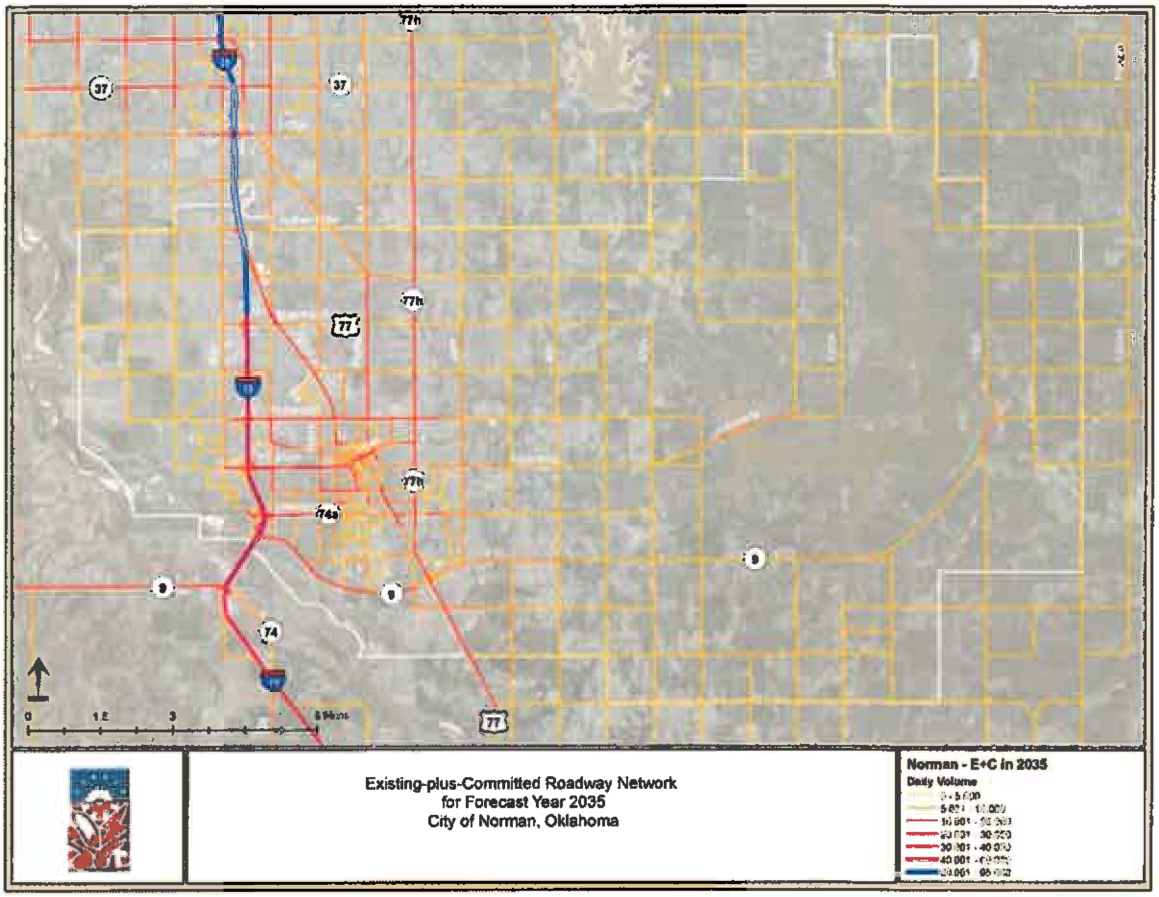


Figure 12: Norman E+C Network – Daily Directional Volumes



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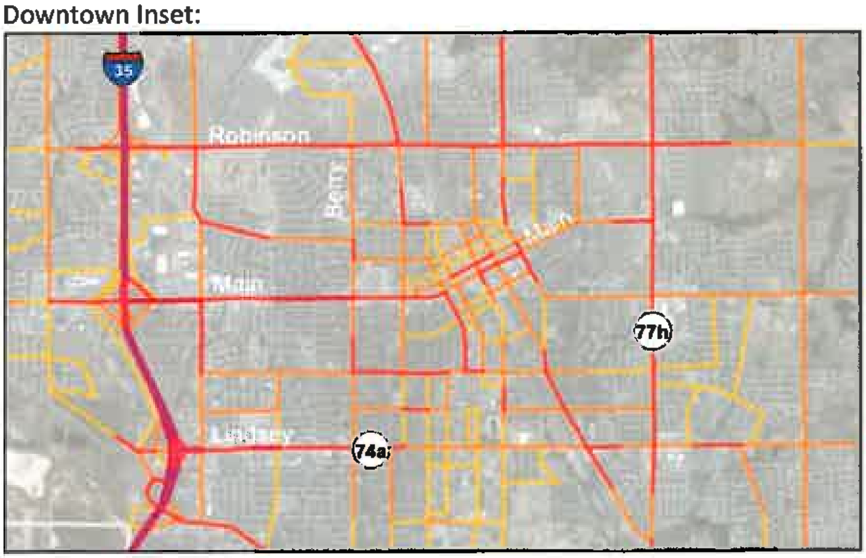
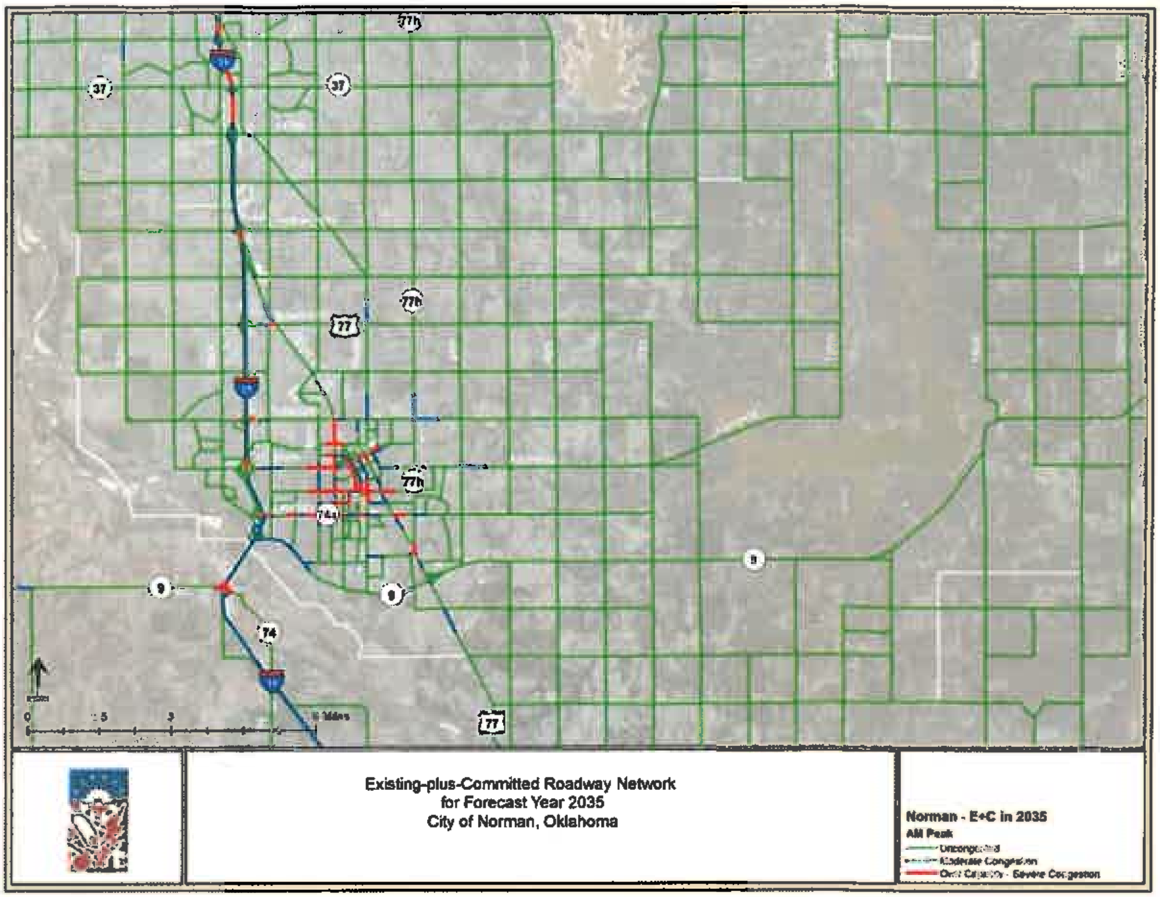


Figure 13: Norman E+C Network – AM Peak Congestion Levels



Downtown Inset:

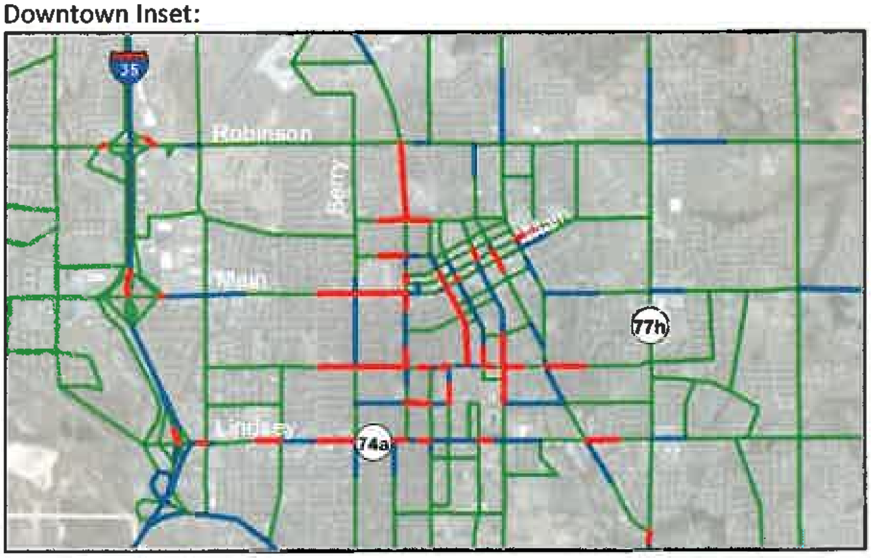
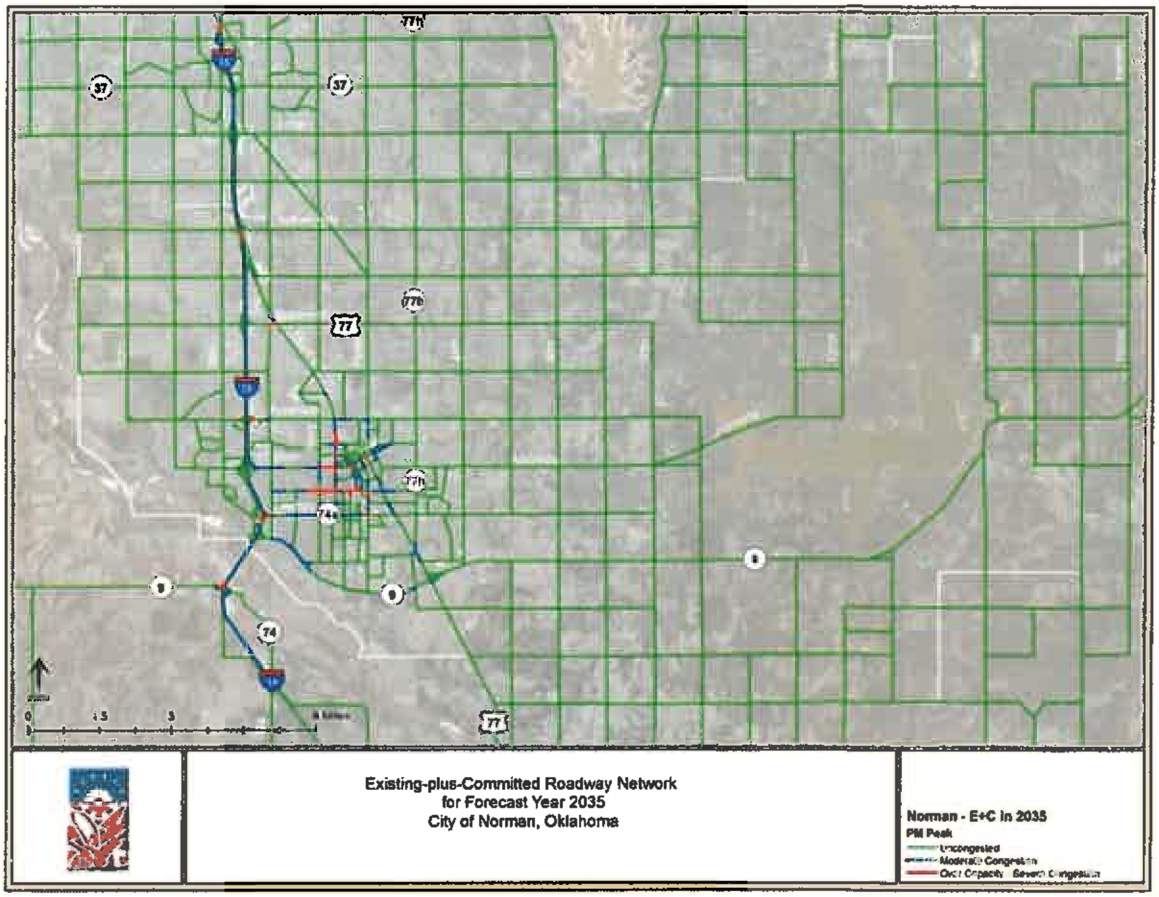
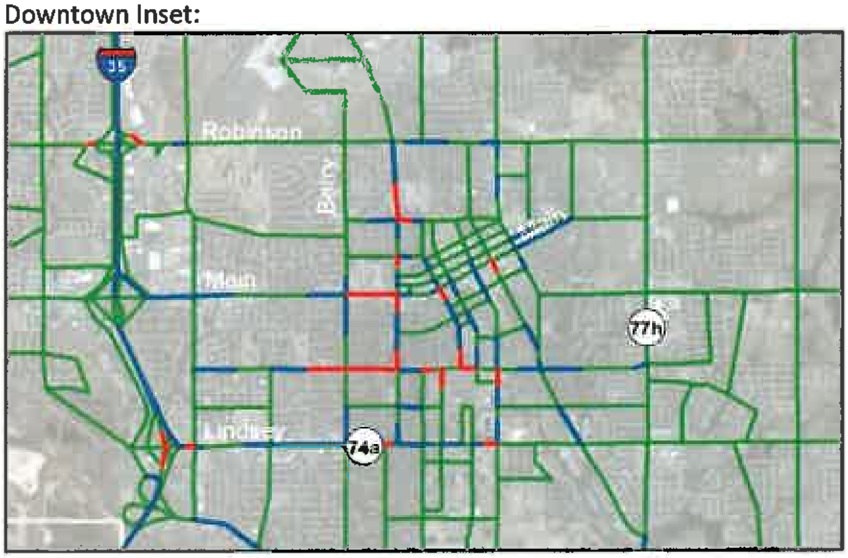


Figure 14: Norman E+C Network – PM Peak Congestion Levels



Downtown Inset:



Enhanced Existing-Plus-Committed

An in-depth review of the forecasted 2035 traffic volumes associated the Norman E+C network revealed that the regional travel demand model estimated significantly different roadway volumes associated with the anticipated University North Park development than had been documented as part of a site-specific traffic impact analysis, undertaken by one of the project team partners.

Upon further analysis, it was determined that affected TAZ 2154 of the underlying socioeconomic data that had been provided by ACOG at the start of the project only took a small amount of the anticipated growth into account, and actual growth had already reached levels commensurate with ACOG forecasted 2035 employment gains.

In order to forecast traffic volumes representative of the entire commercial and residential development, particularly in anticipation that the development would be fully built by 2035, the proposed square footage of retail, office, and other commercial developments was factored to arrive at associated employment growth, based on average employee per square foot ratios.[3] Table 5 shows the original ACOG socioeconomic data and the updated population and employment figures that were used for an updated TDM model run for the Enhanced E+C network for the City of Norman.

Table 5: Update to University North Park related TAZ data

		2035 Population			2035 Employment		
	TAZ	Pop	DU	Occupied DU	Retail	Non-Retail	Total
Existing Data	2154	201	201	201	1,552	1,825	3,377
Revised Data		2,812	1,296	1,206	2,204	3,192	5,396
Increase of Original 2035 Projections		2,611	1,095	1,005	652	1,367	2,019

Source: Freese and Nichols

A review of the underlying roadway network also indicated that the ACOG TDM would benefit from a different representation of traffic flows to better replicate travel patterns associated with the development's roadways. Consequently, one of the centroid connectors for the affected TAZ 2154 was realigned to connect directly to 24th Avenue W, as indicated in

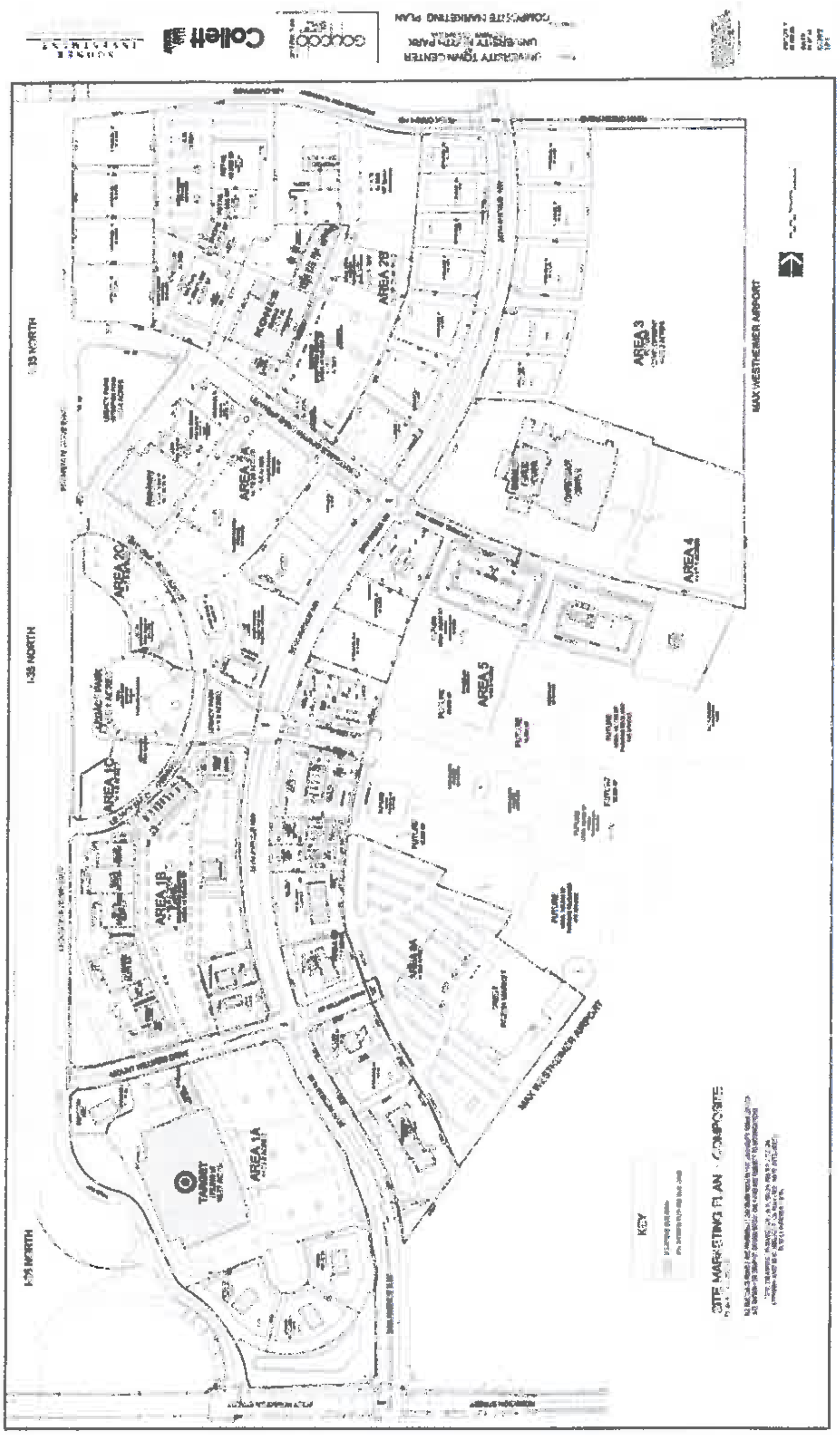
3 The employee per square foot ratios were taken from a survey that had been conducted by the North Central Texas Council of Governments.

Figure 15. The realigned network was rerun with the updated socioeconomic data described above.

Model Results

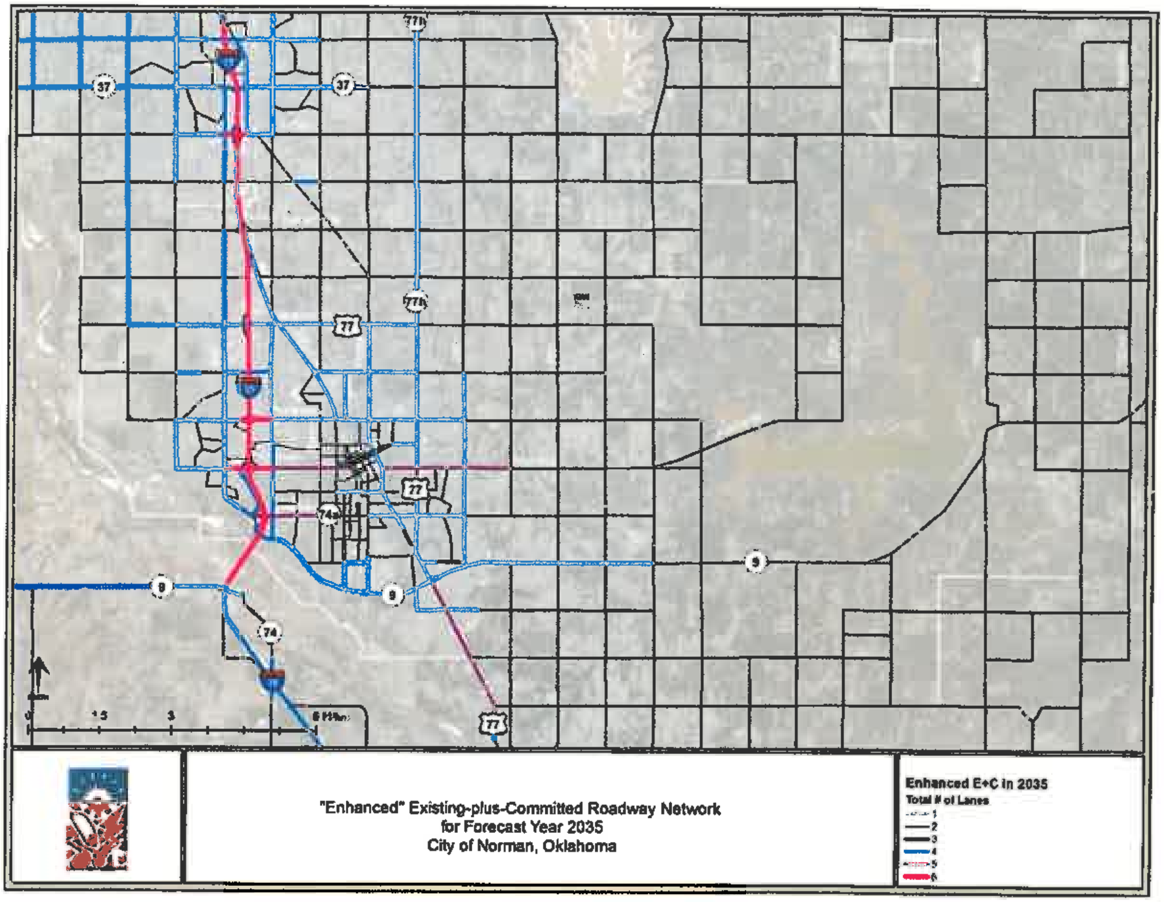
Figure 16 through Figure 19 show the Norman subarea Enhanced E+C network and associated TDM run results for the 2035 horizon year. Similar to the results for the Norman E+C network, the highest levels of peak period congestion occur on Flood, University, Main, Boyd, and Lindsey.

Figure 15: University North Park Development – Preferred Centroid Connector Alignment



Source: City of Norman; annotation by Alliance Transportation Group

Figure 16: Norman Enhanced E+C – Number of Lanes



Downtown Inset:

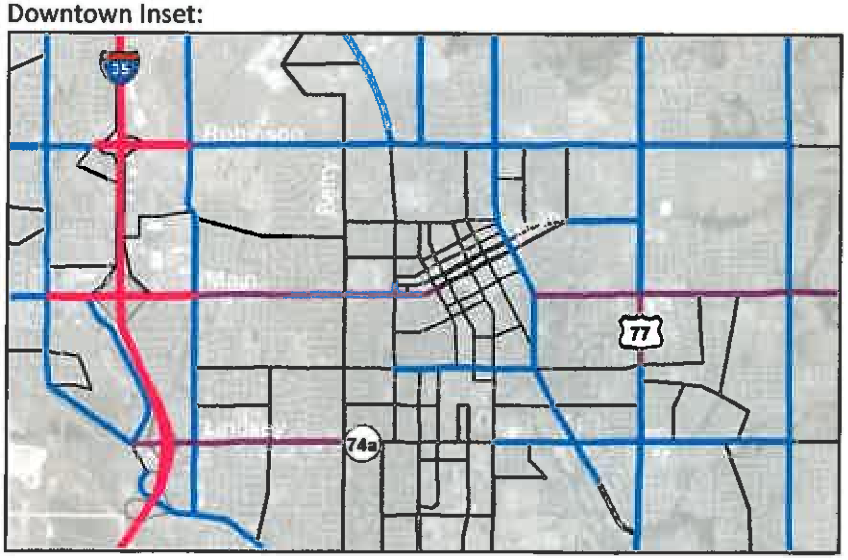
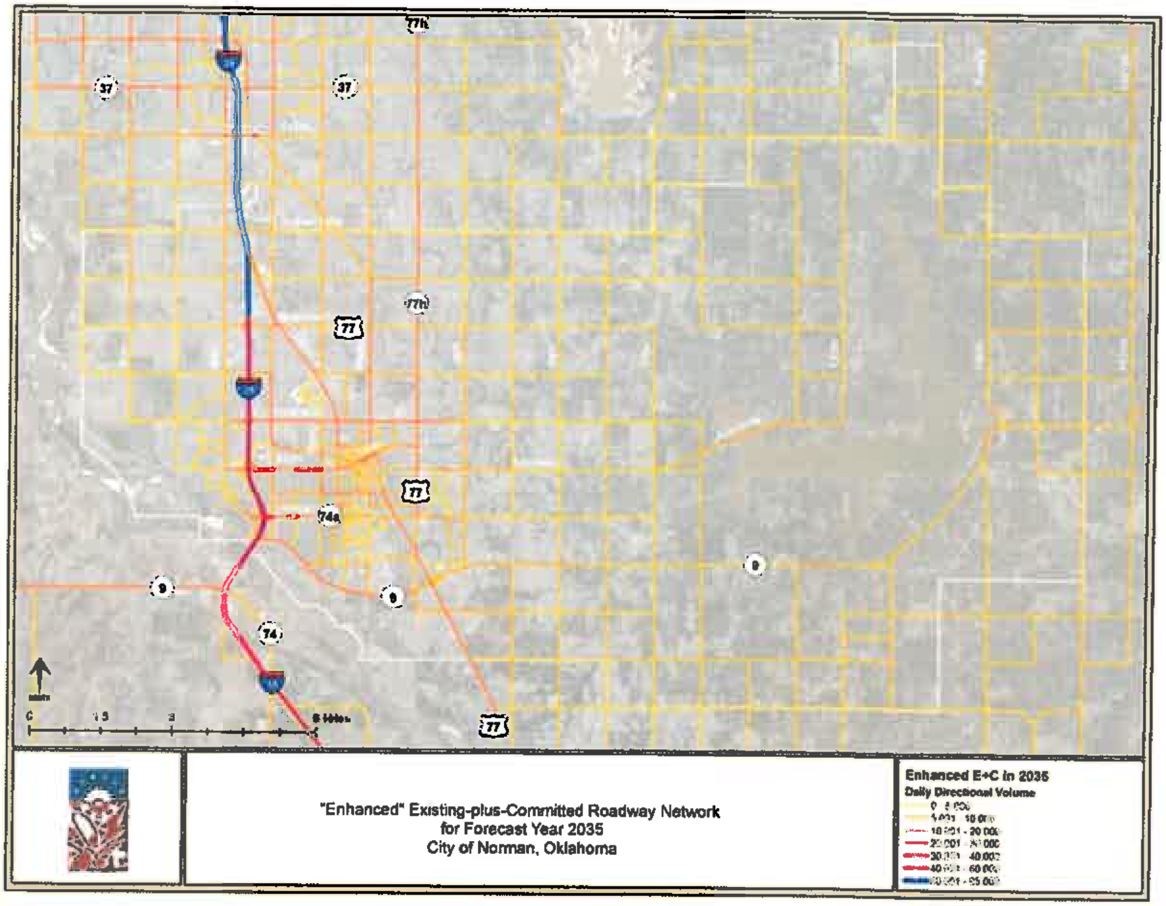


Figure 17: Norman Enhanced E+C – Daily Directional Volumes



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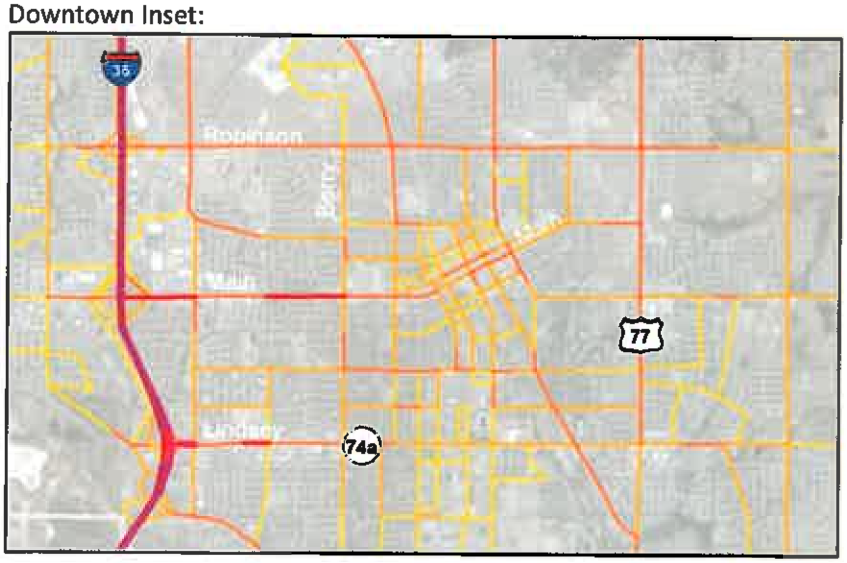
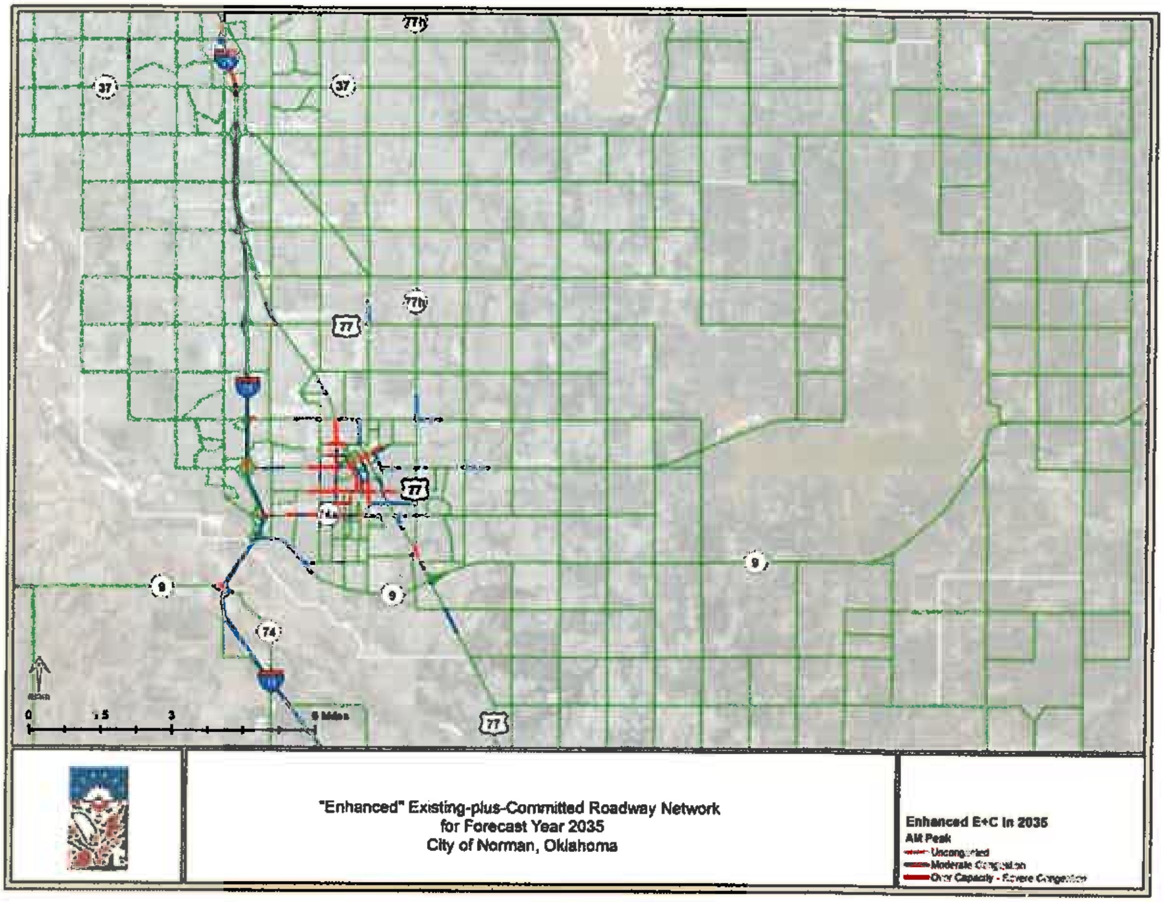


Figure 18: Norman Enhanced E+C – AM Peak Congestion Levels



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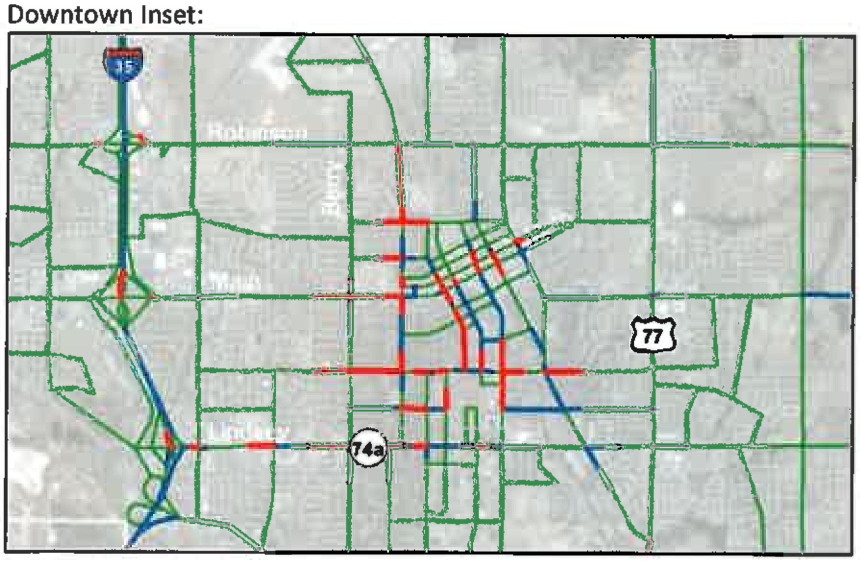
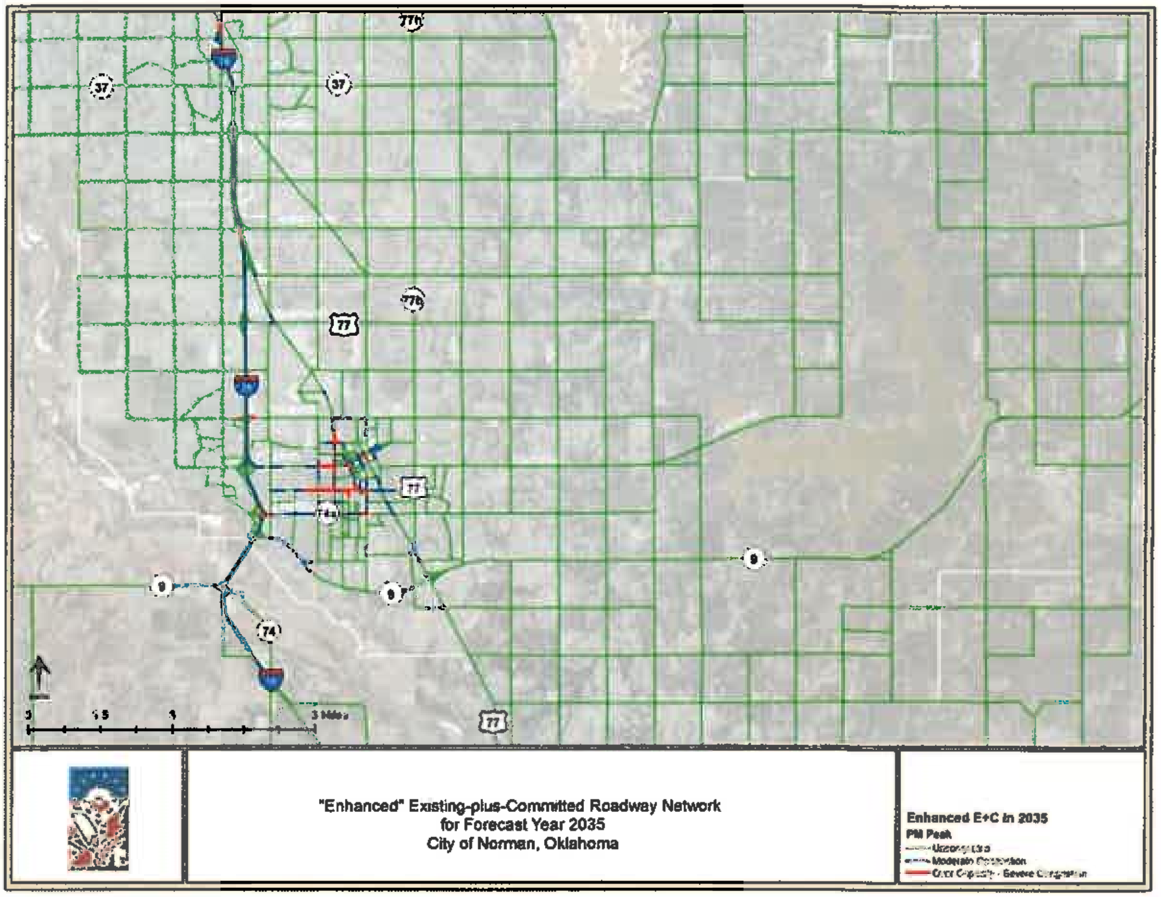


Figure 19: Norman Enhanced E+C – PM Peak Congestion Levels



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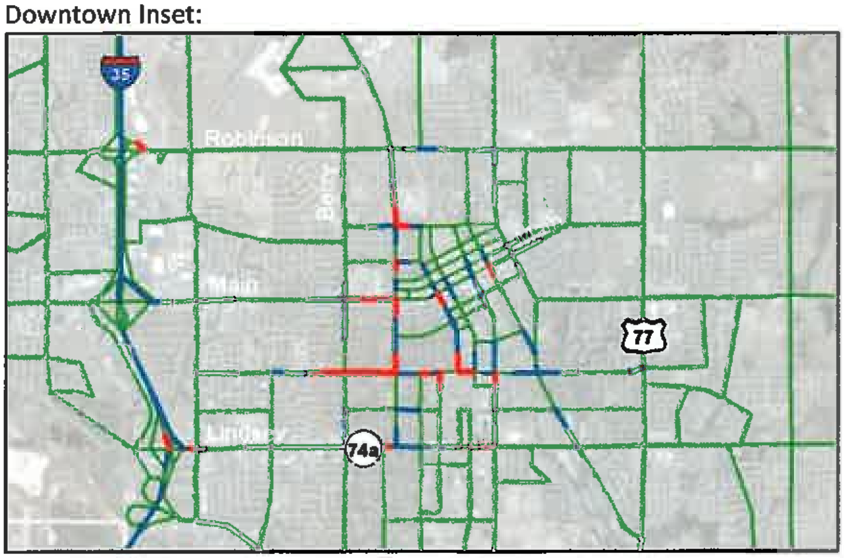


Deficiency Analysis

The TDM run results from the Enhanced E+C network were used to identify those links that might benefit from additional capacity improvements to allow them better accommodate the forecasted travel demand. Table 6 details the findings and provides information on forecasted, average daily 2035 traffic volumes, current roadway configuration, time-of-day period affected by the deficiency, direction of travel affected by the deficiency, and maximum volume to capacity ratio associated with the affected link by time-of-day and direction of travel. This detailed information was shared with project team members and subsequently considered in the determination of which projects should be included in the Norman Build Scenario.

Table 6: Norman Enhanced E+C – Detailed Deficiency Findings

Street | Segment | Functional Classification | 2035 Volume | Number of Lanes | Failure Period | Both Directions | Deficiency | Affected Movement | VC Ratio | Additional Concern

Street	Segment	Functional Classification	2035 Volume	Number of Lanes	Failure Period	Both Directions	Deficiency	Affected Movement	VC Ratio	Additional Concern
12th Avenue E/ Sooner	Classen to Constitution	Principal Arterial	35,000	4	AM		AM Peak Failure	NB	AM 1.08	
12th Avenue E/ Sooner	Constitution to Imhoff	Minor Arterial	34,000	4	AM		AM Peak Failure	NB	AM 1.07	PM 0.98
Acres	Berry to Flood	Minor Arterial	10,000	2	AM		AM Peak Failure	EB	AM 1.11	PM 0.71
Acres	Flood to University	Minor Arterial	19,000	2	AM/PM /MD	x	AM and PM Peak Failure	EB and WB	EB AM 1.05, WB AM 1.45, WB PM 1.25, WB MD 1.01	
Alameda	Porter to 12th Ave E	Minor Arterial	16,000	5			Nearing Capacity (AM Peak)	WB	AM 0.77	
Alameda	12th Ave E to 24th Ave E	Minor Arterial	18,000	5			Nearing Capacity (AM Peak)	WB	AM 0.74	
Alameda	24th Ave E to 36th Ave E	Minor Arterial	18,000	5			Nearing Capacity (AM Peak)	WB	AM 0.72	
Berry	Kansas to Main	Minor Arterial	13,000	2			Nearing Capacity	SB	AM 0.90, PM 0.82	
Berry	Main to Boyd	Minor Arterial	18,000	2			Nearing Capacity (AM Peak)	NB	AM 0.89	
Berry	Brooks to Lindsey	Minor Arterial	16,000	2			Nearing Capacity (PM Peak)	SB	PM 0.78	

Street	Segment	Functional Classification	2035 Volume	Number of Lanes	Failure Period	Both Directions	Deficiency	Affected Movement	V/C Ratio	Additional Concern
Boyd	Asp to Jenkins	Collector	15,000	4			Nearing Capacity (AM Peak)	WB	AM 0.96	
Boyd	Jenkins to Classen	Collector	19,000	4	AM		AM Peak Failure	WB	AM 1.18	EB PM 0.84
Boyd	Classen to 12th Ave E	Collector	13,000	2	AM		AM Peak Failure	WB	AM 1.40	WB PM 0.88; WB MD 0.82
Brooks	Berry to Flood	Collector	16,000	2			Nearing Capacity (AM Peak)	EB	AM 0.88	
Brooks	Flood to Chautauqua	Collector	19,000	2	AM		AM Peak Failure	EB	AM 1.12	WB PM 0.92
Brooks	Chautauqua to Elm	Collector	15,000	2			Nearing Capacity (AM Peak)	EB	AM 0.90	
Brooks	Jenkins to Classen	Collector	14,000	2			Nearing Capacity (AM Peak)	WB	AM 0.90	
Chautauqua	Lindsey to Elmwood	Collector	8,000	2			Nearing Capacity (AM Peak)	NB	AM 0.88	
Classen	Miller to Boyd	Minor Arterial	25,000	4			Nearing Capacity	SB	AM 0.95; PM 0.82	
Classen	Boyd to Lindsey	Minor Arterial	26,000	4		x	Nearing Capacity	NB and SB	NB AM 0.98; SB PM 0.89	
Classen	Lindsey to 12th Ave E	Minor Arterial	20,000	3 to 4			Nearing Capacity (AM Peak)	NB	AM 0.86	

Street	Segment	Functional Classification	2035 Volume	Number of Lanes	Failure Period	Both Directions	Deficiency	Affected Movement	VC Ratio	Additional Concern
Classen	Cedar to City Limits	Principal Arterial	29,000	5			Nearing Capacity (AM Peak)	NB	AM 0.82	
Constitution	Jenkins to Classen	Collector	11,000	2			Nearing Capacity	EB	PM 0.96	AM 0.87, MD 0.82
Elm	Boyd to Brooks	Minor Arterial	17,000	2	PM		PM Peak Failure	NB	PM 1.36	AM 0.99
Flood	Robinson to W Acres	Collector	20,000	2	AM/MD/PM		AM and PM Peak Failure	SB	AM 2.06, PM 1.36, MD 1.27	NB AM 0.83, NB PM 0.84
Flood	W Acres to Main	Collector	13,000	2	AM/PM	x	AM and PM Peak Failure	NB and SB	NB PM 1.26, SB AM 1.10	NB MD and PM > 0.70, SB MD and PM >0.74
Flood	Main to Boyd	Collector	17,000	2	AM/MD/PM/NT	x	AM and PM Peak Failure	NB and SB	NB PM 1.58, NB AM 1.36, SB AM 1.94, SB PM 1.20	NB MD 1.21, NT 1.06, SB MD 1.20
Flood	Boyd to Brooks	Collector	8,000	2			Nearing Capacity (AM Peak)	NB	AM 0.90	
Flood	Brooks to Lindsey	Collector	6,000	2			Nearing Capacity (PM Peak)	SB	PM 0.90	
Gray	Porter to Findlay	Minor Arterial	11,000	2	AM		AM Peak Failure	WB	AM 1.22	PM 0.90
Imhoff	SH 9 to Berry	Collector	10,000	2			Nearing Capacity	WB	AM 0.76, PM 0.79	

Street	Segment	Functional Classification	2035 Volume	Number of Lanes	Failure Period	Both Directions	Deficiency	Affected Movement	VC Ratio	Additional Concern
Imhoff	Pickard to Chautauqua	Collector	9,000	2			Nearing Capacity	EB	AM 0.71	
James Garner	Daws to Tonhawa	Collector	12,000	2			Nearing Capacity	SB	AM 0.77	
James Garner	Tonhawa to Main	Collector	16,000	2	AM		AM Peak Failure	SB	AM 1.35	PM 0.73
James Garner	Main to Linn	Collector	17,000	2		x	Nearing Capacity	NB and SB	NB PM 0.87, SB AM 0.96	NB AM 0.78;
Jenkins	Linn to Duffy	Collector	9,000	2			Nearing Capacity	SB	AM 0.81	
Jenkins	Duffy to Boyd	Collector	11,000	2	AM		AM Peak Failure	SB	AM 1.33	MD 0.76; PM 0.75
Jenkins	Boyd to Brooks	Collector	19,000	2	AM/PM	x	AM and PM Peak Failure	NB and SB	NB PM 1.24, SB AM 1.46	NB MD 0.78
Jenkins	Brooks to Lindsey	Collector	9,000	2			Nearing Capacity (PM Peak)	SB	PM 0.70	
Kansas	Berry to Flood	Minor Arterial	12,000	2	AM		AM Peak Failure	EB	AM 1.03	
Kansas	Flood to University	Minor Arterial	12,000	2			Nearing Capacity	WB	AM 0.89, PM 0.87	MD 0.78
Lindsey	I-35 to 24th Ave W	Minor Arterial	61,000	5	AM/PM		AM and PM Peak Failure	EB	AM 1.82, PM 1.38	MD 1.42
Lindsey	24th Ave W to Berry	Minor Arterial	40,000	5	AM		AM Peak Failure	EB	AM 1.16	EB PM 0.93, WB AM 0.91, WB PM 0.96,

Street	Segment	Functional Classification	2035 Volume	Number of Lanes	Failure Period	Both Directions	Deficiency	Affected Movement	VC Ratio	Additional Concern
										WB MD 0.91
Lindsey	Berry to Pickard	Minor Arterial	26,000	2	AM/PM /MD	x	AM and PM Peak Failure	EB and WB	EB AM 1.02, WB AM 2.01, WB PM 1.96, WB MD 1.61	EB AM 0.87, EB MD 0.79, EB PM 0.97
Lindsey	Pickard to Flood	Minor Arterial	19,000	2	AM/PM /MD	x	AM and PM Peak Failure	EB and WB	EB AM 1.65, WB AM 1.12, WB PM 1.55, WB MD 1.17	EB MD 0.93; EB PM 0.95
Lindsey	Flood to Chautauqua	Minor Arterial	14,000	2	AM		AM Peak Failure	EB	AM 1.19	EB PM 0.79, EB MD 0.78, WB AM 0.96, WB PM 0.88, WB MD 0.79
Lindsey	Chautauqua to Elm	Minor Arterial	14,000	2		x	Nearing Capacity	EB and WB	EB AM 0.93, WB AM 0.76; WB PM 0.78	
Lindsey	Elm to Jenkins	Minor Arterial	15,000	2	AM/PM	x	AM and PM Peak Failure	EB and WB	EB PM 1.23, WB AM 1.29	
Lindsey	Jenkins to George	Minor Arterial	15,000	4			Nearing Capacity	WB	AM 0.74	

Street	Segment	Functional Classification	2035 Volume	Number of Lanes	Failure Period	Both Directions	Deficiency	Affected Movement	VC Ratio	Additional Concern
										WB MD 0.91
Lindsey	Berry to Pickard	Minor Arterial	26,000	2	AM/PM /MD	x	AM and PM Peak Failure	EB and WB	EB AM 1.02, WB AM 2.01, WB PM 1.96; WB MD 1.61	EB AM 0.87, EB MD 0.79, EB PM 0.97
Lindsey	Pickard to Flood	Minor Arterial	19,000	2	AM/PM /MD	x	AM and PM Peak Failure	EB and WB	EB AM 1.65, WB AM 1.12, WB PM 1.55, WB MD 1.17	EB MD 0.93, EB PM 0.95
Lindsey	Flood to Chautauqua	Minor Arterial	14,000	2	AM		AM Peak Failure	EB	AM 1.19	EB PM 0.79, EB MD 0.78, WB AM 0.96, WB PM 0.86, WB MD 0.79
Lindsey	Chautauqua to Elm	Minor Arterial	14,000	2		x	Nearing Capacity	EB and WB	EB AM 0.93, WB AM 0.76, WB PM 0.78	
Lindsey	Elm to Jenkins	Minor Arterial	15,000	2	AM/PM	x	AM and PM Peak Failure	EB and WB	EB PM 1.23, WB AM 1.29	
Lindsey	Jenkins to George	Minor Arterial	15,000	4			Nearing Capacity	WB	AM 0.74	

Street	Segment	Functional Classification	2035 Volume	Number of Lanes	Failure Period	Both Directions	Deficiency	Affected Movement	VC Ratio	Additional Concern
							(AM Peak)			
Lindsey	Classen to 12th Ave E	Minor Arterial	19,000	4			Nearing Capacity (AM Peak)	WB	AM 0.94	
Lindsey	12th Ave E to Biloxi	Minor Arterial	18,000	4			Nearing Capacity (AM Peak)	WB	AM 0.72	
Main	I-35 to Interstate Dr	Minor Arterial	52,000	6	AM		AM Peak Failure	EB	AM 1.20	PM 0.89, MD 0.86
Main	Interstate Dr to 24th Ave W	Minor Arterial	40,000	6			Nearing Capacity (AM Peak)	EB	AM 0.88	
Main	24th Ave W to Berry	Minor Arterial	39,000	4	AM		AM Peak Failure	EB	AM 1.18	EB PM 0.92, EB MD 0.87, WB AM 0.94, WB PM 0.97, WB MD 0.80
Main	Berry to Flood	Minor Arterial	39,000	4	AM/PM	x	AM and PM Peak Failure	EB and WB	EB AM 1.30; EB PM 1.05, WB AM 1.17, WB PM 1.21	EB MD 0.98, WB MD 0.98
Main	Flood to University	Minor Arterial	22,000	4		x	Nearing Capacity	EB and WB	EB AM 0.81, WB AM 0.77	
Main	Porter to Acres	Collector	11,000	2		x	Nearing Capacity	EB and WB	EB PM 0.70, WB AM 0.87	

Street	Segment	Functional Classification	2035 Volume	Number of Lanes	Failure Period	Both Directions	Deficiency	Affected Movement	VC Ratio	Additional Concern
Miller	Boyd to Classen	Minor Arterial	18,000	2		x	Nearing Capacity	NB and SB	NB AM 0.93, SB PM 0.77	
N Peters	Robinson to Acres	Minor Arterial	17,000	2			Nearing Capacity (AM Peak)	SB	AM 0.81	
N Peters	Tonhawa to Gray	Minor Arterial	10,000	2			Nearing Capacity	SB	AM 0.76, PM 0.72	
N Peters	Gray to Main	Minor Arterial	11,000	2	AM		AM Peak Failure	NB	AM 1.01	NB PM 0.71, SB AM 0.83
N Peters	Main to Eufala	Minor Arterial	15,000	2	AM/PM		AM and PM Peak Failure	NB	AM 1.17, PM 1.04	MD 0.80
Pickard	Lindsey to Timberdell	Minor Arterial	11,000	2			Nearing Capacity (AM Peak)	NB	AM 0.91	
Porter	Franklin to Tecumseh	Minor Arterial	21,000	2			Nearing Capacity (AM Peak)	SB	AM 0.70	
Porter	Robinson to Alameda	Minor Arterial	20,000	4		x	Nearing Capacity	NB and SB	NB AM 0.87, NB PM 0.76, SB AM 0.70	
Robinson	24th Ave W to Berry	Principal Arterial	25,000	4			Nearing Capacity (AM Peak)	EB	AM 0.70	
Robinson	Flood to Porter	Principal Arterial	34,000	4		x	Nearing Capacity	EB and WB	EB AM 0.74, EB PM 0.80, WB AM 0.71, WB	

Street	Segment	Functional Classification	2035 Volume	Number of Lanes	Failure Period	Both Directions	Deficiency	Affected Movement	VC Ratio	Additional Concern
									PM 0.74	
Robinson	12th Ave E to 24th Ave E	Minor Arterial	21,000	4			Nearing Capacity (AM Peak)	WB	AM 0.77	
SH 9	I-35 to Chautauqua	Principal Arterial	35,000	4		x	Nearing Capacity	EB and WB	EB AM 0.89; EB PM 0.86; WB AM 0.92; WB PM 0.82	WB MD 0.72
SH 9	Jenkins to 12th Ave E	Principal Arterial	30,000	4			Nearing Capacity (PM Peak)	EB	PM 0.76	
University	Kansas to Main	Collector	10,000	2	AM		AM Peak Failure	SB	AM 1.29	
University	Main to Boyd	Collector	19,000	2	AM/MD/PM	x	AM and PM Peak Failure	NB and SB	NB AM 1.43; NB PM 1.62; SB AM 2.01; SB PM 1.16	NB MD 1.20; SB MD 1.15
US 77	Franklin to Tecumseh	Principal Arterial	38,000	4		x	Nearing Capacity	NB and SB	NB AM 0.90; NB PM 0.89; SB AM 0.80	
US 77	Rock Creek to Robinson	Principal Arterial	29,000	4		x	Nearing Capacity	NB and SB	NB PM 0.70; SB AM 0.77	
Webster	Daws to Main	Collector	10,000	2	AM		AM Peak Failure	SB	AM 1.05	SB PM 0.72; NB PM 0.71
Webster	Main to Symmes	Collector	11,000	2		x	Nearing Capacity	NB and SB	NB AM	

Street	Segment	Functional Classification	2035 Volume	Number of Lanes	Failure Period	Both Directions	Deficiency	Affected Movement	VC Ratio	Additional Concern
									0.75, NB PM 0.76, SB AM 0.72	
Webster/Asp	Symmes to Boyd	Collector	18,000	2	AM		AM Peak Failure	SB	AM 1.84	PM 0.82

Abbreviations used:
AM - Morning; PM - Afternoon; MD - Midday; NT - Nighttime; NB - Northbound; EB - Eastbound; SB - Southbound; WB – Westbound; VC – Volume/Capacity

Initial Build Scenario

Following the Enhanced E+C deficiency review, as well as additional discussion among project team members and City of Norman staff, the following projects were coded as part of the initial Build Scenario for the Norman CTP, including seven (7) capacity, six (6) roadway diet, and two (2) intersection enhancement projects.

Table 7: Norman Initial Build Scenario

ROADWAY WIDENING & NEW ROADWAYS

Name	From	To	Existing	Proposed Improvement
Lindsey St.	Elm	Berry	2 lanes	3 lanes (with reversible center lane = 2 EB/1 WB in AM, 1 EB/2 WB in PM)
Chautauqua	Imhoff	Lindsey	2 lanes	Widen to 4 lanes
Jenkins St	Imhoff	Lindsey	2 lanes	Widen to 4 lanes
Flood St	Robinson	Acres	2 lanes/3 lanes	3 lanes (2 SB, 1 NB)
Berry Rd	Robinson	Lindsey	2 lanes	4 lanes with off-peak parking
Front/Jenkins	Acres	Boyd	2 lanes	3 lanes – with center turn lanes
James Garner Extension	Acres	US 77	New – new link between Nodes	2 lanes (grade separation at Robinson)

ROAD DIETS & ONE WAY COUPLETS

Name	From	To	Existing	Proposed Improvement
Main St.	University	Porter	3 lanes, 1-way	2 lanes, 1-way (3 @ Porter)
Gray St.	Porter	University	3 lanes, 1-way	2 lanes, 1-way (3 @ University - dbl LT, thru & RT)
University	Gray	Main	2 lanes SB, 1 lane NB	3 lanes SB (dbl RT, thru & LT)
Porter	Alameda	Acres	2 lanes each way	1 lane each way plus center turn lane, except for 2 lanes each way between Main & Gray
36th Avenue W	Noble	Franklin	4 lanes	3 lanes
Rock Creek	12th	US 77	4 lanes	3 lanes

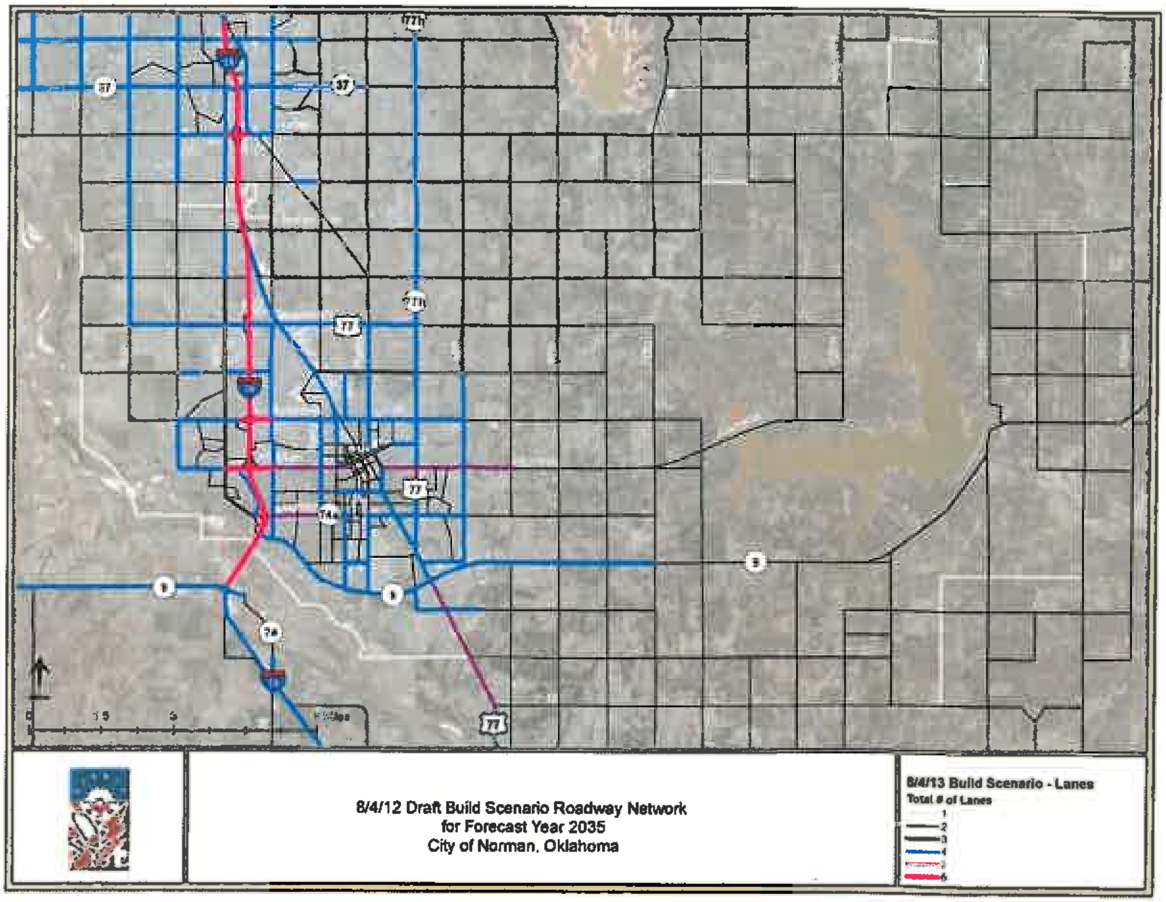
INTERSECTION ENHANCEMENTS

Name	NB	SB	Name	EB	WB
12th E	Dbl LT	Dbl LT	Robinson (recently built)	Dbl LT	Dbl LT
Flood (exist. cond.)	1 LT, 1 thru & RT	1 LT, 2 thru & RT	Main St (exist cond.)	1 LT, 2 thru & RT	1 LT, 2 thru & RT

Model Results

Figure 20 through Figure 23 document the results of the Initial Build Scenario 2035 model run. A reduction of peak period congestion occurred along Flood.

Figure 20: Norman Initial Build Scenario – Number of Lanes



Downtown Inset:

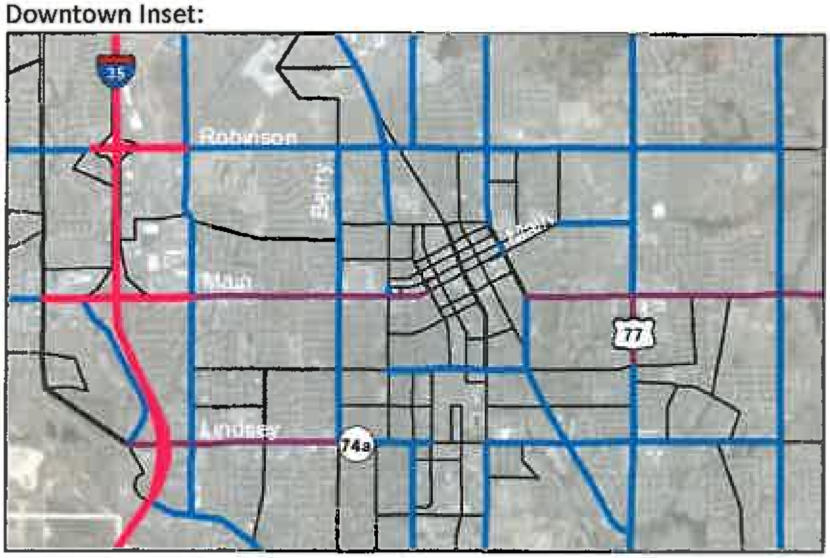
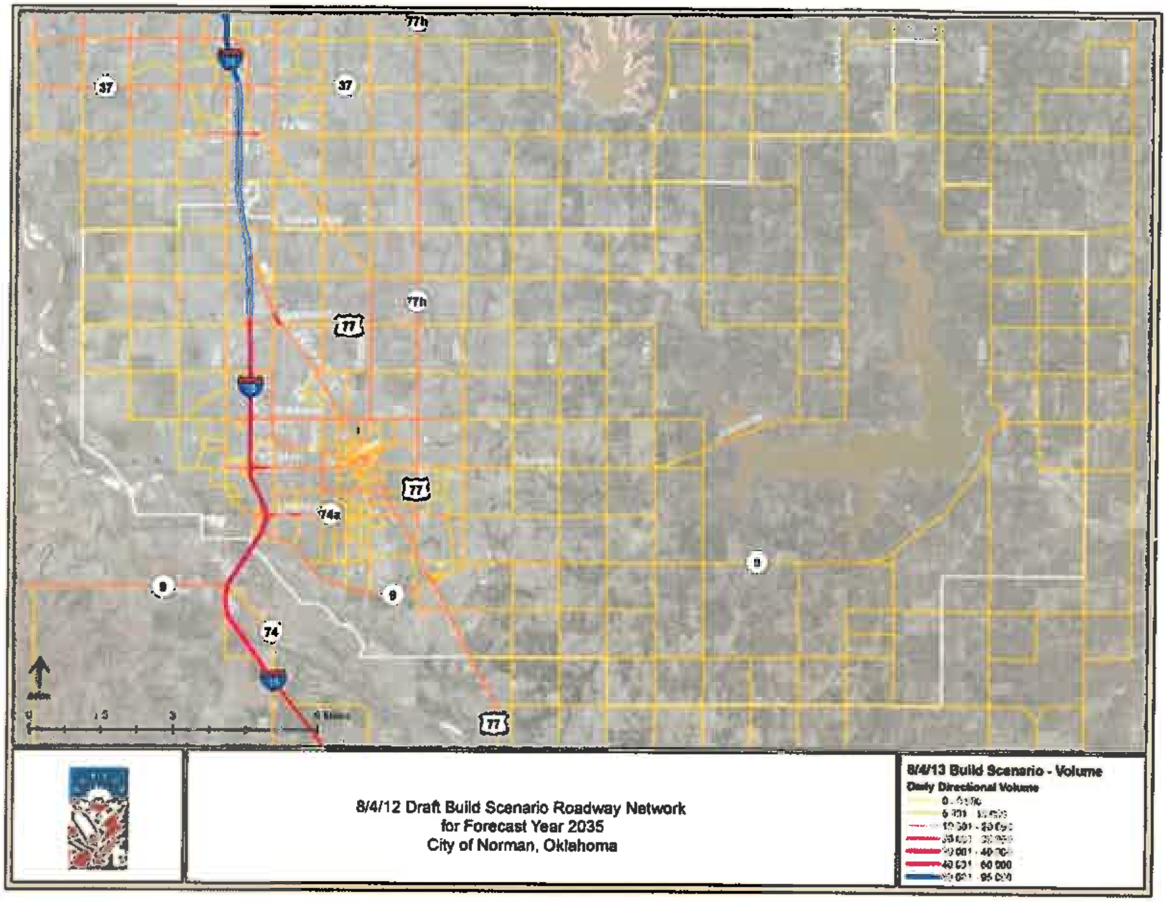


Figure 21: Norman Initial Build Scenario – Daily Directional Volumes



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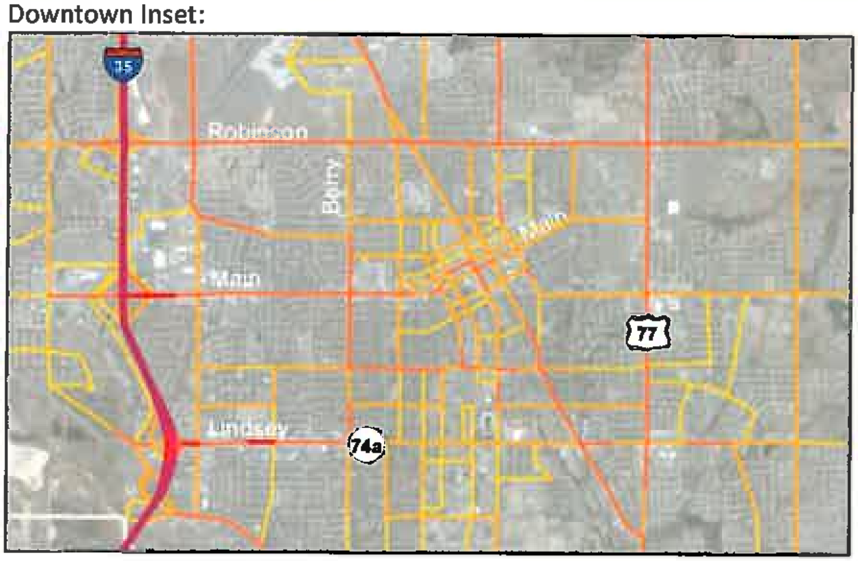
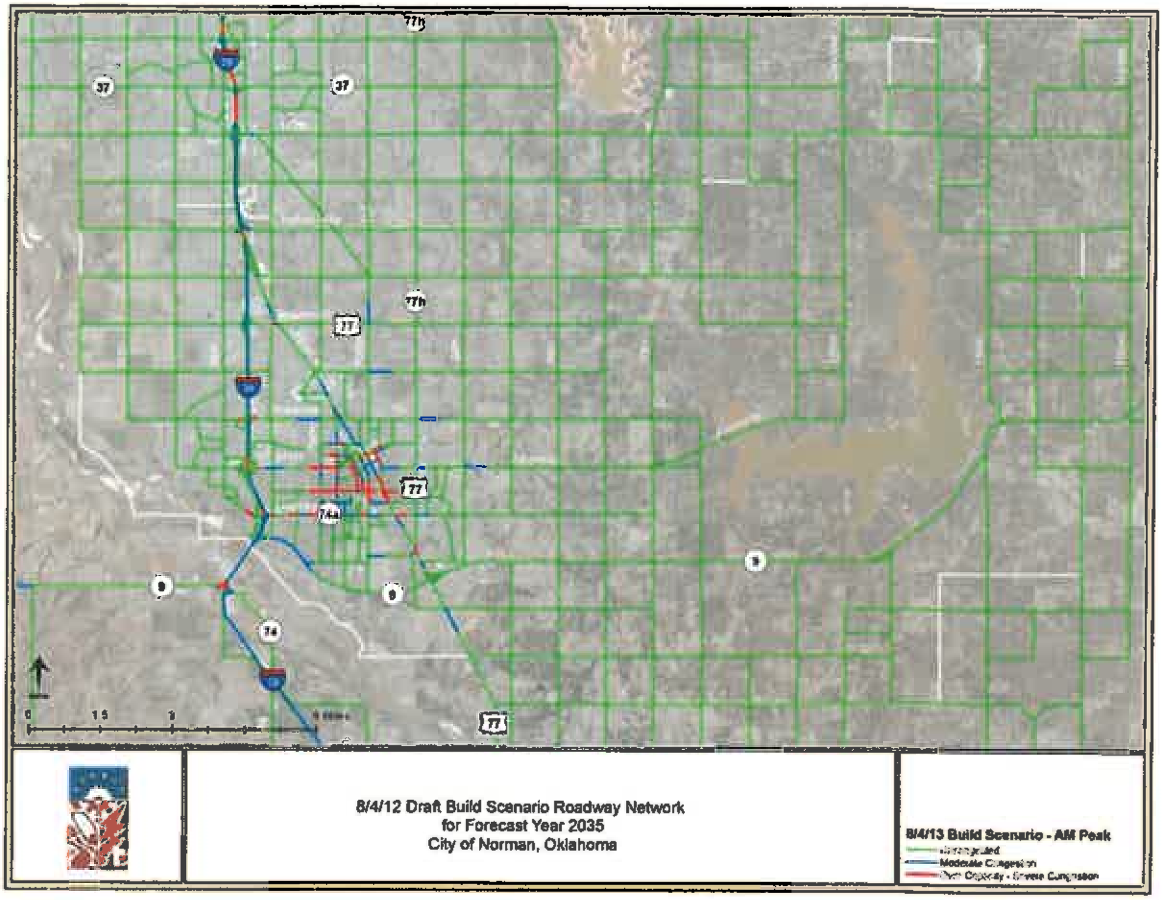


Figure 22: Norman Initial Build Scenario – AM Peak Congestion Levels



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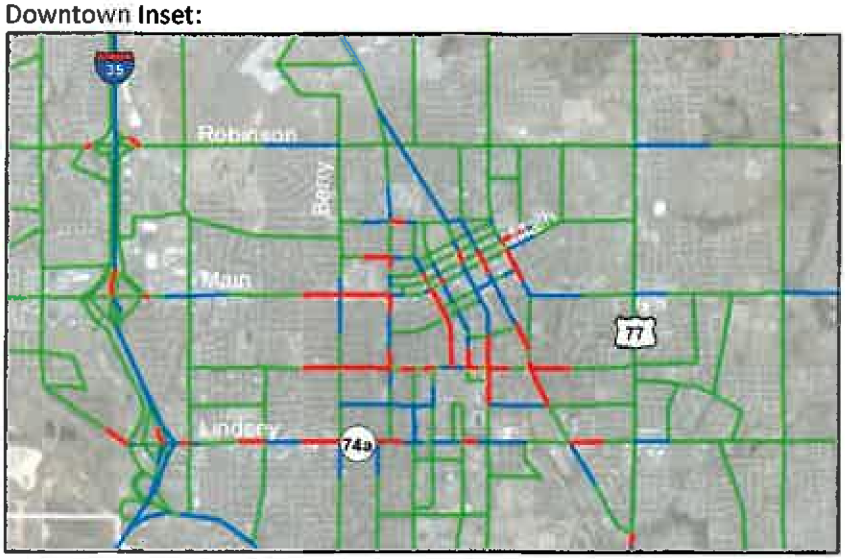
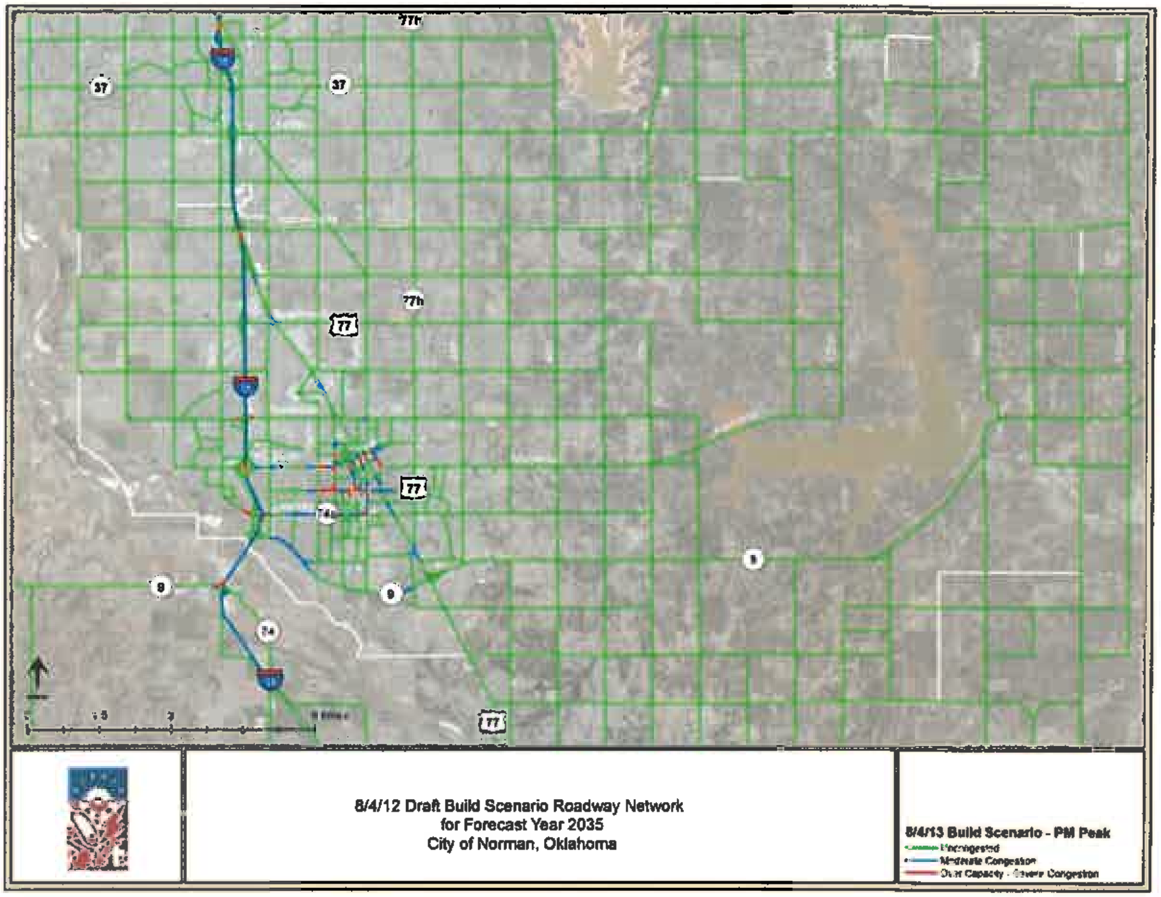
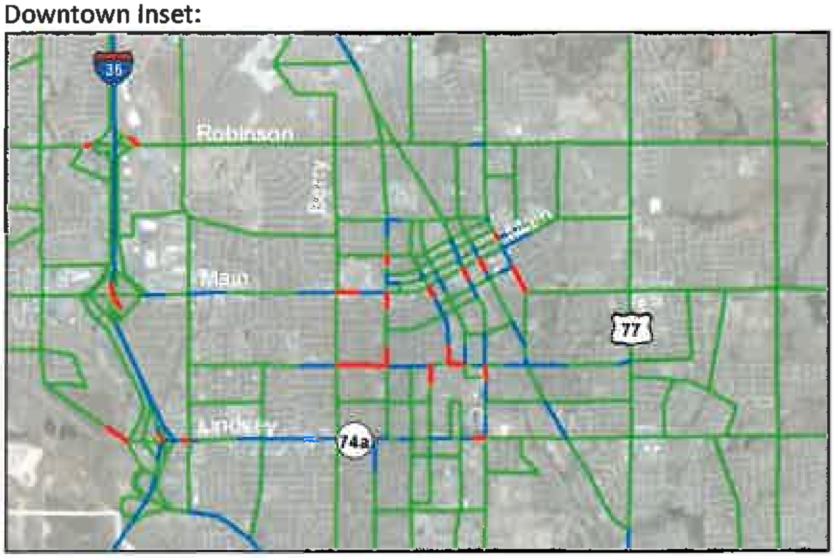


Figure 23: Norman Initial Build Scenario – PM Peak Congestion Levels



Downtown Inset:

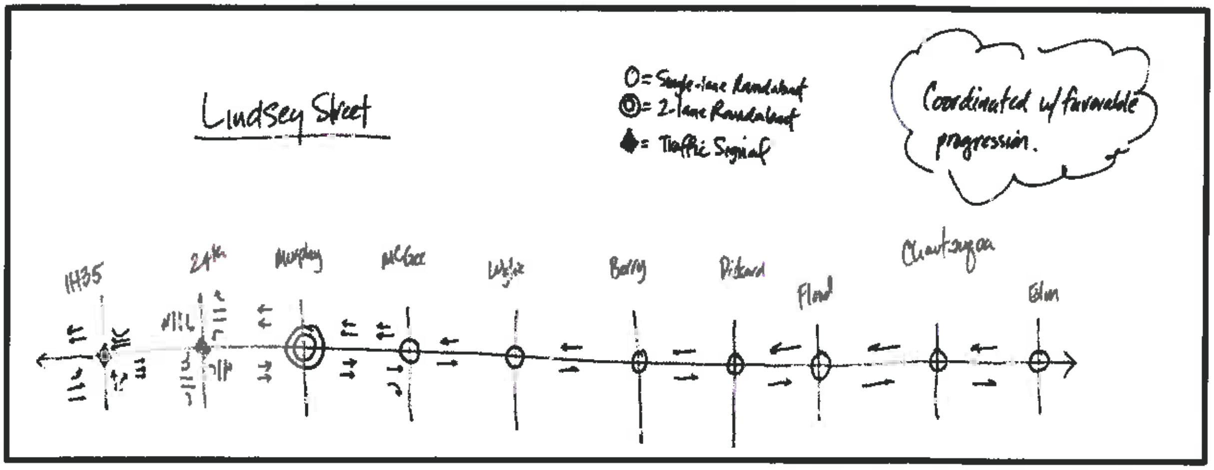


Special Scenario: Lindsey Street – 2-Lane with Roundabouts

The Lindsey Street corridor is an important corridor that provides east-west mobility, including access to the University of Oklahoma campus, which it bisects. It serves nearby commercial and residential areas, is marked by corridor-wide congestion and a higher than average number of traffic crashes.

In response to proposed capacity improvements along Lindsey Street east of I-35, City of Norman staff was approached by representatives of the University of Oklahoma to consider roundabouts as an alternative intersection design in combination with a 2-lane segment stretching from McGee Drive to Jenkins Avenue as is shown in Figure 24. The associated assumptions were that traffic signals would remain at the intersections of Lindsey Street with I-35 and 24th Avenue W, whereas a two-lane roundabout would be considered for the intersection with Murphy Street, and one-lane roundabouts would be implemented for all other intersections up to and including Elm Avenue. Lindsey Street would be reconstructed as a 4-lane divided facility between I-35 and McGee Drive and continue eastward to Elm Avenue as a 2-lane divided roadway. The proposed improvements were coded into the Enhanced E+C network.

Figure 24: Proposed Configuration for Lindsey Street



Source: Freese and Nichols

In comparison, the initial build scenario discussed in the previous section proposed no roundabout intersections, a build-out of Lindsey to a five-lane facility between 24th Avenue W and Berry Road, and four lanes between Berry Road and Elm Avenue.

Model Results

The proposed street improvements were coded and the resulting 2035 traffic forecast is shown in Figure 25 through Figure 28 below. The corridor is forecasted to experience peak period congestion along the proposed 2-lane segment, as volumes rise slightly due to the roundabouts allowing for a higher per hour throughput at the modeled intersections.

Limited traffic diversion occurred in response:

- Main: -2%
- Boyd: -4%%
- Chatauqua: -9%
- McGee: +9%
- Flood: +2%
- SH 9: +2%

Figure 25: Norman Lindsey 2-Lane Scenario – Number of Lanes

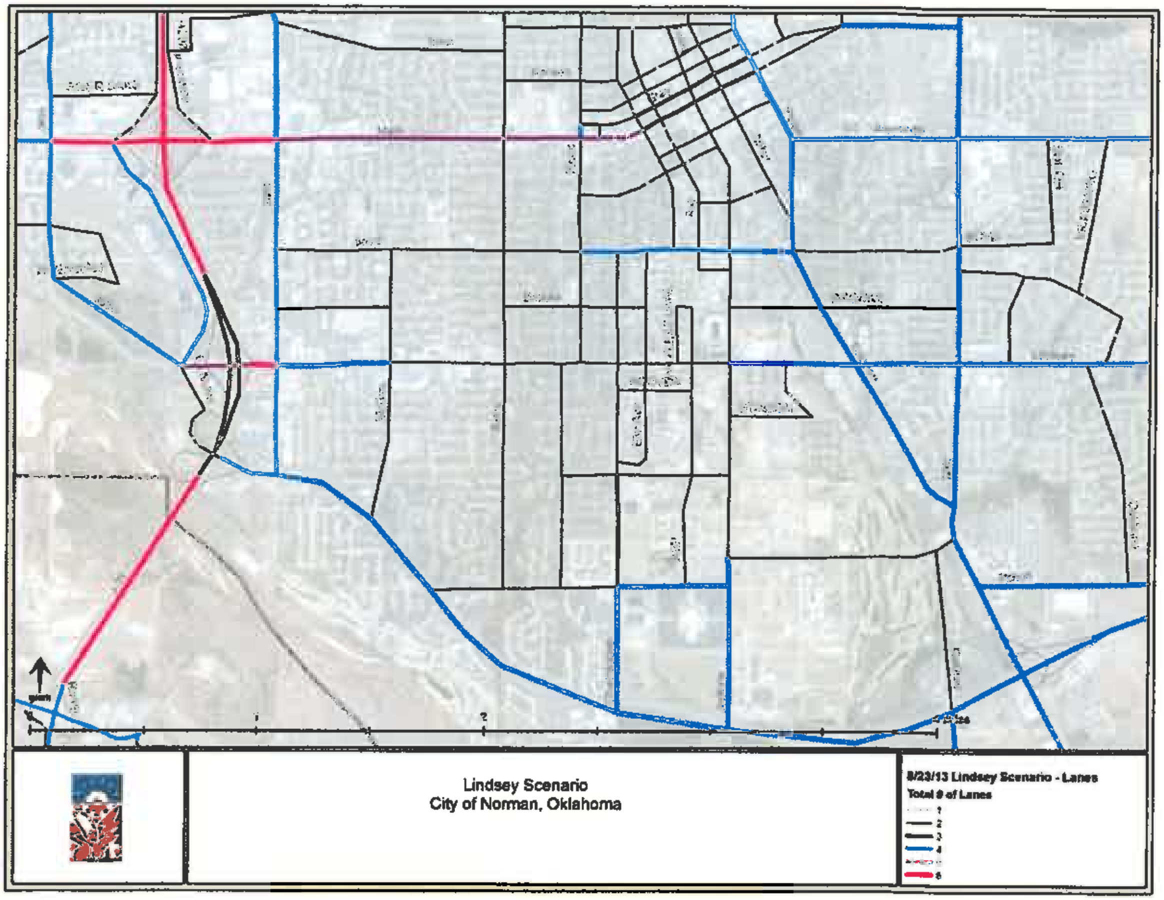


Figure 26: Norman Lindsey 2-Lane Scenario – Daily Directional Volumes

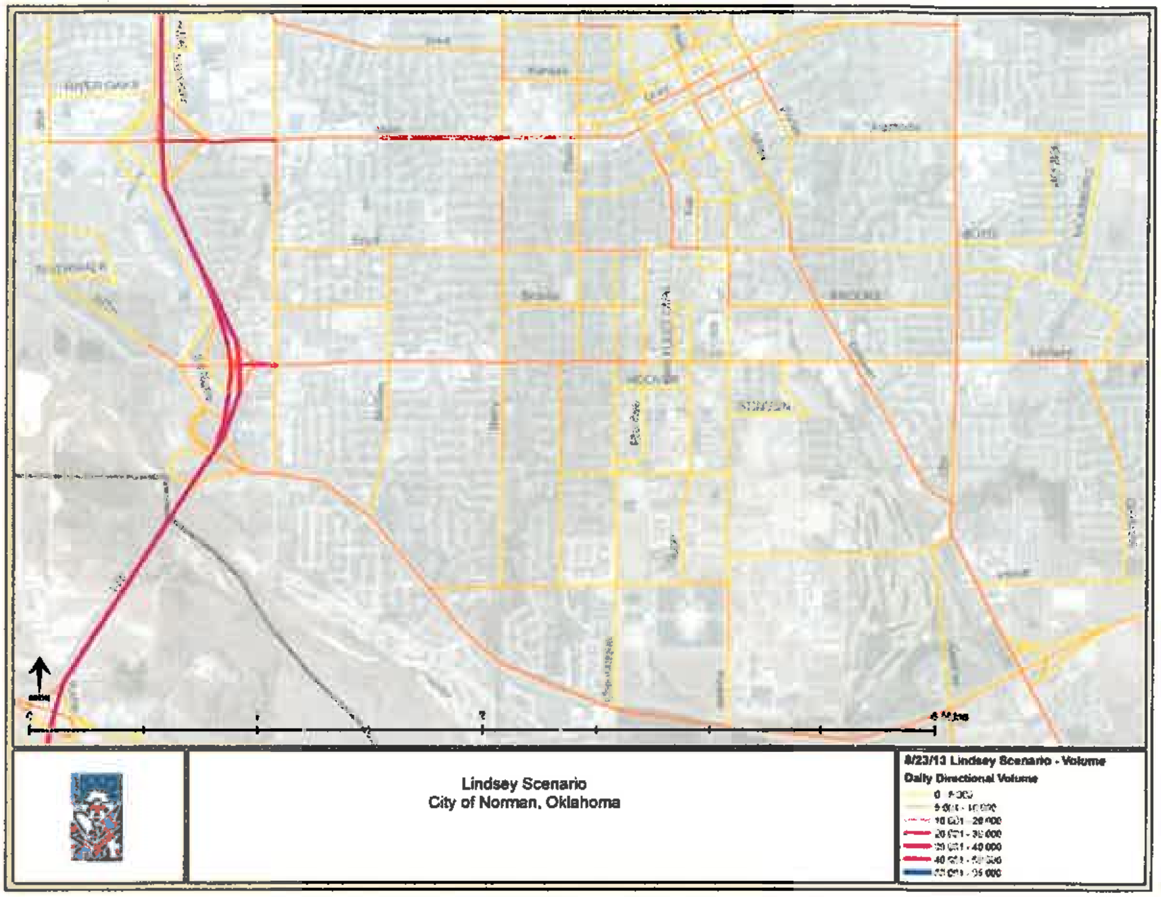


Figure 27: Norman Lindsey 2-Lane Scenario – AM Peak Congestion Levels

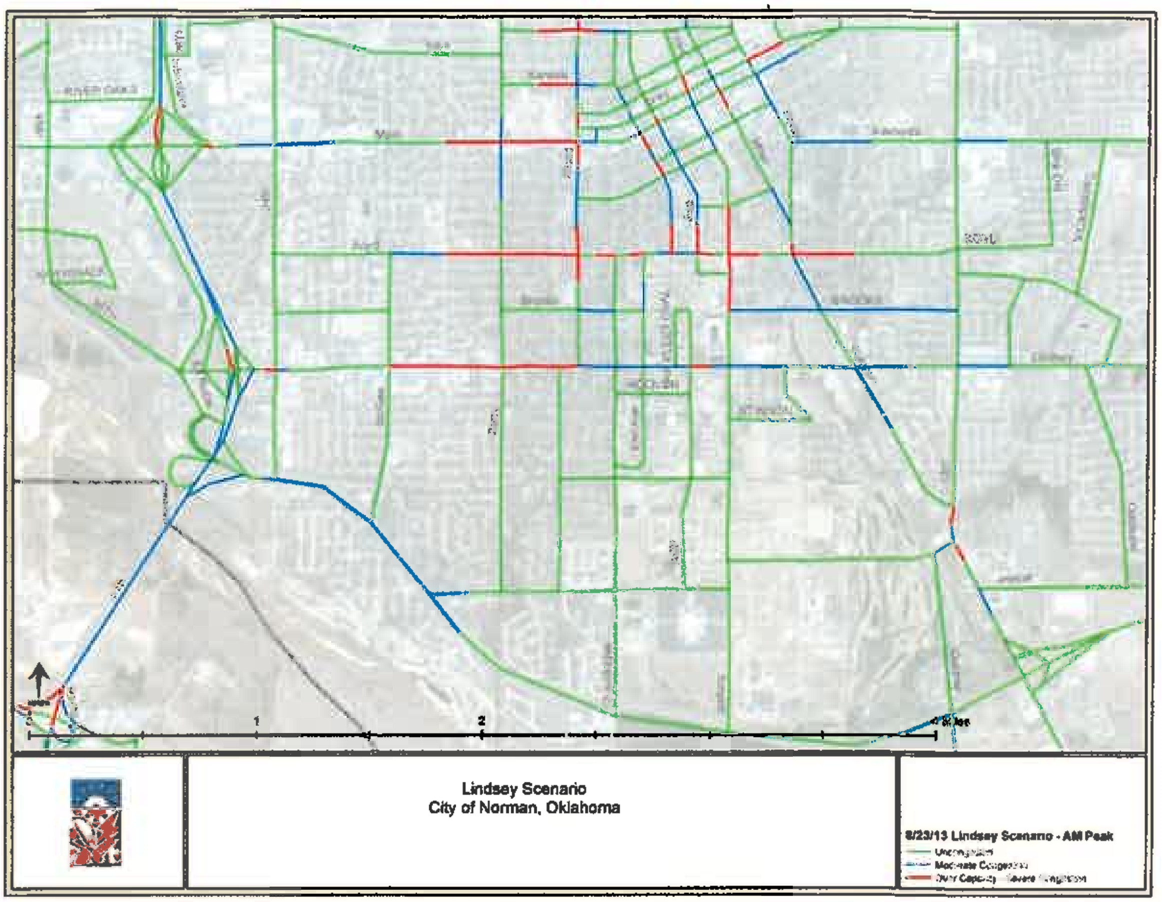
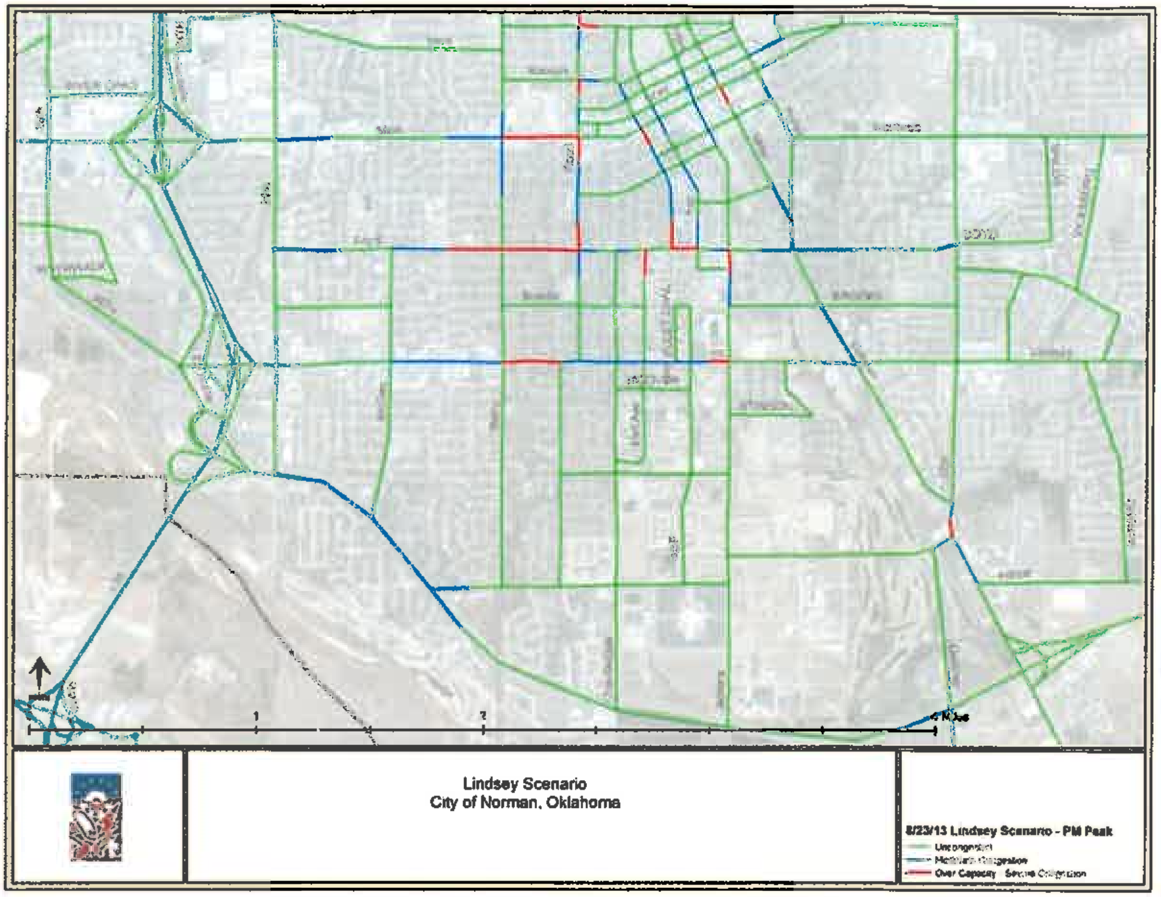


Figure 28: Norman Lindsey 2-Lane Scenario – PM Peak Congestion Levels



Recommendation

In light of Lindsey Street being a key linkage and dispersion of traffic to other corridors being minimal, the team made the following recommendations to City staff:

- Retention of Lindsey with 4-lanes between I-35 to Berry Road
- Roundabouts east of Berry Road
- Sidewalks and bike lanes
- Access management treatment

It was also suggested that micro-simulation of the corridor should be used to determine the ultimate operational configuration along Lindsey Street.

WORK CITED

Federal Highway Administration. (2010). *Travel Model Validation and Reasonableness Checking Manual, 2nd Edition.*

Federal Highway Administration. (1997). *Travel Model Validation and Reasonableness Checking Manual.*

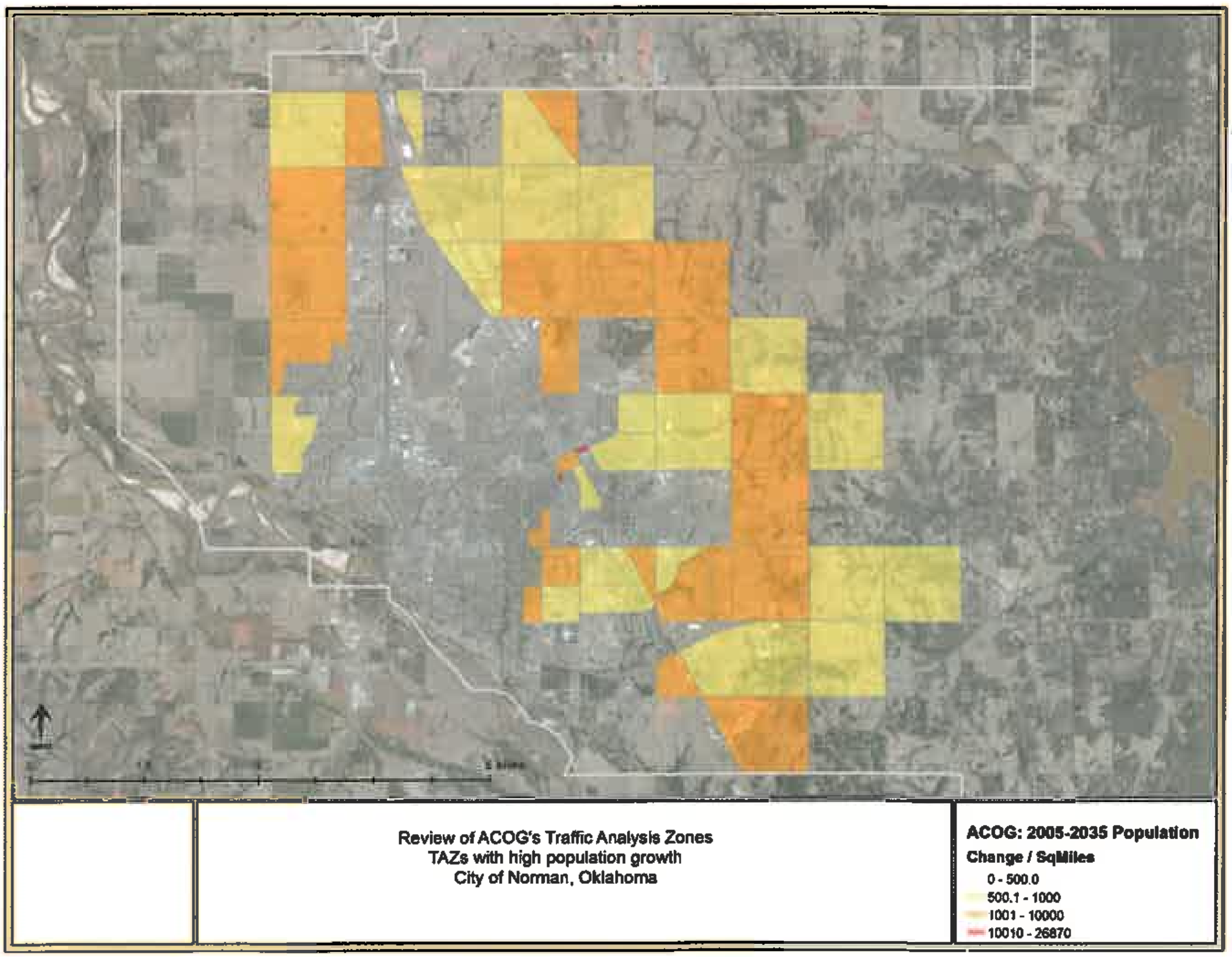
Initially submitted to city of Norman as
Technical Memorandum
February 1, 2013

1.0 TAZ Review related to forecasted Population & Employment Growth

For the purpose of "adequate coverage for anticipated growth", I reviewed all TAZs that showed a 25+% of growth in either population or employment, if at least a 500+ new pop change/sq mile or 100+ emp change/sq mile is forecasted for 2035.

1.1 *Population Growth Review*

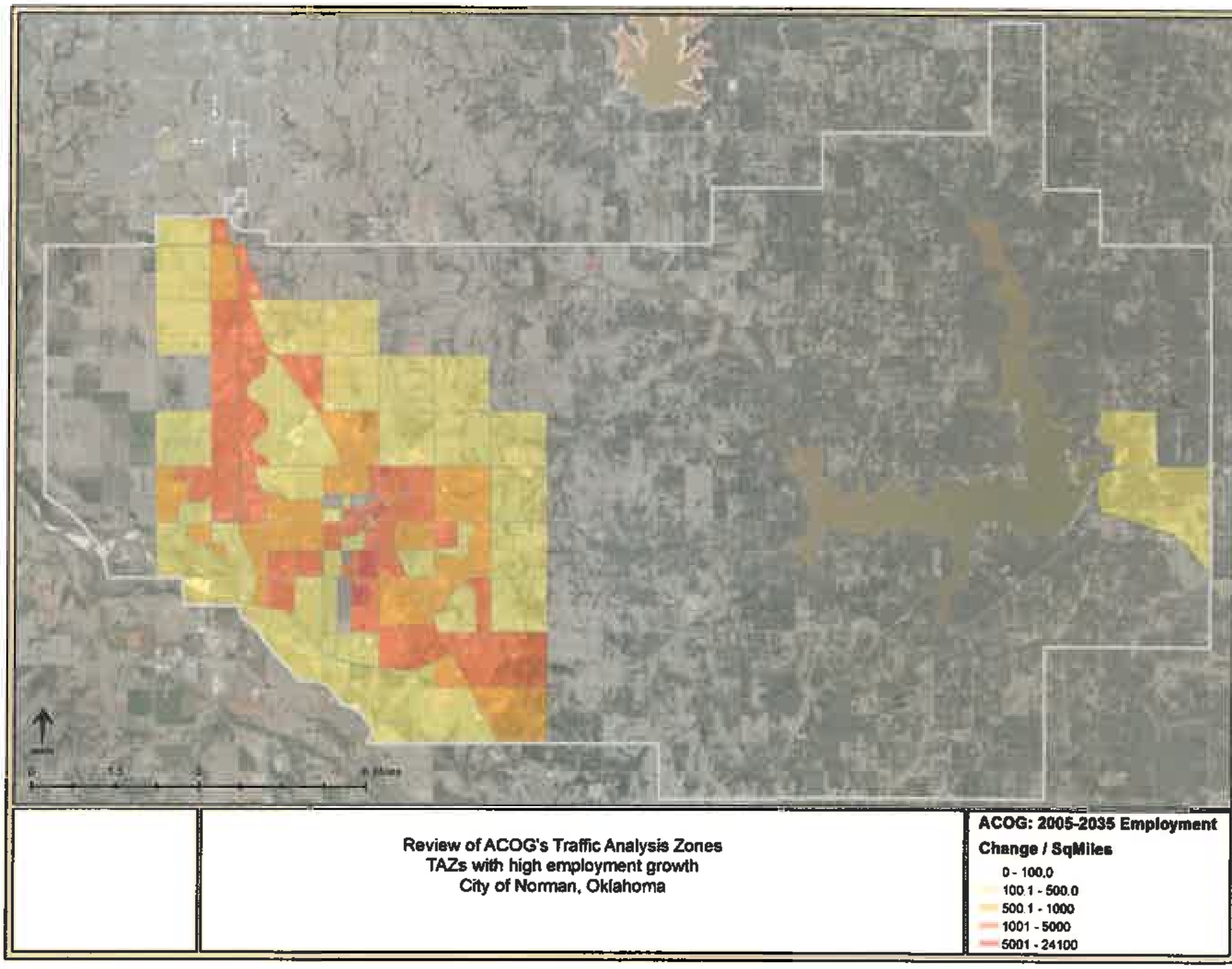
Of 50 TAZs with a 500+ change in persons per square mile (see image below), approximately 39 showed an actual growth of more than 25%; of these 39, five TAZs with an area of less than 0.025 sq miles (16 acres) were removed from further consideration, as a refinement of the model network at this scale would not have improved the representation of traffic flows; the remaining 34 TAZs were reviewed in detail, but additional network modifications based on population growth were not thought to be necessary, as the TAZs in question were adequately represented in the model network.



1.2 *Employment Growth*

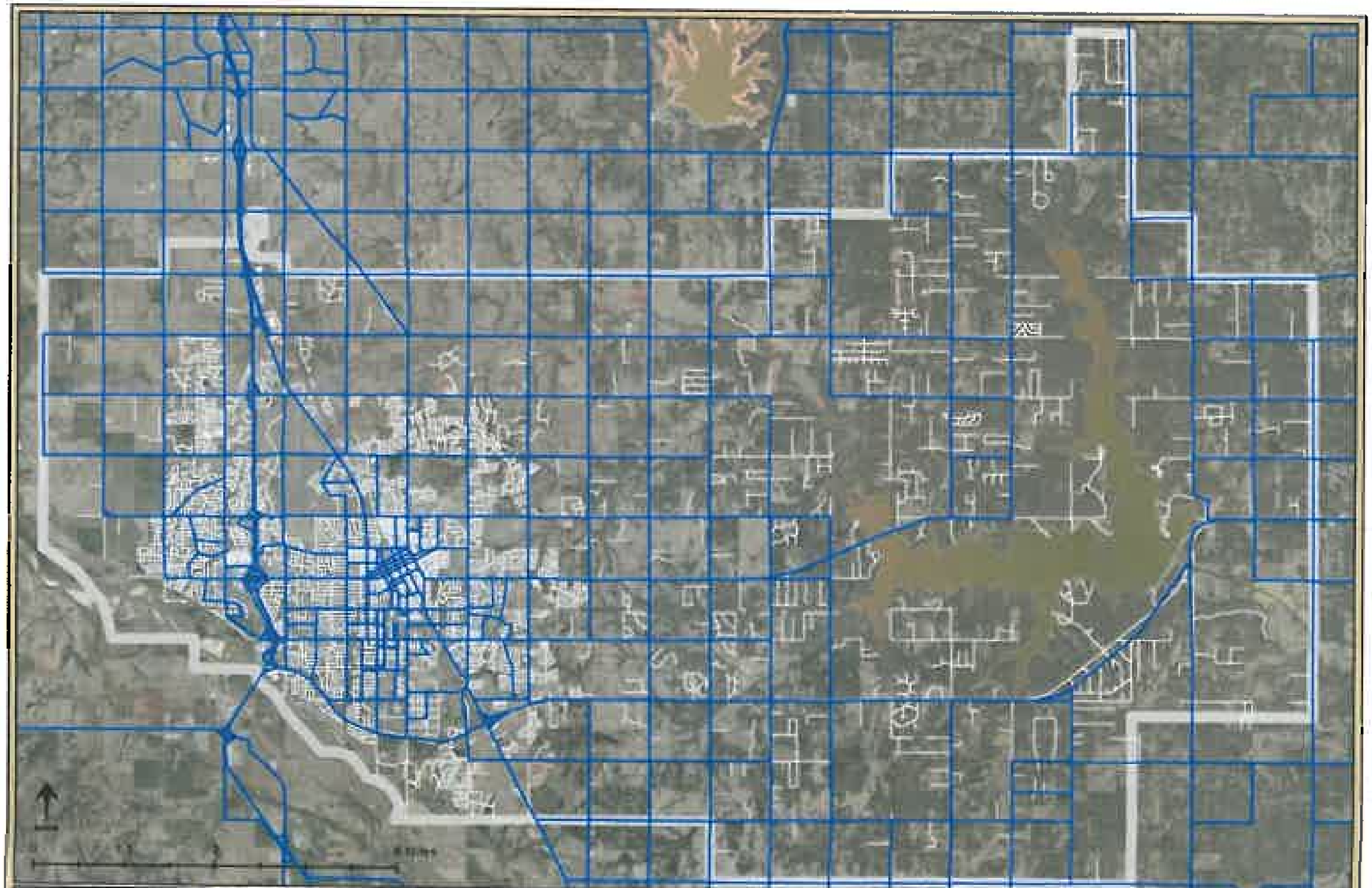
111 Norman TAZs are forecasted to have a growth of more than 100 employees per sq mile (see map below). 8 of the selected TAZs showed less than 25% growth over 2005 employment and were removed from the detailed analysis; 12 TAZs with an area of less than 0.025 sq miles (16 acres) were also eliminated from further consideration, as a refinement of the model network at this scale would not have improved the representation of traffic flows.

Of the 91 TAZs that underwent a more detailed assessment, 37 had already undergone a detailed review for population growth; the review of the remaining TAZs did not reveal any concerns about the high-growth TAZs not being captured adequately within the model network.



2.0 Network Review

The layout of links and centroid connectors within the ACOG travel demand model was reviewed in detail, to ensure a depiction of traffic flows within the City of Norman and reasonable access to each one of the traffic analysis zones within the jurisdiction. The figures on the next pages delineate the travel demand model network links and associated traffic analysis zones. The subsequent table details the findings of the analysis.



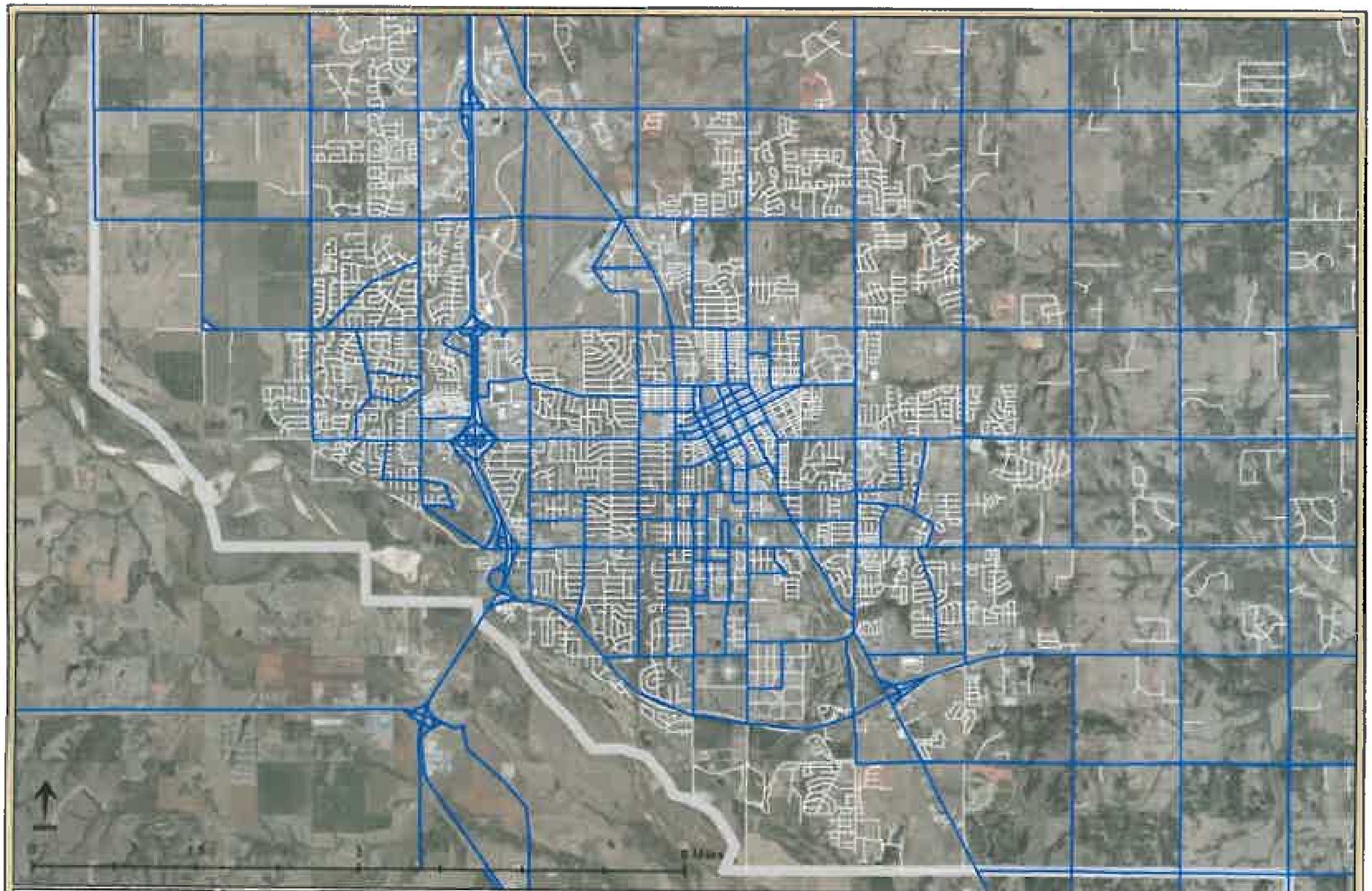
ACOG Travel Demand Model - Network Links
Overview
City of Norman, Oklahoma

Please note that the model network links represent, but do not always line up with the underlying roadway centerline information.

Legend

ACOG: Model Network Links

Norman: Roadway Centerline

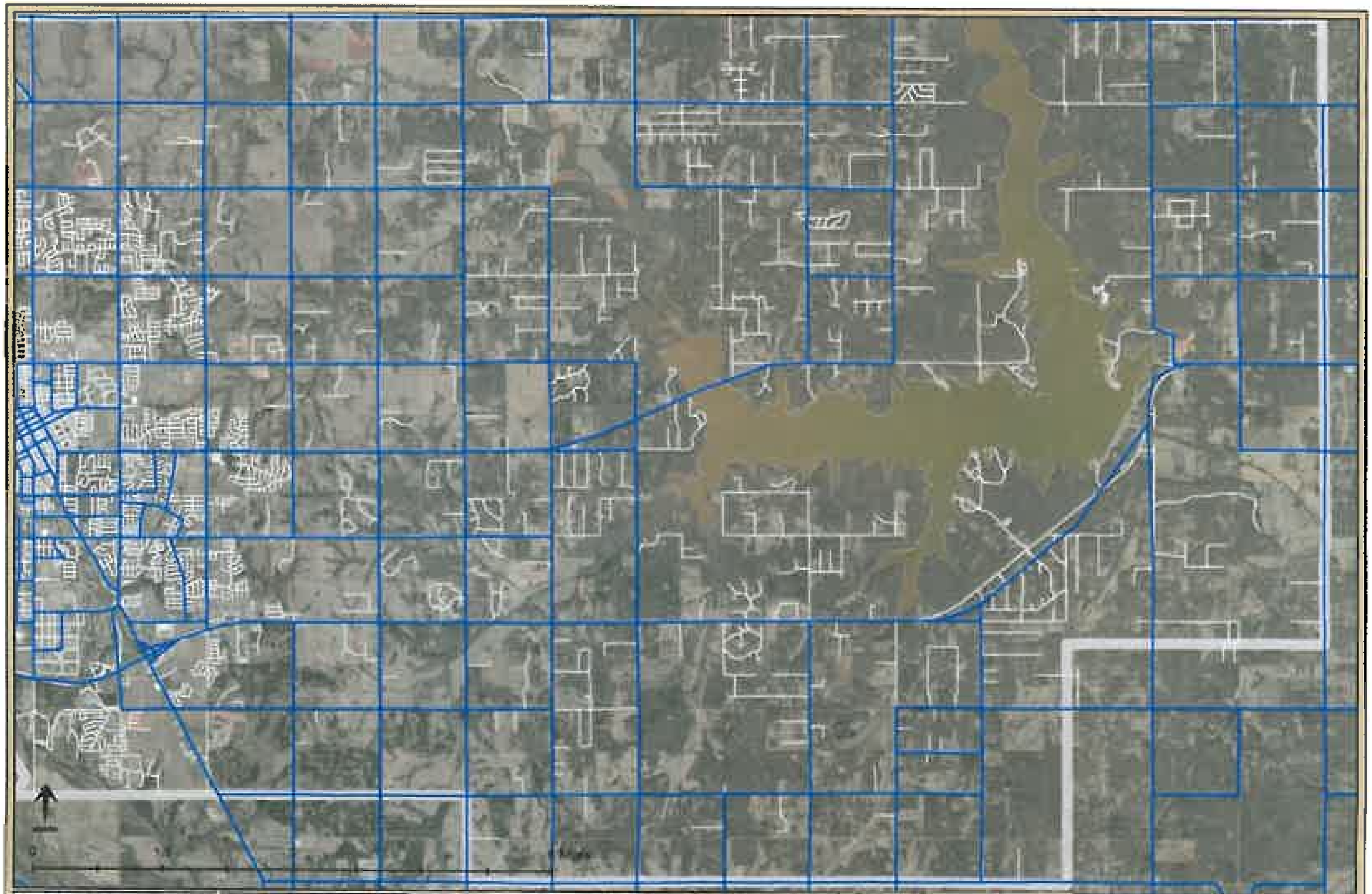


ACOG Travel Demand Model - Network Links
Focus on Central and West Norman
City of Norman, Oklahoma

Please note that the model network links represent, but do not always line up with the underlying roadway centerline information.

Legend

ACOG: Model Network Links
Norman: Roadway Centerline



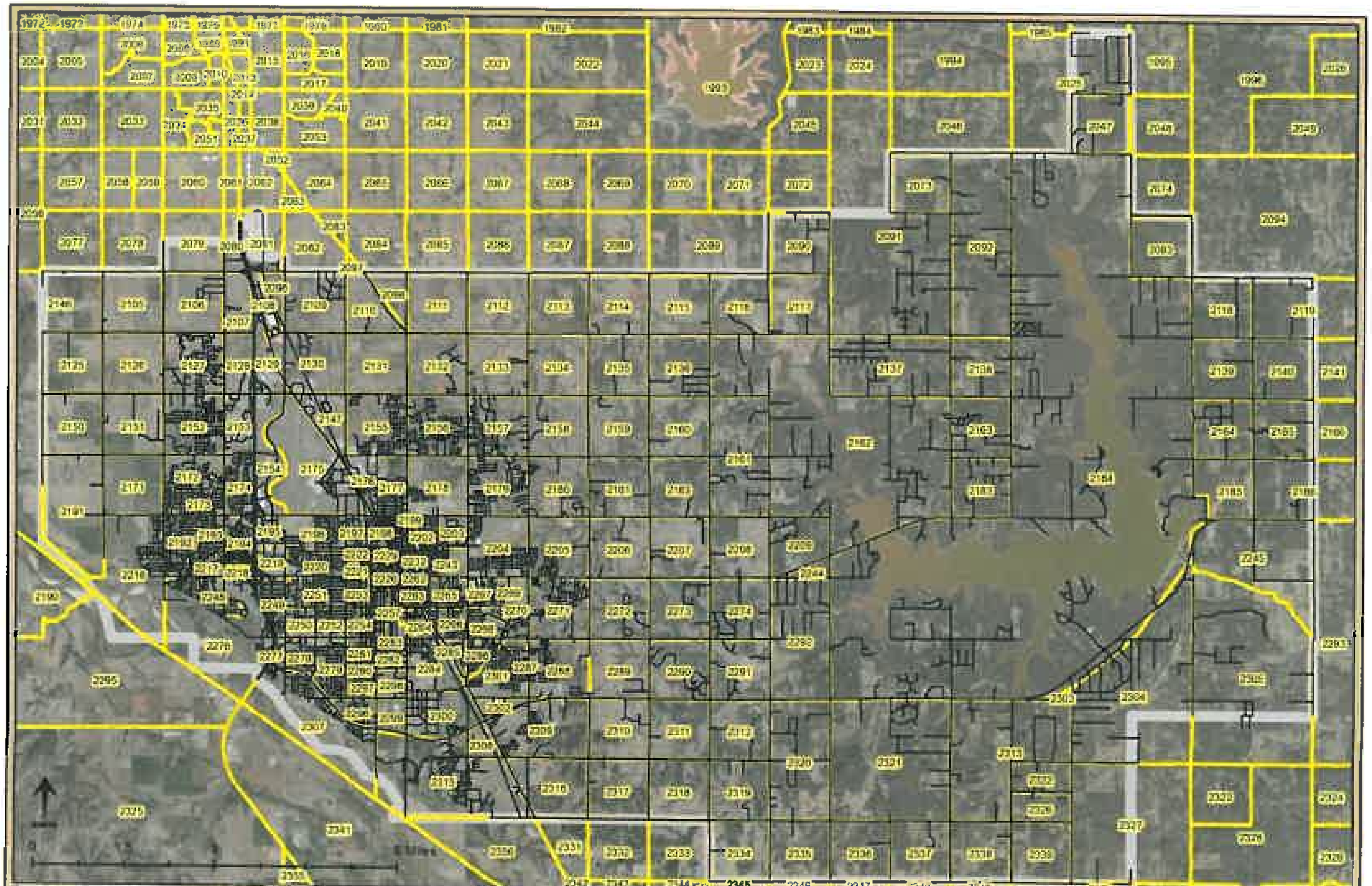
ACOG Travel Demand Model - Network Links
Focus on East Norman
City of Norman, Oklahoma

Please note that the model network links represent, but do not always line up with the underlying roadway centerline information.

Legend

ACOG: Model Network Links

Norman: Roadway Centerline

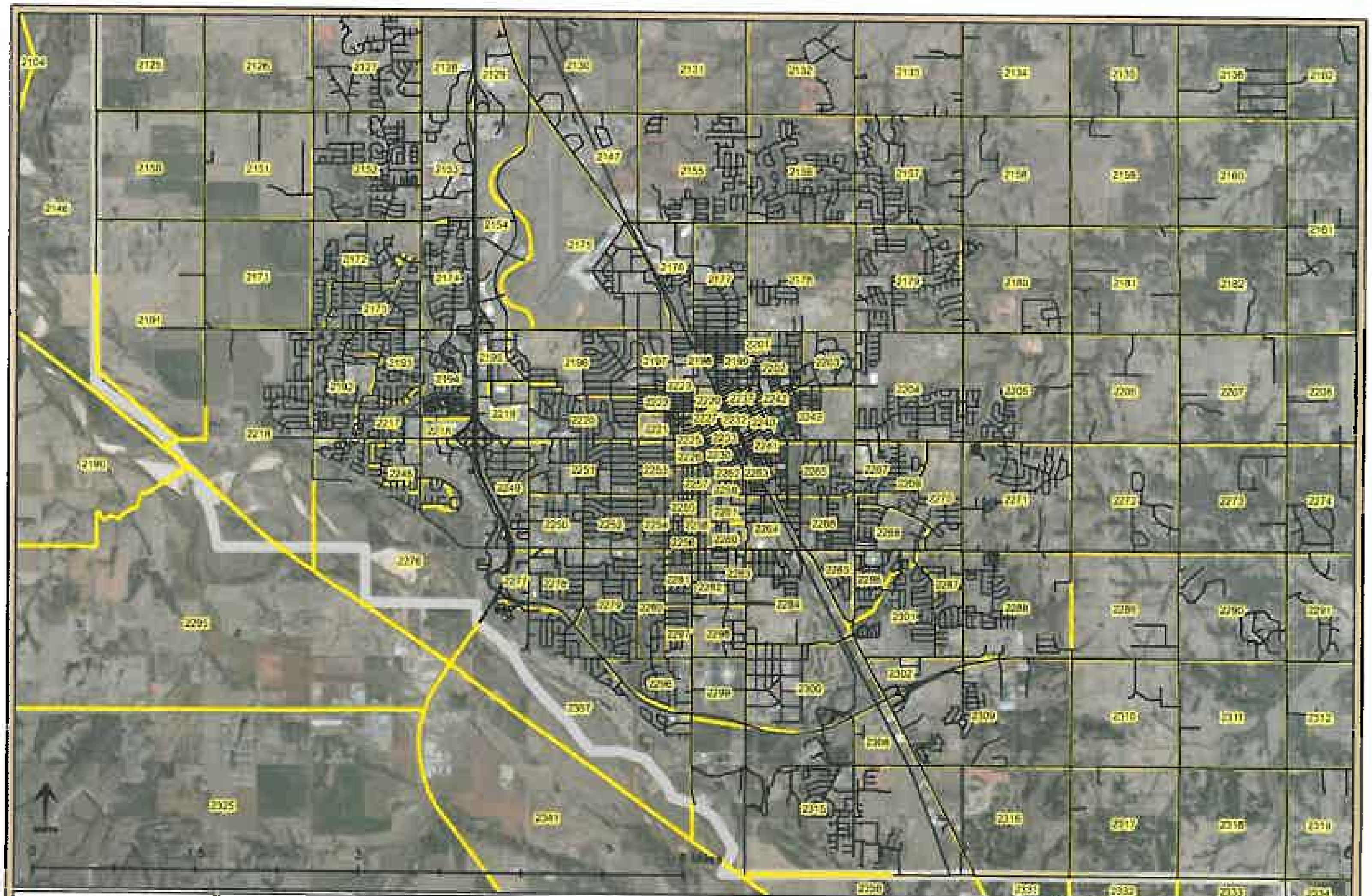


ACOG Travel Demand Model - Traffic Analysis Zones (TAZ)
Overview
City of Norman, Oklahoma

Legend

Norman: Roadway Centerline

ACOG: 2005 TAZ



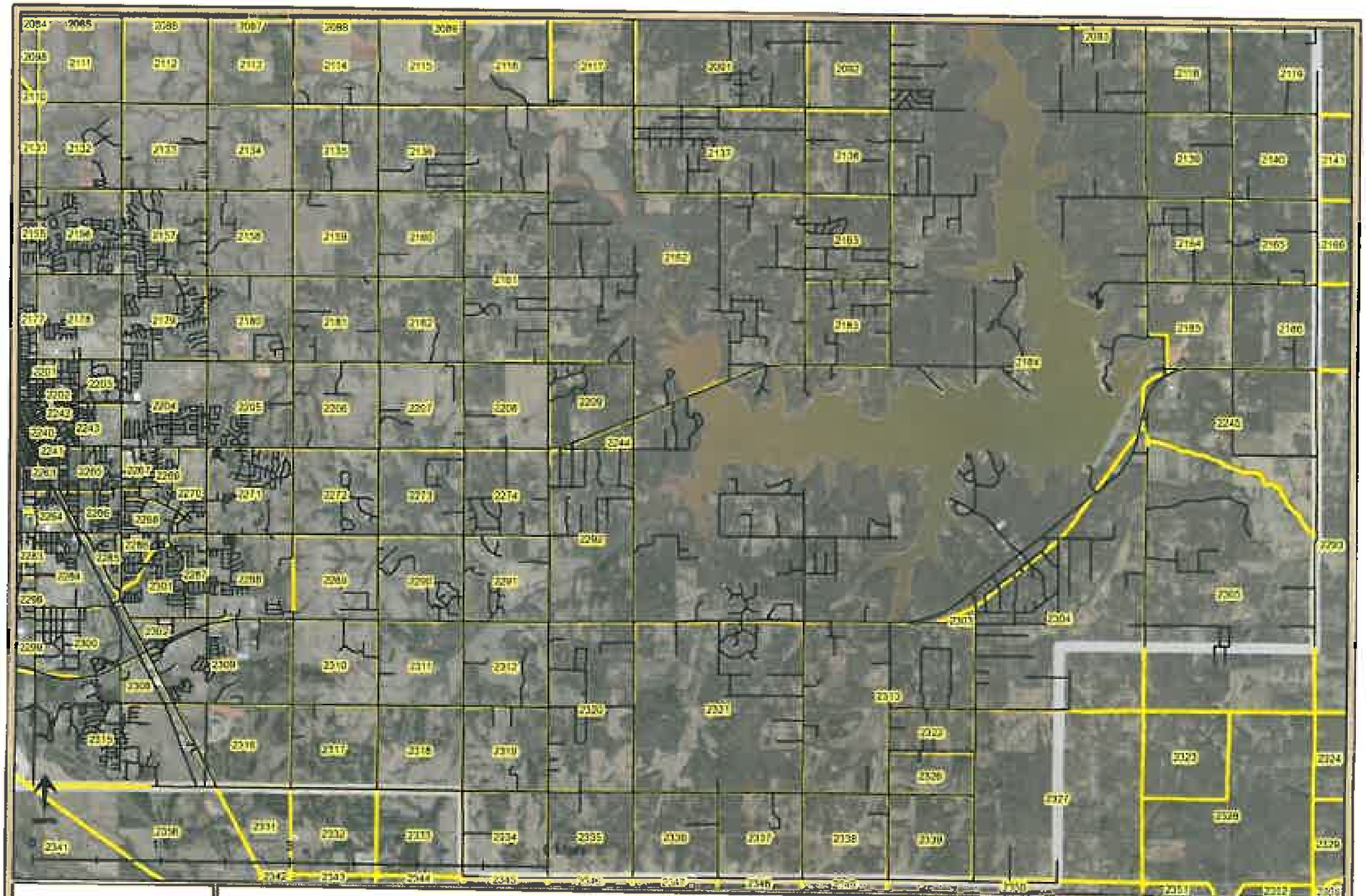
ACOG Travel Demand Model - Traffic Analysis Zones (TAZ)
Focus on Central and West Norman
City of Norman, Oklahoma

Legend

Norman: Roadway Centerline

ACOG. 2005 TAZ

Travel Demand Modeling



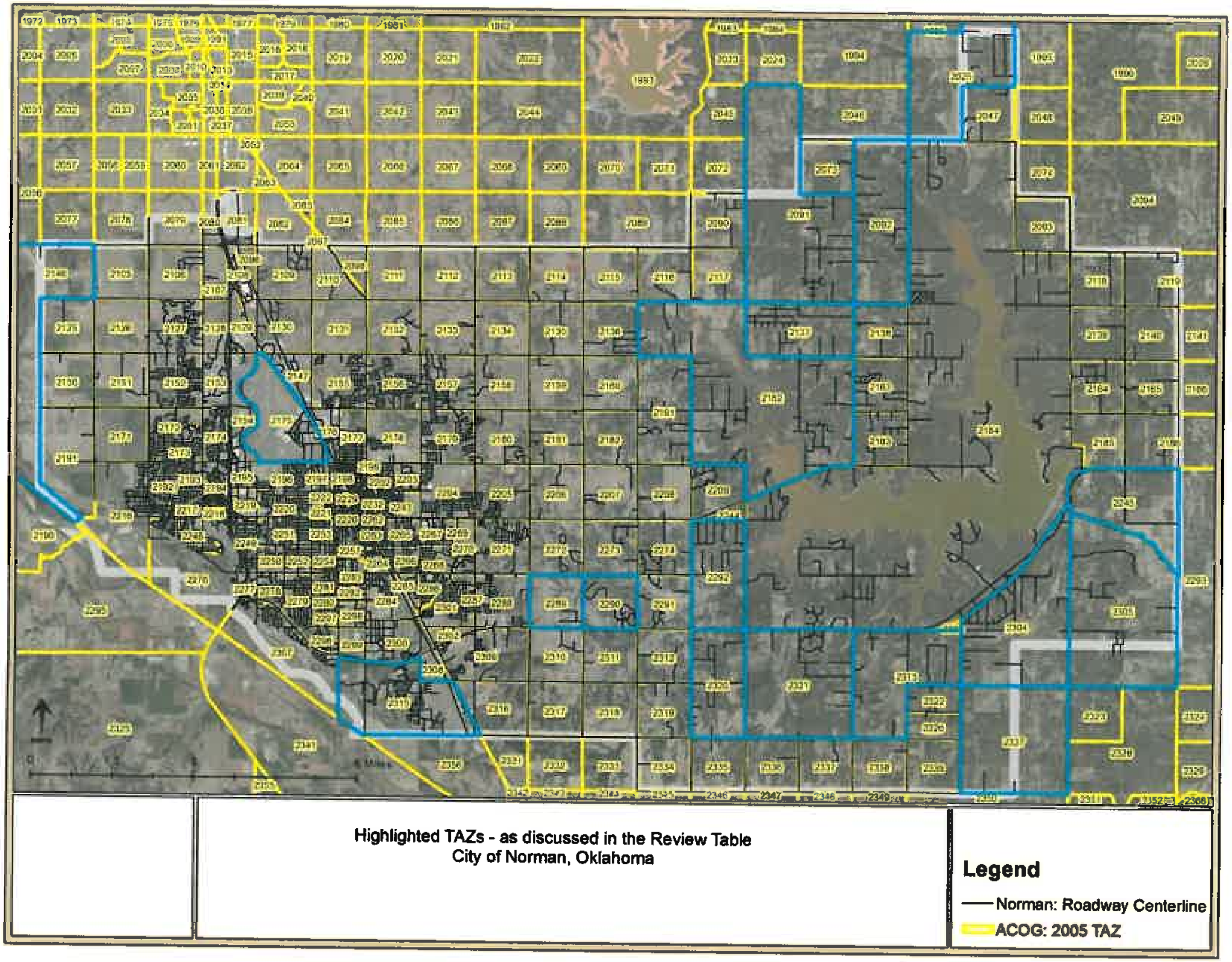
ACOG Travel Demand Model - Traffic Analysis Zones (TAZ)
Focus on East Norman
City of Norman, Oklahoma

Legend

Norman: Roadway Centerline

ACOG: 2005 TAZ

TAZ	*Concern*	*Findings*	*Recommended Action*
2025, 2091, 2146, 2304, 2327	Large TAZ across jurisdictional boundary	Found no continuous section line road	None
2091, 2092, 2137, 2162, 2292, 2305, 2321	Large TAZ	Found no continuous section line road	None
2320	Large TAZ	Continuous section line road found	Consider split
2313	Large TAZ	Contains functionally classified major collector	Split
2315	Large TAZ – considered using Jenkins to split W portion from remainder	Would not benefit the representation of travel patterns	Consider additional centroid connector to 12th Ave SE
2288-2289, 2245-2305	TAZ pairs without a boundary link	Found no continuous section line road – creek locations	None
2175	Link between nodes 7644 and 8488 does not exist	The link is located on airport property (and bisects the runway).	Consider removing



Highlighted TAZs - as discussed in the Review Table
City of Norman, Oklahoma