CONGESTION MANAGEMENT PROCESS UPDATE

Association of Central Oklahoma Governments

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1 Introduction

1.1 What is a Congestion Management Process?

A Congestion Management Process (CMP) is a systematic process used to identify, evaluate, respond to and alleviate traffic congestion. This CMP identifies specific strategies for locations in the Oklahoma City Area Transportation Study (OCARTS) region to minimize traffic congestion and enhance the ability of people and goods to reach their destinations in a timely manner. The CMP was prepared for the Association of Central Oklahoma Governments (ACOG) by Olsson Associates and Cambridge Systematics. An ad hoc committee called the CMP Work Group, comprised of transportation and planning professionals from local governments, the Oklahoma Department of Transportation and the Federal Highway Administration provided input and guidance throughout the update.

The CMP advances the goals developed as part of *Encompass 2040*, the Metropolitan Transportation Plan (MTP) for the OCARTS region. The CMP also works to strengthen the connection between projects identified in the long-range transportation plan and the projects that are ultimately implemented through the short-range Transportation Improvement Program (TIP).

Metropolitan areas above 200,000 population are required by federal law to develop and maintain a CMP. Regulations[1] require that alternatives to building roadway capacity should be explored prior to developing additional physical capacity. Where additional capacity must be added, supplemental multimodal and/or operational improvement strategies should be included in the improvements in order to provide the maximum benefit from the investment.

Incorporating operational and multimodal strategies can save money in the short term by reducing the number of roadway miles that need to be widened and in the long term by providing additional travel options that extend the effectiveness of the primary investment. Regulations require projects that add Single Occupancy Vehicle (SOV) capacity be consistent with the CMP in order to be eligible for federal funding.

ACOG's previous Congestion Management System (CMS) Plan was adopted in 2007. Since that time, ACOG has monitored the CMS network and collected data on which to base network improvements. This CMP update addresses the congestion management needs of the region that have emerged since 2007 and incorporates consistent methods to support the *Encompass 2040* plan update and ensure compliance with federal performance measure requirements of the Moving Ahead for Progress in the 21st Century (MAP-21) Act, and continued under the Fixing America's Surface Transportation (FAST) Act. The CMP identifies congested corridors and targets operational and multimodal strategies to mitigate congestion. It also identifies emerging and regionally significant corridors where proactive steps are important to prevent congestion as well as cost-effective strategies that are appropriate throughout the region. The CMP process continues through the implementation of selected strategies and the evaluation and ongoing monitoring activities to assess the performance of the system and its improvements.

[1] 23 CFR Part 450 Section 320 http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title23/23cfr450_main_02.tpl

1.2 Overview of the Congestion Management Process

The Congestion Management System (CMS) was first introduced as part of the *Intermodal Surface Transportation Efficiency Act (ISTEA)* of 1991 and was outlined as a systematic process for state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) to provide information on transportation system performance and alternative strategies to alleviate congestion and enhance mobility of people and goods.[2] The *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)* of 2005 did little to change requirements, but changed the name of the CMS to the Congestion Management Process (CMP). While the CMS was often used as a stand-alone data analysis/planning exercise, the CMP was intended to be an ongoing process, fully integrated into the overall transportation planning process of both states and regions.[3]

The *Moving Ahead for Progress in the 21st Century (MAP-21) Act* of 2012 also generally preserved the existing laws related to CMPs, but with an increased focus on a performance measure based approach to decision-making and the development of transportation plans. MAP-21 specifically enhanced the monitoring and reporting of congestion and reliability performance measures. Additionally, all metropolitan areas with populations greater than 200,000 residents, known as Transportation Management Areas (TMAs), were required to develop a CMP under MAP-21.

The *Fixing America's Surface Transportation (FAST) Act* of 2015, which provides funding for surface transportation infrastructure and planning over fiscal years 2016 through 2020, supports and continues the national goals and overall performance management approach introduced by MAP-21[4]. The FAST Act also continues the Metropolitan Planning program, including MAP-21's requirement that TMA's develop a CMP. Additionally, it allows that MPOs serving a TMA develop a congestion management plan (distinct from the Congestion Management Process) to be considered as an input to the MPO's Transportation Improvement Program (TIP)[5]

The current CMP is a systematic process of identifying congestion and its causes, applying congestion mitigation strategies to improve transportation system performance and reliability, and evaluating the effectiveness of implemented strategies. Federal regulations are provided in the 23 Code of Federal Regulations (CFR) Section 450.32. As shown in **Figure 1-1** and listed below, fundamental steps in the CMP include:

- **Step 1: Develop Regional Objectives for Congestion Management.** Congestion management objectives should be developed with meaningful stakeholder participation and an understanding of the needs and desires of the public related to congestion. Ideal objectives should focus on outcomes and be SMART: Specific, Measureable, Agreed, Realistic, and Time-bound.
- **Step 2: Define CMP Network.** Define the geographic boundaries and the system components/network of facilities. Although the CMP has traditionally focused primarily

[2] Framework of the Capital Region Transportation Planning Agency (CRTPA) Congestion Management Process Report.

[3] Federal Highway Administration (FHWA) CMP Guidebook.

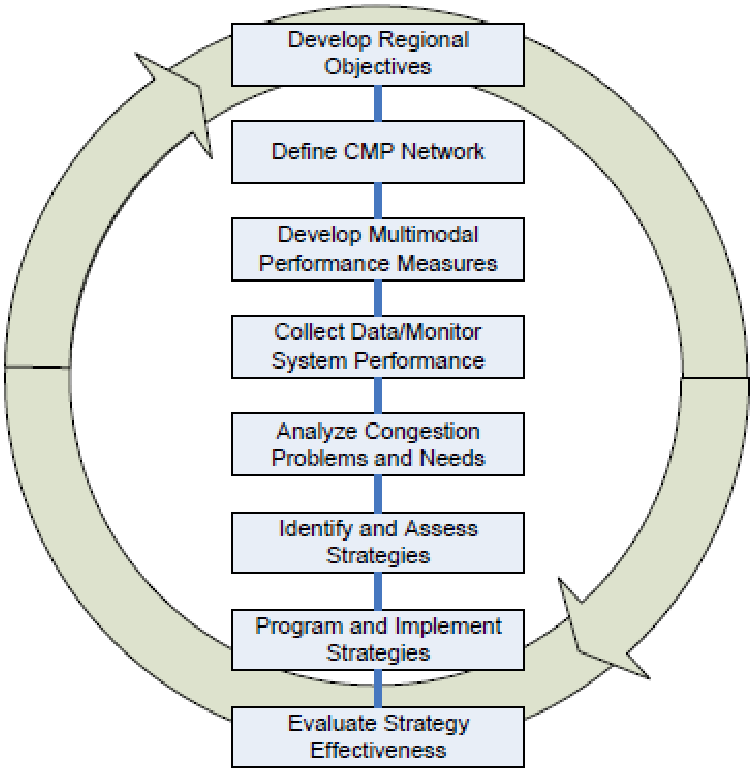
[4] Federal Highway Administration (FHWA) Fixing America's Surface Transportation (FAST) Act Website, Summary, https://www.fhwa.dot.gov/fastact/summary.cfm.

[5] Federal Highway Administration (FHWA) Fixing America's Surface Transportation (FAST) Act Website, Metropolitan Planning Fact Sheet, https://www.fhwa.dot.gov/fastact/factsheets/metropolitanplanningfs.cfm.

on the road network, the network should consider the transit, bicycle, and pedestrian networks as well as their interface with the highway network.

- **Step 3: Develop Multimodal Performance Measures.** Performance measures should be developed and used at the regional level to measure the performance of the system and at the local level (corridor, segment, intersection) to identify specific locations with congestion problems and measure the performance of individual segments and system elements. Performance measures should be adapted and adjusted over time.
- **Step 4: Collect Data/Monitor System Performance.** Numerous agencies must collaborate to collect data and monitor system performance.
- **Step 5: Analyze Congestion Problems and Needs.** Raw data are translated into meaningful measures of performance to analyze congestion problems and needs. The analysis should include locations of major trip generators, seasonal traffic variations, time-of-day traffic variations, and separation of trip purpose.
- **Step 6: Identify and Assess Strategies.** The data and analysis can then be used to identify and assess CMP strategies to effectively manage congestion and achieve congestion management objectives. Important considerations include contribution to meeting regional congestion management objectives, local context, contribution to other goals and objectives, and jurisdiction over CMP strategies.
- **Step 7: Program and Implement Strategies.** Next, these strategies should be programmed and implemented through inclusion of congestion management strategies in various components of the metropolitan transportation planning process, including the Metropolitan Transportation Plan (MTP), TIP, corridor plans, and the Regional Intelligent Transportation Systems (ITS) Architecture.
- **Step 8: Evaluate Strategy Effectiveness.** After implementation, agencies should evaluate strategy effectiveness through system-level performance evaluation and strategy-effectiveness evaluation. Ongoing monitoring of transportation system performance provides a feedback loop designed to inform future decision making about the effectiveness of transportation strategies.

Figure 1-1 Elements of the Congestion Management Process



Source: FHWA, Congestion Management Process: A Guidebook.[6]

Federal requirements have explicitly outlined the CMP implementation and development process to be part of an overall metropolitan transportation planning process that involves coordination with transportation system management and operations activities. The CMP does not have an update cycle established by Federal regulations, though the four-year certification review cycle and the four- or five-year Metropolitan Transportation Plan (MTP) update cycle for each TMA provide a baseline for a reevaluation/update cycle in the absence of a specific requirement.

Federal focus on performance measures is tied to a set of seven national goals, as well as the broader goals of increased accountability and improved transparency. Of the seven national goals outlined in MAP-21 and carried forward into the FAST Act, the following are directly or indirectly related to congestion management:

1. **Safety –** To achieve a significant reduction in traffic fatalities and serious injuries on all public roads;
2. **Infrastructure Condition** - To maintain the highway infrastructure asset system in a state of good repair
3. **Congestion Reduction** – To achieve a significant reduction in congestion on the National Highway System;

[6] http://www.fhwa.dot.gov/planning/congestion_management_process/cmp_guidebook/

4. **System Reliability –** To improve the efficiency of the surface transportation system; and
5. **Freight Movement and Economic Vitality** - To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.

The USDOT is implementing new performance requirements related to these goals through a series of rulemakings. One of these rulemaking processes focuses on specifically congestion and system performance and involves[7]:

- Defining performance of the interstate system, non-interstate National Highway System, and freight movement on the interstate system;
- Finalizing interpretation of scope of Congestion Mitigation and Air Quality Improvement (CMAQ) performance requirements, including congestion and on-road mobile source emissions; and
- Summarizing FAST Act highway performance measure rules.

In addition, a number of rules are expected for transit performance, including a requirement that transit providers embark on target setting and progress reporting. Recent modifications to Sections 5303 and 5304 made in MAP-21 and continued in the FAST Act related to Metropolitan and Statewide Planning require that MPOs serving TMAs include transit agency officials in their governing structure and establishment of performance targets.

Lastly, MAP-21 established, and the FAST Act continued, the National Highway Performance Program (NHPP), which provides financial support for the condition of the National Highway System (NHS). More than half of highway funding is dedicated to this program and devoted to preserving and improving the most important highways both in states and regions. The NHPP will require MPOs to coordinate with states in selecting performance targets to ensure program consistency. In addition, MPOs will be required to report on metropolitan system performance as part of the transportation plan every 4 or 5 years. Reporting requirements include:

- Evaluating the condition and performance of the transportation system;
- Documenting progress achieved in meeting performance targets in comparison with the performance in previous reports;
- Evaluating how the preferred scenario has improved conditions and performance, where applicable; and
- Evaluating how local policies and investments have impacted costs necessary to achieve performance targets, where applicable.

Table 1-1 summarizes the FAST Act national goals related to congestion management, and provides an overview of the current status of proposed rulemaking, including proposed performance measures and guidance on target setting.

[7] MAP-21: Putting Performance into Action, http://www.fhwa.dot.gov/tpm/about/action.pdf#page=2

Table 1-1 FAST Act National Goals

FAST Act National Goals Related to Congestion Management	Notice of Proposed Rulemaking Date	Proposed Performance Measures	Target Setting Guidance
Safety - To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.	Final Rule: April 14, 2016[8]	5-year rolling average on all public roads: • Number of fatalities • Rate of fatalities per 100 million VMT • Number of serious injuries • Rate of serious injuries per 100 million VMT • Number of non-motorized fatalities and non-motorized serious injuries	MPOs will establish targets for the same five safety performance measures for all public roads in the MPO planning area within 180 days after the State establishes each target. The targets will be established in coordination with the State, to the maximum extent practicable. The MPO can either agree to support the State DOT target or establish a numerical target specific to the MPO planning area. MPOs' targets are reported to the State DOT, which must be able to provide the targets to FHWA, upon request. A State is considered to have met or made significant progress toward meeting its safety targets when at least 4 of the 5 targets are met or the outcome for the performance measure is better than the baseline performance the year prior to the target year. Optional urbanized area or non-urbanized area targets will not be evaluated. Each year that FHWA determines a State has not met or made significant progress toward meeting its performance targets, the State will be required to use obligation authority equal to the baseline year HSIP apportionment only for safety projects. States must also develop a HSIP Implementation Plan[9].

[8] Highway Safety Improvement Program Final Rule https://www.federalregister.gov/articles/2016/03/15/2016-05202/national-performance-management-measures-highway-safety-improvement-program

[9] HSIP and Safety Performance Management Measures Final Rules Overview http://safety.fhwa.dot.gov/hsip/spm/measures_final_rules.cfm

FAST Act National Goals Related to Congestion Management	Notice of Proposed Rulemaking Date	Proposed Performance Measures	Target Setting Guidance
Infrastructure Condition - To maintain the highway infrastructure asset system in a state of good repair	NPRM January 5, 2015 Comment period closed April 6, 2015[10]	Percent of Interstate pavement in good, fair, and poor condition based on the International Roughness Index (IRI) Percent of non-Interstate NHS pavement in good, fair, and poor condition based on IRI Pavement Structural Health Index Percent of deck area on structurally deficient bridges NHS bridges in good, fair, and poor condition based on deck area	State DOTs to establish 2- and 4-year targets for a 4-year performance period for the condition of highway and bridge infrastructure. First targets to be established 1 year after the effective date of this rule. The MPO could either support the State DOT target or set a numerical target specific to the MPO planning area, within 180 days following the establishment of the State DOT's target[11].
Congestion Reduction - To achieve a significant reduction in congestion on the National Highway System	NPRM April 22, 2016 Comment period closes August 20, 2016[12]	Annual hours of excessive delay per capita	Threshold: A travel time segment is considered to have excessive delay if the travel speed is equal to or slower than the following: • 35 mph for Interstates, freeways, or expressways • 15 mph for principal arterials and all other NHS roads The Threshold Travel Time would be the travel time segment length divided by the threshold speed. Measure: The Annual Hours of Excessive Delay Per Capita would be computed to the nearest tenth for each applicable urbanized area by summing the Total Excessive Delay (vehicle-hours) for all travel time segments and dividing it by the population of the urbanized area. A

[10] Assessing pavement condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program https://www.federalregister.gov/articles/2015/01/05/2014-30085/national-performance-management-measures-assessing-pavement-condition-for-the-national-highway

[11] Infrastructure Condition (Pavement and Bridge) Performance Measures NPRM. https://www.federalregister.gov/articles/2015/01/05/2014-30085/national-performance-management-measures-assessing-pavement-condition-for-the-national-highway

[12] Assessing performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program https://www.federalregister.gov/articles/2016/04/22/2016-08014/national-performance-management-measures-assessing-performance-of-the-national-highway-system

FAST Act National Goals Related to Congestion Management	Notice of Proposed Rulemaking Date	Proposed Performance Measures	Target Setting Guidance
			2-year target would not need to be established in the initial Baseline Performance Period Report.[13]
System Reliability - To improve the efficiency of the surface transportation system	NPRM April 22, 2016 Comment period closes August 20, 2016[11]	Percent of the Interstate System and non-Interstate NHS providing for reliable travel times Percent of the Interstate System and non-Interstate NHS where peak hour travel times meet expectations	TBD – Measure calculation: The Percent of the Interstate System and non-Interstate NHS providing for Reliable Travel Times and the Percent of the Interstate System and non-Interstate NHS where Peak Hour Travel Times meet expectations would be computed to the nearest tenth of a percent using the following formula: $100 \times \frac{\sum_{i=1}^{R} SL_i}{\sum_{i=1}^{T} SL_i}$ where: • i = reporting segment • R = total number of reporting segments operating at a specified performance level, as defined through a threshold proposed for each metric • T = total number of reporting segments in the system and area applicable to the measure • SL_i = length of the reporting segment, to the nearest thousandth of a mile[14]
Freight Movement and Economic Vitality - To improve the national freight network, strengthen the ability of rural communities to access national and	NPRM April 22, 2016 Comment period closes August 20, 2016[11]	Percent of the Interstate System mileage providing for reliable truck travel times Percent of the Interstate System mileage uncongested	TBD – Measure calculation: The Percent of the Interstate providing for Reliable Truck Travel Times would be computed for the Interstate System to the nearest tenth of a percent using the following formula:

[13] Traffic Congestion (Subpart G) and On-Road Mobile Source Emissions (Subpart H) http://www.fhwa.dot.gov/tpm/rule/cmaq20042016.pdf

[14] Performance of the National Highway System (Subpart E) http://www.fhwa.dot.gov/tpm/rule/systemperf20042016.pdf

FAST Act National Goals Related to Congestion Management	Notice of Proposed Rulemaking Date	Proposed Performance Measures	Target Setting Guidance
international trade markets, and support regional economic development.			$$100 \times \frac{\sum_{i=1}^{R} SL_i}{\sum_{i=1}^{T} SL_i}$$ Where: • a = an Interstate System reporting segment exhibiting Reliable Truck Travel Times • SLa = segment length, to the nearest thousandth of a mile, of Interstate System reporting segment "a" • R = total number of Interstate System reporting segments exhibiting Reliable Truck Travel Times • i = an Interstate System reporting segment • SLi = segment length, to the nearest thousandth of a mile, of Interstate System reporting segment "i" • T = total number of Interstate System reporting segments The Percent of the Interstate System Mileage Uncongested would be computed for the Interstate System to the nearest tenth of a percent using the following formula: $$100 \times \frac{\sum_{g=1}^{U} SL_g}{\sum_{i=1}^{T} SL_i}$$ Where: • g = an uncongested Interstate System reporting segment • SLg = segment length, to the nearest thousandth of a mile, of Interstate System reporting segment "g"

FAST Act National Goals Related to Congestion Management	Notice of Proposed Rulemaking Date	Proposed Performance Measures	Target Setting Guidance
			• U = total number of uncongested Interstate System reporting segments • i = an Interstate System reporting segment • SLi = segment length, to the nearest thousandth of a mile, of Interstate System reporting segment "i" • T = total number of Interstate System reporting segment[15]

1.3 Peer Review and Best Practices

A review of recently adopted CMPs from peer communities around the nation was conducted at the outset of the update process. In order to focus the review on communities that were the most similar and would potentially have the most applicability to the challenges that the OCARTS region is facing, screening criteria were developed. These criteria were used to identify candidate peer communities and potential best practices. The criteria are shown below:

- **Last CMP Update:** To be considered for review, the MPO had to have published a CMP document within the last four years (2011 or later).
- **Regional Population:** Peer agencies were identified as having a regional population similar to the ACOG region (1.1 million residents); the exception being Dallas-Ft Worth, which was included due to its proximity and to provide an example of a high-quality CMP for a larger region. Populations in the urbanized areas for peer agencies range from 760,000 (Albuquerque) to 1.6 million (Kansas City); the population in the Dallas-Ft Worth region is 5.5 million.
- **Percent of Lane-Miles in Congested Conditions:** This figure measures the geographic extent of congestion in the region during peak travel hours. Values ranged from 18 percent (Albuquerque) to 34 percent (San Antonio), with 23 percent of Oklahoma City's network congested at rush hour.
- **Delay per Commuter:** This metric measures the annual excess delay in hours experienced by each commuter. Figures ranged from 36 hours (Albuquerque) to 53 hours (Dallas-Ft Worth), with Oklahoma City experiencing an average of 49 excess hours per commuter per year.

[15] Freight Movement on the Interstate System (Subpart F) http://www.fhwa.dot.gov/tpm/rule/freightmeas20042016.pdf

- **Attainment status:** This metric shows which cities failed to meet regulatory standards for one or more of the EPA's criteria air pollutants, which affects funding through the Federal Congestion Mitigation and Air Quality Improvement Program (CMAQ). Oklahoma City is currently in attainment for all pollutants. The best practices review considered a mix of regions with both attainment and nonattainment status.

Peer Communities

Based upon these criteria, six peer communities were selected for review. The results of the peer community screening are shown below in **Table 1-2.**

Table 1-2 Selected Peer Communities

City	MPO	Last CMP Update	Population	Lane-Miles Congested	Delay Per Commuter [16]*	EPA Non-attainment
Albuquerque	Mid-region Council of Governments (MRCOG)	2012	760,000	18%	36	
Charlotte	Charlotte Regional Transportation Planning Organization (CRTPO)	2013	1,200,000	24%	43	•
Dallas-Ft. Worth	North Central Texas Council of Governments (NCTCOG)	2013	5,485,000	27%	53	•
Kansas City	Mid-America Regional Council (MARC)	2011	1,600,000	21%	41	•
Memphis	Memphis Urban Area Metropolitan Planning Organization (MUA-MPO)	2015	1,085,000	20%	43	•
Oklahoma City	**Association of Central Oklahoma Governments (ACOG)**	**2007**	**1,100,000**	**23%**	**49**	
Salt Lake City	Wasatch Front Regional Council (WFRC)	2013	1,100,000	25%	37	•
San Antonio	Alamo Area Metropolitan Planning Organization (AAMPO)	2014	1,935,000	34%	44	

* Total annual hours.

[16] Source: *Urban Mobility Scorecard,* Texas Transportation Institute (2015); *Criteria Pollutant Nonattainment Summary Report*, US EPA (2015).

Best Practices

While the CMP is a federally-required planning document, in practice the quality and usefulness of CMP preparations varies considerably. Extra attention to a few key focal areas can help ensure that a CMP contributes substantially to the cohesiveness, efficiency and effectiveness of the regional transportation process. Key takeaways from the peer best practices review include:

- **Cohesiveness and Integration**. Goals, objectives, measures, and evaluation methodologies should have clear, hierarchical relationships. A consistent and coherent set of goals and objectives should link the CMP, NEPA studies, TIP and MTP.
- **Consistency and Rigor**. Performance measures and evaluation criteria should have well-vetted methodologies for the collection and analysis of their underlying data. Inclusion requirements for elements in the CMP network should be clear, objective, and logical. Performance measures should be collected using consistent methodologies and schedules to allow longitudinal analysis of congestion trends but should also be adaptable to new methods of data collection and analysis that provide higher quality information at lower cost.
- **Appropriateness of Scope**. The network and performance measures should be comprehensive enough to fully characterize congestion in the region, but not so numerous that the information presented becomes unwieldy. Performance measures should be readily obtainable, relevant, and easy to understand.
- **Relevance and Accessibility**. Clear timelines for evaluation and CMP updates should be established. The CMP network should reflect the current state of the transportation system. Strategies and performance measures should reflect the state-of-the-art. Results should be publically available, documented, well-curated and easily interpretable.
- **Practicality and Community Support**. Strategies and measures should be locally-appropriate and reflect the capabilities and values of their agencies and communities. Buy-in from stakeholders and the community at large should be integrated into the evaluation process. Strategies should be cost-effective, efficient, and serve the community as part of a cohesive transportation network.

2 Regional Objectives for Congestion Management

2.1 Objective Development

The CMP objectives were primarily defined through detailed discussions with ACOG staff and the CMP Work Group, a subcommittee of the Intermodal Transportation Technical Committee at the project's kickoff meeting in December 2015. Additional definition was gained through ongoing discussions with ACOG about the need to better link congestion management planning, performance measures, and the overall CMP with the ongoing *Encompass 2040* effort.

The objectives for the CMP Update are consistent with the overall congestion management-related goals and objectives currently being defined in the *Encompass 2040* update. These included:

- Meet the Federal requirements for congestion management planning;
- Provide the technical foundation for the development of the CMP Update;
- Integrate the CMP with ACOG's current 2040 Metropolitan Transportation Plan (MTP), *Encompass 2040*; and
- Address the public and agency stakeholder goals for congestion management as defined through ACOG's ongoing *Encompass 2040* process.

2.2 CMP Guiding Principles

Consistent with *Encompass 2040*, the CMP is focused on a comprehensive set of Travel Demand Management (TDM), Transportation System Management and Operations (TSM&O)/Intelligent Transportation Systems (ITS), transit, and pedestrian and bicycle strategies. This focus provides an emphasis on projects that are quick to implement and are low cost (relative to traditional capacity expansion). Where capacity projects are shown to be needed, these projects will complement roadway capacity enhancement projects in both the CMP and *Encompass 2040*.

The primary guiding principles of the ACOG CMP Update include:

- Identification of a mix of strategies and projects designed to best manage current congestion and to reduce congestion anticipated in the future.
- Identification of opportunities and processes to incorporate CMP strategies into larger capital investment projects.
- Identification and application of performance measures that can realistically be collected and analyzed, to provide ACOG with an objectives-driven approach to planning. Performance measures should allow evaluation of the congestion relief impacts of multimodal strategies, in addition to roadway capacity expansion projects.
- Identification of opportunities to increase use of alternative travel modes, including public transit and non-motorized travel.
- Incorporate the impact of emerging services and technologies such as carsharing and on-demand transportation services into the CMP process.

2.3 Objectives for Congestion Management

Objectives have been developed for the updated CMP based upon guiding principles discussed in the previous section. The objective areas were developed to link the guiding principles to potential performance measures and ultimately to improvement strategies that will be implemented on the CMP network. The objectives are broad-based and can apply to multiple system improvements. Similarly, system improvements may be categorized under multiple objectives.

Objectives for the ACOG CMP are shown below:

- Invest in improvements that enhance the efficiency of the existing transportation system.
- Improve design, construction, and maintenance of infrastructure to reduce the number and severity of crashes, injuries and fatalities.
- Expand and maintain accessible and connected pedestrian and bicycle facilities.
- Improve and increase the walkability and bikeability of the region.
- Implement local complete streets policies where appropriate.
- Increase capacity where needed.

Efficiency improvements comprise the largest possible objective category in that almost all of the implementation strategies will yield some level of efficiency improvement. The remainder of the objectives flow in descending order of general applicability with the exception of capacity improvements. As stated in **Chapter 1**, capacity improvements may be necessary to ensure the efficiency of the system and to remove bottlenecks. However, capacity improvements should be regarded as a last resort solution to a given issue and should include various other CMP strategies in order to maximize the benefit of the investment.

2.4 Connection to *Encompass 2040* Goals and Objectives

Encompass 2040 is organized around seven regional goals. Each of the goals relate to congestion management in some way. This linkage is described by a subset of the *Encompass 2040* objectives that address regional mobility and congestion (**Table 2-1**). For example, Equity and Options and Healthy Communities each relate to the development transportation demand management strategies by increasing access to and awareness of alternative transportation options. Similarly, Economic Strength, Safety and Security, and Performance all relate to the development of transportation system management and operations strategies (e.g., advanced traveler information systems, ramp metering, or dynamic message signs), among other congestion management strategies. As a result, the CMP goals have been framed to be consistent with the overall goals and congestion management-related objectives contained in *Encompass 2040*.

The objectives and performance measures for the ACOG CMP Update are displayed in **Table 2-1** below. The objectives are shown in relation to the *Encompass 2040* goal to which they are most closely tied. *Encompass 2040* contains additional objectives that focus on long term system changes and were therefore deemed inappropriate for inclusion in this CMP.

Table 2-1 Linkage Between *Encompass 2040* Goals and CMP Objectives

Encompass 2040 **Goal Areas**	**CMP Objectives**
Economic Strength: Promote economic vitality through enhanced mobility.	- Invest in improvements that enhance the efficiency of the existing transportation system.
Safety and Security: Provide a safe and secure transportation system.	- Improve design, construction, and maintenance of infrastructure to reduce the number and severity of crashes, injuries and fatalities.
Equity and Options: Provide transportation access for the movement of all people and goods.	- Expand and maintain accessible and connected pedestrian and bicycle facilities.
Healthy Communities: Recognize and improve the connection between land use and transportation to enable citizens to live healthier lives and reduce environmental impact from vehicle travel.	-Improve and increase the walkability and bikeability of the region.
Connectivity: Develop connections among all types of transportation.	- Implement a local Complete Streets policy where appropriate.
Performance: Increase the efficiency and reliability of the transportation system.	-Increase capacity where needed.

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3 CMP Network

The congestion management process must be applied to a specific set of links throughout a region's transportation network. In order to determine the best use of this process and its resulting management and implementation strategies, the OCARTS transportation network was reviewed.

The CMP network is a specific set of links that provide the framework for analyzing congestion problems within the OCARTS transportation management area. Network definition began with the existing Enhanced National Highway System in the OCARTS region. Further screening and definition was conducted to develop the final, CMP Focus Network. The CMP network described in this section is not necessarily intended to be comprehensive or all-inclusive as it is anticipated that new and revised corridors will be defined over time as the CMP is applied to emerging congestion challenges.

3.1 Initial Screening of the OCARTS Network

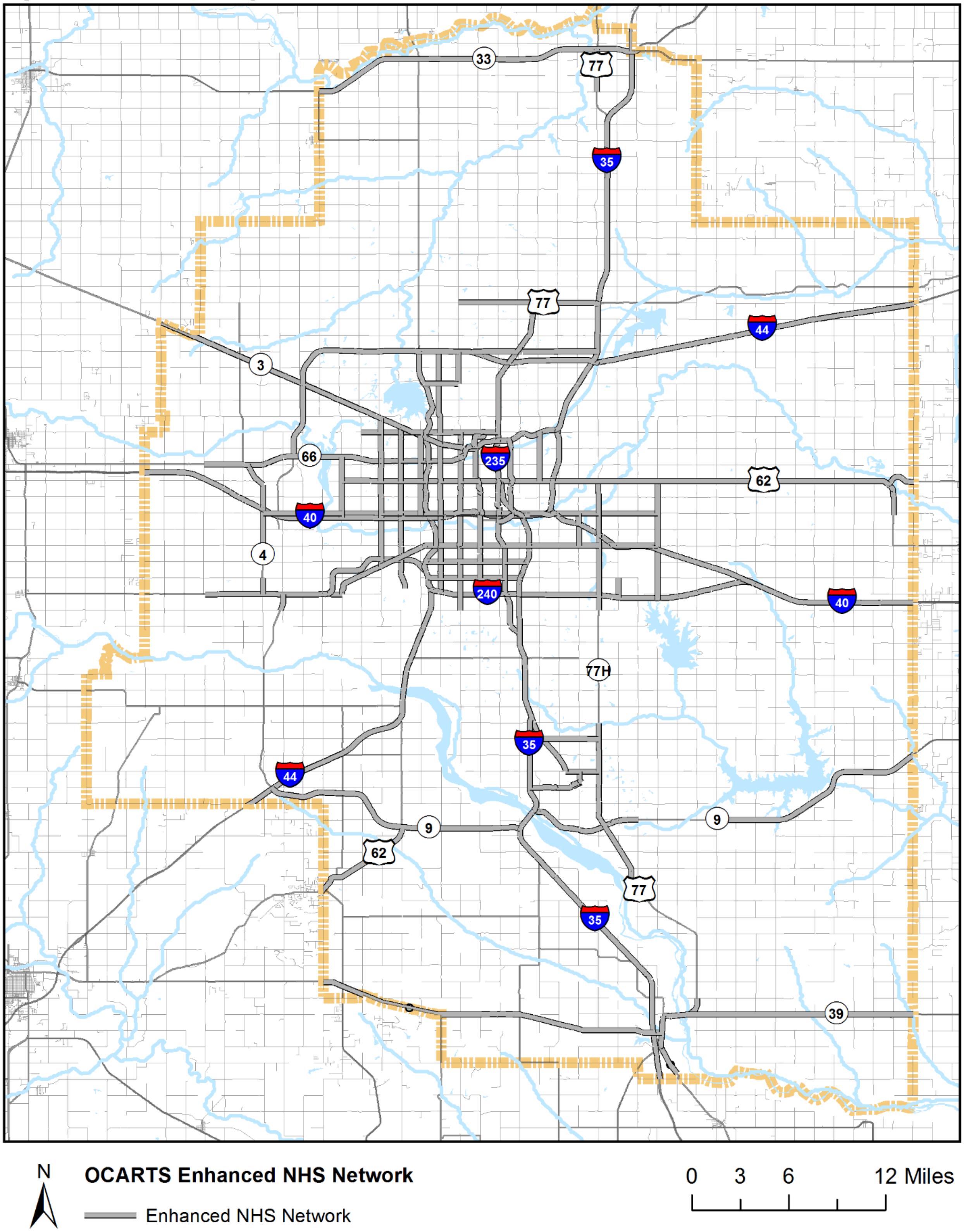
The criteria used to initially screen the existing OCARTS transportation network to identify the new CMP network was based upon the Enhanced National Highway System (NHS) as designated by MAP-21. The Enhanced NHS includes roadways that exhibit the following characteristics:

- All Freeways and tollways;
- All other US Highways;
- All State Highways;
- All other principal arterials;
- All routes with average daily mid-block traffic volumes of 25,000 or more for segments of 2 miles or more in length; and
- All routes with high levels[17] of transit service.

ACOG's Enhanced NHS network provides a thorough and complete system of primary roadways from which to develop a more refined and focused CMP network. The Enhanced NHS network for the OCARTS region is shown in **Figure 3-1** on the following page.

[17] "The level of transit service depends on such factors as ridership and frequency and hours of service. ACOG will consult with transit providers in the region to ensure that appropriate transit routes are considered when designating and updating the congestion management network."

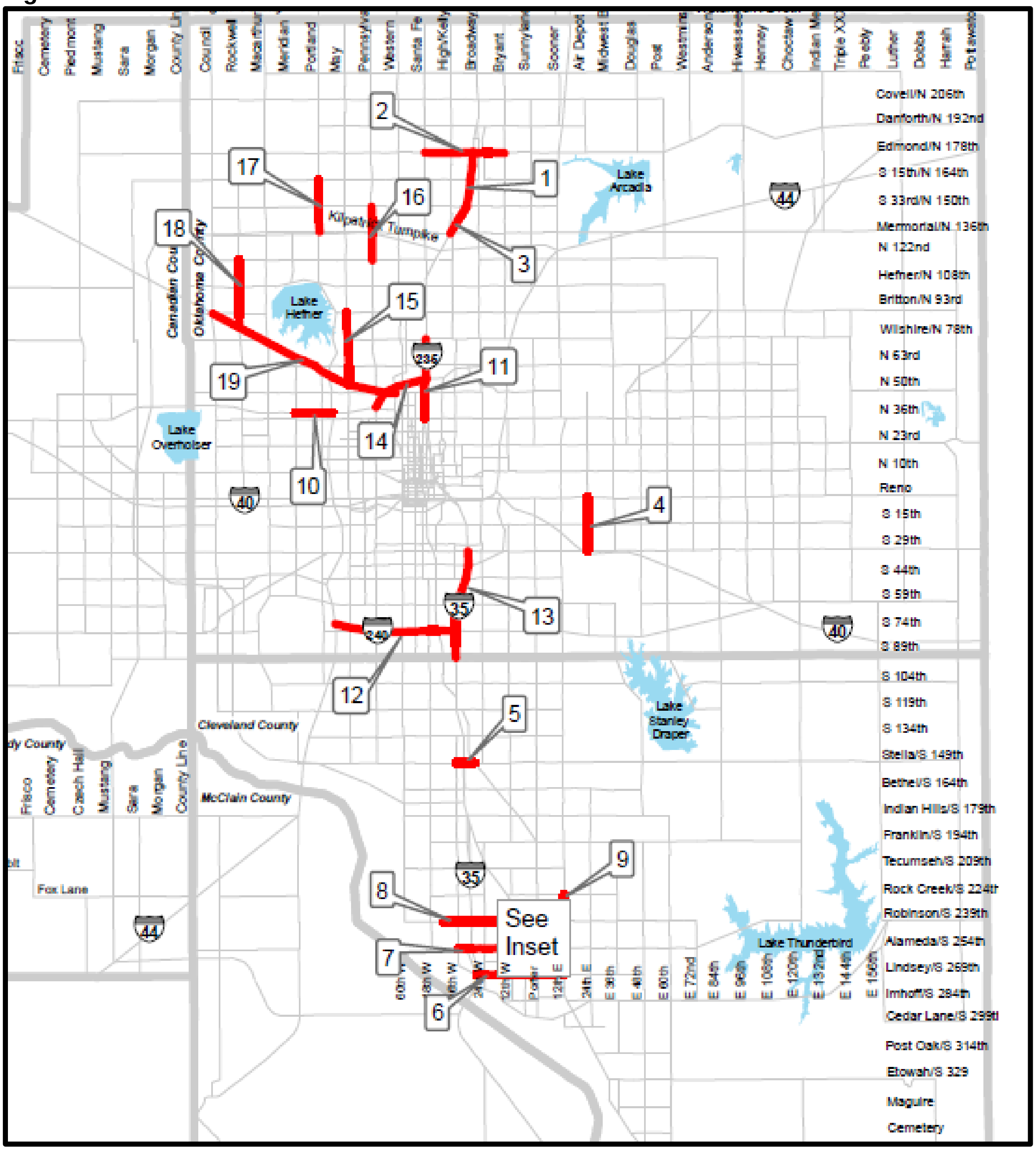
Figure 3-1 OCARTS Regional Enhanced NHS Network



3.2 Past CMS Network Review

As part of the 2007 Congestion Management Process development, the ACOG Congestion Management Work Group (CMWG) recommended each entity within the OCARTS area identify corridors or hotspots that should be evaluated for inclusion into the congestion management network. Additional corridors were submitted by local governments and included as part of the CMP network. After an evaluation process to refine the submittals, ACOG recommended 19 corridors for inclusion in the CMP network. The previous OCARTS CMP network can be seen in **Figure 3-2** below.

Figure 3-2 Previous OCARTS CMP Network



3.3 Travel Time Data Availability

Recently, the Federal Highway Administration (FHWA) contracted with HERE North America, LLC to provide information for the National Performance Measure Research Data Set (NPMRDS) as a tool for performance measurement. HERE North America collects vehicle probe-based travel time data in five minute increments 24 hours a day, seven days a week for National Highway System routes.

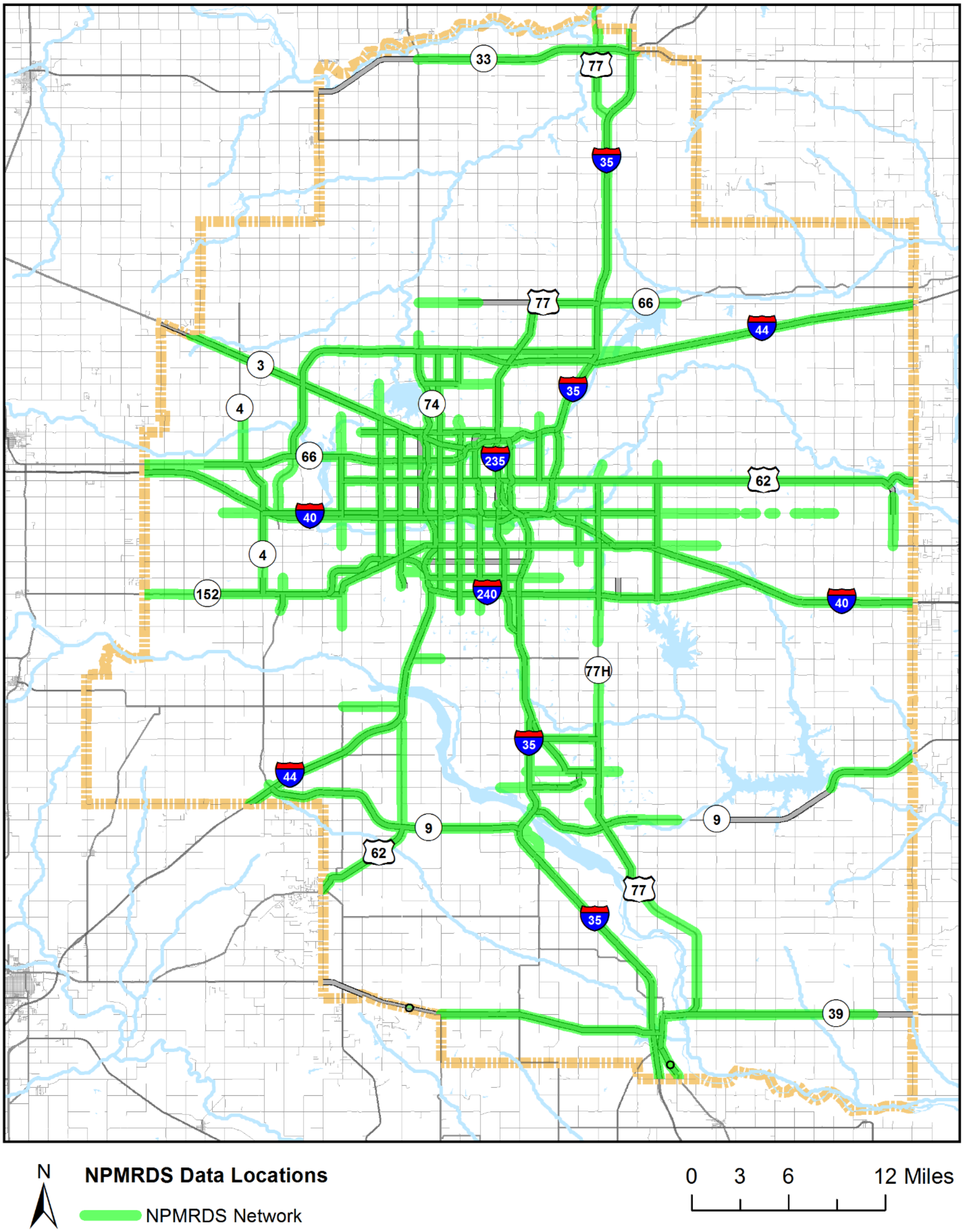
The NMPRDS dataset for this CMP Update includes data collected over a 31-month period from June 2013 to November 2015. Travel time data for the OCARTS region is available for approximately 1,300 roadway segments for five-minute increments, resulting in a total of over 80 million individual data points. **Figure 3-3** shows the roadway network within the OCARTS region for which NPMRDS data are available. This network serves as the starting point for the development of the new CMP network.

Each data point contains the average travel time over segment of known length allowing both travel speed and Travel Time Index (TTI) to be calculated. TTI is the ratio of congested travel time to free-flow travel time. A travel time value of 1.0 means that the congested travel time and the free-flow travel time are identical. Travel time values higher than 1.0 represent locations in which congested travel times are greater than free-flow travel times. For the purpose of this analysis, a segment displaying a TTI greater than 1.1 is considered to be mildly congested. Severe congestion is deemed to be occurring where TTI levels are 1.4 or greater. TTI levels are explained further below in **Table 3-1.**

Table 3-1 Travel Time Indices and Congestion Levels

Travel Time Index (TTI)	Congestion Level	A 20-minute free-flow trip will take…
1.0	None (free-flow)	20 minutes
1.1	Mild	22 minutes
1.2	Modest	24 minutes
1.3	Moderate	26 minutes
1.4	Substantial	28 minutes

Figure 3-3 NPMRDS Network



3.4 Transit Network

Public transportation in the OCARTS region is provided by three different operators. Each of the transit operators provide some sort of regional commuter service connecting urban Oklahoma City to smaller communities and university campuses.

Cleveland Area Rapid Transit (CART) provides transit service in the Norman, OK (Cleveland County) area. CART is operated by the University of Oklahoma and runs a total of 10 fixed routes plus a single commuter route, the Sooner Express. This route provides access to Oklahoma City. The majority of CART routes provide 30-minute service.

The Central Oklahoma Transportation and Parking Authority (COTPA) and the Oklahoma City Public Transportation and Parking Department provide integrated parking and public transportation services to the Oklahoma City area. Both services were rebranded as EMBARK in 2013 and continue to provide fixed route, ADA paratransit, ferry river transit, bike sharing and public parking service in and around Oklahoma City. EMBARK operates 22 routes that provide service to a variety of destinations. The frequency of the EMBARK system varies but most of the routes operate 30-minute service.

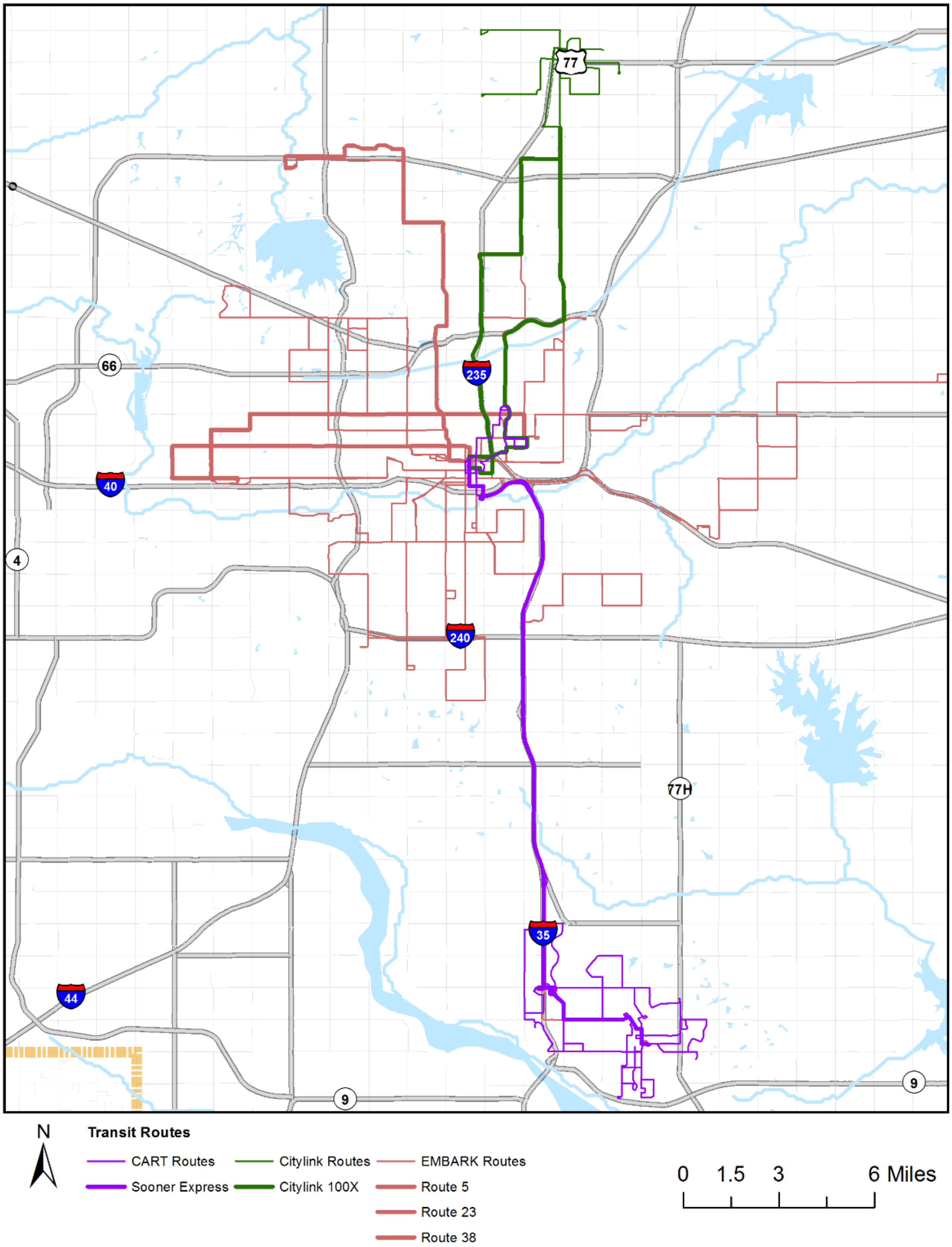
The City of Edmund in partnership with the University of Central Oklahoma provide transit service as Citylink. Citylink offers five regularly scheduled routes. Four of the routes serve the city of Edmund and the UCO campus and are augmented by a single express bus route that provides connections to Oklahoma City and the EMBARK system.

Transit can assist in congestion management by providing more person-capacity as compared to vehicle capacity on a given roadway. For this project the following transit routes have been included in the initial CMP Network:

- CART Sooner Express
- EMBARK Route 5
- EMBARK Route 23
- EMBARK Route 38
- Citylink 100X Expresslink

The transit corridors are shown in **Figure 3-4** on the following page.

Figure 3-4 CMP Transit Corridors



3.5 CMP Network Refinement

Following an initial review of the NPMRDS data on the Enhanced NHS, the CMP network was refined to focus on areas that exhibited the highest level of congestion and need based upon the data available. Conditions on the existing network show some degree of congestion during both morning and evening peak commuting periods. Generally, the evening commute period is slightly more congested for the NHS network. NHS arterials tended to display more congestion in the exurban and regional communities; freeways tended to be more congested inside the Oklahoma City core.

A focused CMP network of 16 corridors displaying substantial congestion as identified by the NPMRDS. Corridors are deemed to be experiencing substantial congestion if they meet one of the following criteria for Travel Time Index (TTI):

1. Moderate peak period TTI (greater than 1.1) across the entire corridor, or
2. Presence of at least one segment with a High TTI (greater than 1.4)

Using these criteria, eight freeway corridors (including one alternate alignment) and eight arterial corridors have been identified as the CMP focus network. It is intended that these routes serve as the focus for observation, monitoring, evaluation and strategy implementation efforts as a part of the *Encompass 2040* and TIP development programs. The CMP Focus Network is outlined in **Table 3-2** below.

Table 3-2 CMP Focus Network Corridor Details

CMP Focus Network Corridor Details				
Name	**From**	**To**	**Type**	**Length**
Douglas Blvd.	I-240	NE 23rd St	Arterial	14.6
E. Reno Ave.	S Eastern Ave	S Hiwassee Rd	Arterial	19.7
Flood Ave.	I-35	Robinson St	Arterial	7.8
NE 23rd St.	N Lincoln Blvd	N Henney Rd	Arterial	24.8
NW Expressway - Classen	SH-74	W Reno Ave	Arterial	13.5
Robinson St.	I-35	24th Ave NE	Arterial	11.0
SH-4	SH-152	W Wilshire Blvd	Arterial	22.9
I-235 - US-77 - Broadway Ext.	I-40/I-35/I-235 Interchange	E Memorial Rd	Freeway	23.0
I-240/I40 Interchange	S Anderson Rd	S Choctaw Rd	Freeway	9.9
I-35 (South)	SH-37	I-240	Freeway	9.0
I-35/I-40	I-40/I-35/I-235 Interchange	I-44/I-35 Interchange	Freeway	6.7
I-40	John Kilpatrick Turnpike	S Pennsylvania Ave	Freeway	18.9
I-44	I-240	NE Grand Blvd	Freeway	28.9
I-44 (74 Alternate)	I-240	NW 63rd St	Freeway	20.5
SH-152 - Airport Rd.	S Clear Springs Rd	I-44	Freeway	24.0
SH-9	I-35	36th Ave SE	Freeway	12.2

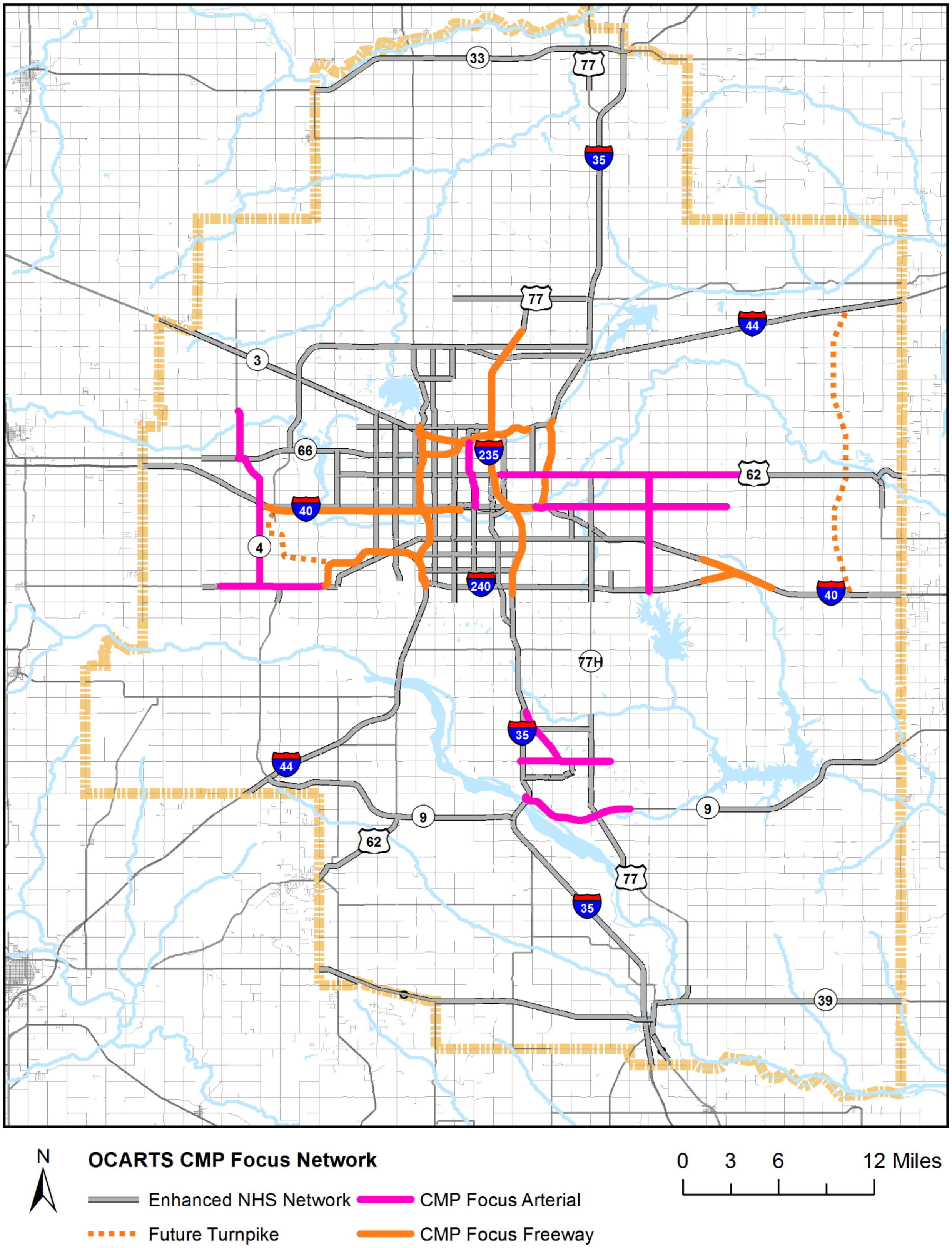
TTI information for the all-day, AM peak and PM peak periods is shown in **Table 3-3** on the following page. The CMP Focus network is shown in **Figure 3-5**.

Table 3-3 Summary of Travel Time Indices for the CMP Focus Network

			All-day 6:00am – 11:00pm			AM Peak 7:00am – 9:00pm			PM Peak 4:00pm – 6:00pm		
Name	**Type[18]**	**Length of Segment (Bidirectional)**	**Miles Congested**	**Percent of Length Congested**	**Average TTI**	**Miles Congested**	**Percent of Length Congested**	**Average TTI**	**Miles Congested**	**Percent of Length Congested**	**Average TTI**
I-35 (South)	F	9.0	1.2	14%	1.3	6.1	68%	1.3	5.9	66%	**1.6**
I-44 (74 Alternate)	F	20.5	1.0	5%	1.2	3.5	17%	1.2	13.2	64%	**1.6**
I-44	F	28.9	2.7	9%	1.2	3.4	12%	1.1	13.6	47%	**1.5**
I-240/I40 Interchange	F	9.9	-	0%	1.1	-	0%	1.0	3.4	35%	**1.4**
Robinson St.	A	11.0	1.9	18%	1.2	1.9	18%	1.2	3.0	27%	**1.4**
I-35/I-40	F	6.7	0.4	5%	1.1	-	0%	1.1	2.4	35%	**1.4**
I-235 - US-77 - Broadway Ext.	F	23.0	2.1	9%	1.1	3.8	17%	1.1	7.0	31%	**1.4**
I-40	F	18.9	-	0%	1.1	-	0%	1.1	3.9	20%	**1.3**
OK-9	F	12.2	-	0%	1.1	-	0%	1.1	3.7	31%	**1.2**
Flood Ave.	A	7.8	-	0%	1.1	-	0%	1.1	1.3	16%	**1.2**
OK-152 - Airport Rd.	F	24.0	-	0%	1.1	-	0%	1.0	4.1	17%	**1.2**
E. Reno Ave.	A	19.7	4.0	20%	1.1	-	0%	1.1	4.0	20%	**1.1**
OK-4	A	22.9	1.0	4%	1.1	2.1	9%	1.0	1.0	4%	**1.1**
Douglas Blvd.	A	14.6	1.0	7%	1.0	-	0%	1.0	1.0	7%	**1.1**
NE 23rd St.	A	24.8	1.0	4%	1.0	1.0	4%	1.0	2.0	8%	**1.0**
NW Expressway - Classen	A	13.5	0.1	1%	1.0	-	0%	1.0	0.1	1%	**1.0**

[18] F: Freeway; A: Arterial.

Figure 3-5 CMP Focus Network Map



4 Performance Measures

4.1 Performance Measure Development

This section presents the multimodal performance measures that will be applied to understand congestion problems, assess potential solutions, and monitor the effectiveness of implemented congestion management strategies. Performance measures were identified using the following approach:

- A comprehensive review of recently adopted CMP performance measures was conducted for six peer communities as well as currently adopted measures used in other ACOG programs.
    - Peer communities included:
        - Albuquerque, NM
        - Charlotte, NC
        - Kansas City, MO/KS
        - Memphis, TN
        - Salt Lake City, UT
        - San Antonio, TX
- Work Group and coordination meetings were conducted in order to ensure consistency among the proposed CMP performance measures and the performance measures that will be used for the *Encompass 2040* plan.
- A short-list of potential measures was developed by assessing the proposed *Encompass 2040* measures for applicability to the shorter term CMP implementation strategies. Additional measures were added or removed based upon the peer review and the potential to provide multimodal assessments of the congestion benefits to CMP implementation strategies.
- Finally, the short-list of potential measures was assessed for its applicability to the CMP using the following criteria:
    - easily understood,
    - supported by available data and models,
    - provides consistency with other planning processes, and
    - provides an adequate comparison of congestion.

Based upon this assessment and a review by the ACOG CMP Work Group a list of final performance measures was developed. It is hoped that this list of indicators is small enough to be manageable and easily maintained by ACOG and its member agencies while meaningful enough to indicate actual system performance and identify areas requiring review and improvement.

4.2 Relation to *Encompass 2040*

This section presents the performance measures and related objectives for the ACOG Congestion Management Process. In some cases, performance measures may apply across multiple objective strategies and goal areas. Where possible, performance measures for the CMP update were carried over from the *Encompass 2040* update to promote consistency and directly link the CMP to the region's metropolitan transportation plan and short range improvement program.

As stated in **Section 2.3** of this document, *Encompass 2040* is organized around six regional goals. Each of the goal areas can be impacted by the implementation of a congestion management process to some extent. Similarly, the objects that flow from the goals are directly linked to this CMP. Wherever possible, the CMP performance measures will also be used as key indicators for *Encompass 2040* performance.

4.3 Federal Performance Measures

MAP-21 and the FAST Act include provisions that require certain performance measures be monitored by state DOTs and regional MPOs. FHWA is in the process of developing rules for specific performance measures that will be required in to be included in metropolitan transportation plans (such as *Encompass 2040*). DOTs and MPOs may add additional performance measures if they so choose; the federal measures serve as a starting point for monitoring the performance of the nation's transportation network. The federal performance measures are shown below:

- Number of Fatalities
- Rate of fatalities per 100 million Vehicle Miles Traveled
- Number of Serious Injuries
- Rate of Serious Injuries per 100 million Vehicle Miles Traveled
- Number of Non-Motorized Fatalities and Non-Motorized Serious Injuries
- Percent of Lane Miles of Pavement in Good/Fair Condition for the National Highway System
- Percent of Bridge Deck Area that is Non-Structurally Deficient
- Level of Travel Time Reliability
- Peak Hour Travel Time Ratio
- Truck Travel Time Reliability
- Average Truck Speed

4.4 ACOG Objectives and Added Measures

As a part of the development of *Encompass 2040*, ACOG and its constituents have selected several performance areas that are important to the region but not addressed by the Federal measures. Specifically, ACOG reviewed performance measures to evaluate the following objective areas:

- Bicycle and Pedestrian Connectivity
- Transit
- Land Use

- Linkage to the CMP
- Security
- Efficiency, Sustainability, and the Environment

Five additional performance measures have been identified by ACOG to further formalize the linkage between *Encompass 2040* and the congestion management process presented in this document. The five performance measures are discussed below:

- **Mode Share** – this performance measure corresponds to the goal of reducing dependence on automobiles and encouraging trips via other modes. Mode share will change slowly at the regional level but the impact specific investments can be evaluated using the regional travel demand model.
- **Percent of Population/Jobs within ¼ mile of Transit Stops** – measuring the access to other modes of transportation can be difficult. Understanding the level to which population and employment are located around the existing transit system can assist in providing a measure of transportation and land use connectivity. While this measure may be slow to change at the regional level, specific redevelopment of land uses or expansion/relocation of transit routes can yield results that are easily evaluated through census data and GIS processing.
- **Miles of Sidewalk and Bicycle Paths/Lanes Added within ¼ Mile of Transit Stop** – much like the previous measure, this factor will assist ACOG in evaluating the completeness of the regional transportation system with respect to providing access to alternative modes of transportation. The development of supporting systems to enhance intermodal connectivity can be monitored over-time to help better understand how the systems are being used.
- **Miles of Area Operating Under a Newly Implemented Local Complete Streets Policy** – formalizing the support for alternative modes in the development of new or reconstructed infrastructure assists in developing a multimodal transportation system. This measure monitors the policy changes by local governments.
- **Total Miles of Sidewalk and Bicycle Facilities** – this basic inventory measure assists ACOG and its constituents in understanding the extent of the non-motorized network.

4.5 CMP Performance Measures

The proposed objectives and performance measures for the ACOG CMP Update are presented in **Table 4.1** on the following pages. The proposed objectives are shown in relation to the *Encompass 2040* goal to which they are most closely tied. Performance measures are shown adjacent to the associated goal area and objectives that they track most closely with and are presented in two categories. These categories represent the prioritization of the performance measures based on their perceived effectiveness in measuring the impact of CMP strategies and the availability of data to support measurement. Performance measures categorized as Tier 1 are readily available and recommended for short-term implementation. Tier 2 measures may not be readily available and are recommended for phasing in over time due to limitations of currently available data and existing processing constraints.

Table 4-1 Linkage Between *Encompass 2040* Goals and CMP Goals and Performance Measures

Encompass 2040 Goal Areas	CMP Objectives	Performance Measures
Economic Strength: Promote economic vitality through enhanced mobility.	- Enhance the efficiency of the existing transportation system through strategic investments (e.g., roadway design, maintenance, signalization, and signage).	**Tier 1** - Congestion intensity (Travel time index) - Reliability (buffer index) - Mode share for all trips - Person or vehicle hours of delay - Truck Travel Time Index - User cost (as a function of delay) **Tier 2** - Vehicle Miles Traveled (VMT) per capita. - Person Miles Traveled (PMT).
Safety and Security: Provide a safe and secure transportation system.	- Improve design, construction, and maintenance of infrastructure to reduce the number and severity of crashes, injuries and fatalities.	**Tier 1** - Number of crashes by severity for vehicle crashes, vehicle-bicycle crashes, and vehicle-pedestrian crashes. - Fatality and serious injury crash rate per 100M VMT. **Tier 2** - Response and/or incident clearance time.
Equity and Options: Provide transportation access for the movement of all people and goods.	- Expand and maintain accessible and connected pedestrian and bicycle facilities.	**Tier 1** - Total miles of sidewalk and bicycle paths/lanes. - Percent of population and jobs located within ¼ mile of transit. **Tier 2** - Miles of sidewalk and bicycle paths/lanes added within ¼ mile of transit stop.
Healthy Communities: Recognize and improve the connection between land use and transportation to enable citizens to live healthier lives and reduce environmental impact from vehicle travel.	- Improve and increase the walkability and bikeability of the region.	**Tier 1** - Transit ridership per revenue vehicle hour - Mode share for commuter trips. - Annual air quality index reading for the region.
Connectivity: Develop connections among all types of transportation.	- Improve connectivity between and within the roadway, transit, bicycle, and pedestrian systems.	**Tier 1** - Pedestrian Composite Index **Tier 2** - Miles of area operating under a newly implemented Local Complete Streets policy.

Encompass 2040 **Goal Areas**	**CMP Objectives**	**Performance Measures**
Performance: Increase the efficiency and reliability of the transportation system.	- Increase capacity where needed.	**Tier 1** - Lane miles severely congested. - Travel time ratio (morning/afternoon peak vs. midday travel times). - Lane-miles covered by ITS services and devices including cameras, Dynamic Message Signs, Service Patrols and advanced signal coordination. **Tier 2** - Person or vehicle hours of nonrecurring delay. - Duration of congestion.

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5 Performance Monitoring Plan

This chapter presents a performance monitoring plan for acquiring, analyzing, and monitoring the data needed to implement the multimodal performance measures identified in **Chapter 4**.

5.1 Data Collection

Data to support the CMP can be derived from multiple sources. Understanding the type and availability of data that is collected is essential in analyzing the CMP network as the data will be used to accurately and efficiently calculate the system's performance. For the CMP, some sources provide data that could be used more often in analysis than other sources. The project team has reviewed applicable data sources and coverage and recommends the following data be used to support the CMP. Data sources for specific measures are shown below in **Table 5-1.**

Table 5-1 CMP Data Sources and Measure Alignment

Data	Data Source	Description	Applicable Measures
FHWA National Performance Measure Research Data Set (NPMRDS)	FHWA	-Vehicle-probe speed data -Travel-time data	-Travel Time Index -User Cost -Vehicle Hours of Delay (VHD) -Truck Travel Time Index -Reliability (Buffer Index)
ACOG Travel Model Outputs	ACOG	-Congestion speed -Volume -Capacity -Vehicle Miles Traveled(VMT)	-Level of Service -User Cost -Vehicle Hours of Delay (VHD) -Reliability (Buffer Index) -Average Trip Distance
Crash Data	ODOT FARS	-Crash severity -Crash frequency -Collision type -Bicycle/Pedestrian involvement	-Number of crashes by severity for vehicle crashes, vehicle-bicycle crashes, and vehicle-pedestrian crashes -Fatality and serious injury crash rate per 100M VMT
Roadway Shapefiles	ODOT	-Roadway alignments -Traffic counts -Functional classification -Truck routes	-Serves as base information for multiple measures
Demographic Shapefiles	ODOT	-Population -Employment -Transit information	-Percent of population and jobs located within ¼ mile of transit stops
Transit Data	CART, EMBARK, CityLink	-Monthly ridership counts -Ridership per revenue hour	-Transit ridership per revenue hour - Miles of sidewalk and bicycle paths/lanes added within ¼ mile of transit stop

Data	Data Source	Description	Applicable Measures
Annual Air Quality Ratings	ACOG	-Ozone levels -Status of meeting NAAQS	-Annual Air Quality Index
Mode Split	US Census Transportation Planning Products (CTPP)	-Traveler mode split	-Mode share for commuter trips
Bicycle/ Pedestrian Network	ACOG	-Pedestrian Composite Index -Sidewalk location/condition -Bicycle path/lane location/condition	-Total miles of sidewalk and bicycle lane/path - Miles of sidewalk and bicycle paths/lanes added within ¼ mile of transit stop
ITS Network	ACOG/ODOT	-Location/type of ITS Devices -Location for future deployments	-Total miles of network covered by ITS Devices

5.2 Data Analysis

This section discusses the methodology used to calculate the indicators by *Encompass 2040* goal areas for each performance measure.

Economic Strength

The CMP proposes six Tier 1 and two Tier 2 performance measures to indicate the level to which the ACOG region is meeting its goals with regard to Economic Strength. **Table 5-2** shows the methodology for calculating performance both Tier 1 and Tier 2 performance measures.

Tier 1 Performance Measures

- Congestion Intensity (Travel Time Index)
  - The travel time index (TTI) is the ratio of peak period travel time to travel time under free-flow conditions. For example, a TTI of 1.20 indicates that for peak periods, a trip on the given segment would take 120% of the time as compared to off-peak periods. Specifically, a six-minute peak travel time for a trip that typically takes five minutes under free flow conditions would yield a TTI of 1.20.
  - TTI information from the available NPMRDS dataset is shown in **Figure 5-1** for the morning peak and **Figure 5-2** for the afternoon peak period.
- Reliability (Buffer index)
  - The buffer index represents the extra time that most travelers add to their average travel time when planning trips to ensure on-time arrival at their destination. The buffer index is calculated as the difference between the 95^{th} percentile travel time (near worst case) and the average travel time, divided by the average travel time.
- Mode share for all trips

  - The mode share is a common outcome measure that is used to determine the effectiveness of efforts to reduce the dependence on automobiles. Mode share can be identified by using the US Census Journey to Work (JTW) data.

- Truck Travel Time Index (TTI)
  - TTI information specifically for trucks is not readily available. That said, truck travel time index can be derived from the observed general TTI information for truck routes. FHWA is developing additional data and performance measures to identify and monitor truck travel times across the nation.

- User cost as a function of delay
  - The user cost of delay is the value of time multiplied by the hours of delay. The United States Department of Transportation (USDOT) estimated a national average cost per vehicle-hour of delay for passenger cars (exclusive of trucks) of $12.70 as of 1998. If inflated by three percent per year, it is $20.99 per hour for 2015. This number can represent the local value of time since the average and median hourly wage in the Oklahoma City area is $28.95 and $22.00, respectively.

- Person or vehicle hours of delay
  - The delay measurements are based on the 2010 travel model output which is assumed to be able to represent the 2015 traffic condition. The person hours of delay can be calculated by multiplying the local vehicle occupancy rate of 1.2 persons per vehicle by the vehicle hours of delay.

Tier 2 Performance Measures

- Vehicle miles traveled (VMT) per capita
  - VMT per capita is the total number of miles traveled by motor vehicles in the OCARTS region divided by the population of the region.

- Person miles traveled (PMT)
  - PMT is a calculation of miles traveled in the OCARTS region by mode by occupancy. For example, a person using a single occupancy vehicle, driving alone, traveling 5 miles would yield 5 person miles traveled. A transit vehicle traveling 1 mile, carrying 40 passengers would yield 40 person miles traveled.

Table 5-2 Baseline Tier 1 Performance Measurements for Economic Strength Goal

Goal Area/ Performance Measure	Calculation Method	Existing Results		Source Data System
Economic Strength				
Congestion intensity (Travel Time Index)	(Peak travel time/free-flow travel time)	Varies by route		FHWA NPMRDS
Reliability (Buffer index)	95th percentile travel time for CMP Focus Network	Varies by route		FHWA NPMRDS
Mode share	Look-up	Car, Truck, Van - Drive alone	82.20%	2010 Census Journey to Work
		Car, Truck, Van - 2+	10.93%	
		Transit, Railroad	0.50%	
		Bicycle	0.28%	
		Walked	1.54%	
		Taxi, Motorcycle, Others	1.13%	
		Work at home	3.42%	
Truck travel time index (TTI)	Identify truck routes and calculate weighted average TTI for those routes.			FHWA NPMRDS
	Weighted Average = Segment TTI x Segment Length / Total Length	Weighted Average for Truck Routes	1.05	
	Max TTI = Max TTI among all the monitored segments	Max TTI for Truck Routes	2.89	
User Cost (as a function of delay)	Vehicle hours of delay x value of time ($ 20.99 Dollar/hours)	Vehicle delay cost	$3,573,841	ACOG Travel Model 2010
	Person hours of delay x value of time ($ 20.99 Dollar/hours)	Person delay cost	$4,288,610	
Vehicle hours of delay	((VMT/Congestion Speed) – (VMT/free-flow speed))	Interstate & Freeway	100,721	ACOG Travel Model 2010
		Turnpike	12,520	
		Principal Arterial	57,023	
		Total	170,264	
Person hours of delay	((VMT/Congestion Speed) – (VMT/free-flow speed)) x 1.2 persons/vehicles	Interstate & Freeway	120,865	ACOG Travel Model 2010
		Turnpike	15,024	
		Principal Arterial	68,428	
		Total	204,317	

Safety and Security

The CMP proposes two Tier 1 and a single Tier 2 performance measure to indicate the level to which the ACOG region is meeting its Safety and Security goals. Data to for evaluating the Safety and Security of the OCARTS CMP network is readily available from ODOT's crash data and statistics website[19] and the National Highway Traffic Safety Administration's Fatality Analysis Reporting System (FARS).[20]

Tier 1 Performance Measures

- Number of crashes by severity for vehicle crashes, vehicle-bicycle crashes, and vehicle-pedestrian crashes
    - Crash information by severity can be found through the Oklahoma DOT's data and statistics website. Information relating to fatalities can be found through the FARS system if not readily available from ODOT.
- Fatality and serious injury crash rate per 100M VMT
    - Fatality and serious injury rates can be calculated for specific segments of the CMP network based upon the information collected from ODOT and FARS.

Tier 2 Performance Measure

- Response and/or incident clearance time
    - The length of time that it takes for first police, fire, and/or tow operators to respond to an incident or the duration of an incident from the time the incident begins to the time in which normal conditions are restored to the system.

Table 5-3 Baseline Tier 1 Performance Measurements for Safety and Security Goal

Goal Area/ Performance Measure	Calculation Method	Existing Results		Source Data System
Safety and Security				
Number of crashes by severity for vehicles, vehicle-bicycle crashes, and vehicle-pedestrian crashes	Lookup	Varies	**Figure 5-4**	ODOT Crash Data Website, FARS
Fatality and serious injury crash rate per 100M VMT	Formula based for segments or intersections	Location specific Intersection formula: Rate = (# of Fatal and Serious Injury Crashes x 1,000,000)/(ADT x 365) Segment formula: Rate = (# of Fatal and Serious Injury Crashes x 1,000,000)/(Length of segment in miles x ADT x 356)		ODOT Crash Data Website, FARS

[19] https://www.ok.gov/ohso/Data/Crash_Data_and_Statistics/index.html

[20] http://www.nhtsa.gov/FARS

Table 5-3 summarizes the number of crashes by severity in the OCARTS area from 2012 to 2014. The severity levels follow the traditional "KABCO" scale developed by the National Safety Council (NSC): fatal injury (K), incapacitating injury (A), non-incapacitating (B), possible injury (C), and no injury or property damage only (O).

Table 5-4 Number of Crashes in OCARTS by Severity Level (2012-2014)

Collision Type	Year	Property Damage Only	Possible Injury	Non-Incapacitating	Incapacitating Injury	Fatal Injury	Total
All	2012	17,787	4,832	2,713	788	122	26,242
	2013	18,892	4,866	2,681	723	116	27,278
	2014	18,199	4,849	2,533	699	104	26,384
Pedestrian	2012	8	56	100	55	24	243
	2013	6	78	84	50	17	235
	2014	13	51	75	49	11	199
Bicycle	2012	12	39	62	12	0	125
	2013	18	34	42	15	4	113
	2014	13	51	75	49	11	199

Figure 5-1 displays the number of fatal and incapacitating injury crashes (corresponding to the y-axis on the left) along with the total crashes (corresponding to the y-axis on the right) for each year from 2012-2014. Although the total number of crashes was slightly increased in year 2013 and 2014 as compared to the year 2012, the number of sever crashes with incapacitating injuries and fatalities has been decreasing.

Figure 5-1 Severe Crashes VS. Totals for 2012-2014

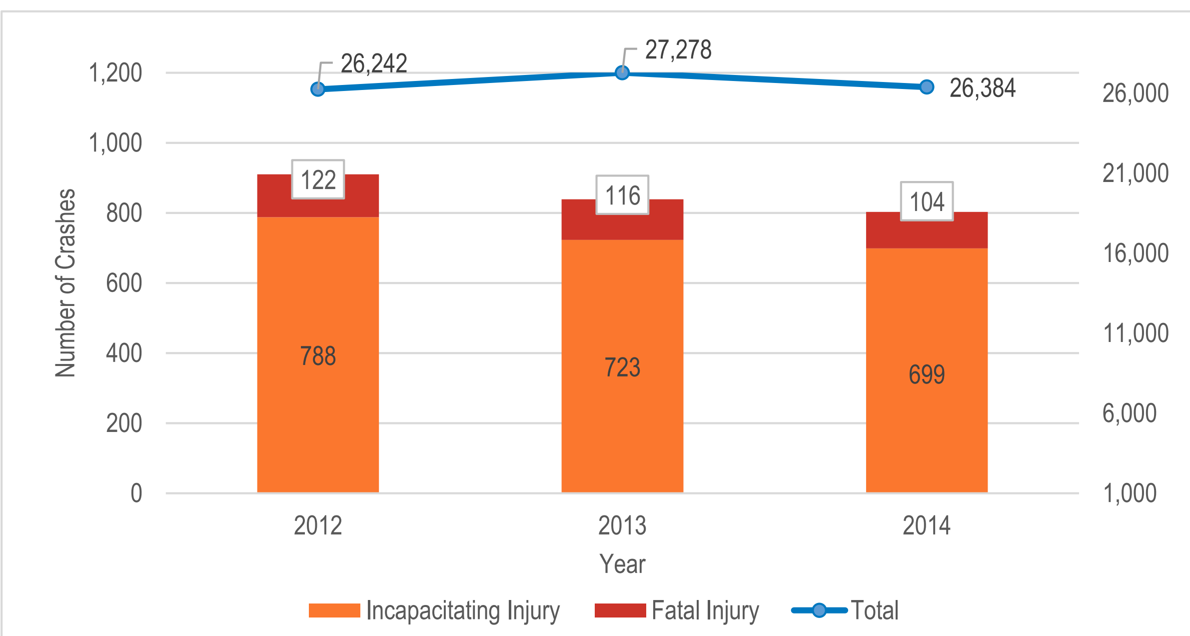


Figure 5-2 shows the number of crashes involving bicycles by severity during the 2012-2014 time period. 2013 had the lowest total number of crashes but 2014 showed an improvement in the reduction of crashes with incapacitating and fatal injuries (from 19 total in 2013 to 16 total in 2014).

Figure 5-2 Number of Crashes by Severity for Vehicle-Bicycle Crashes

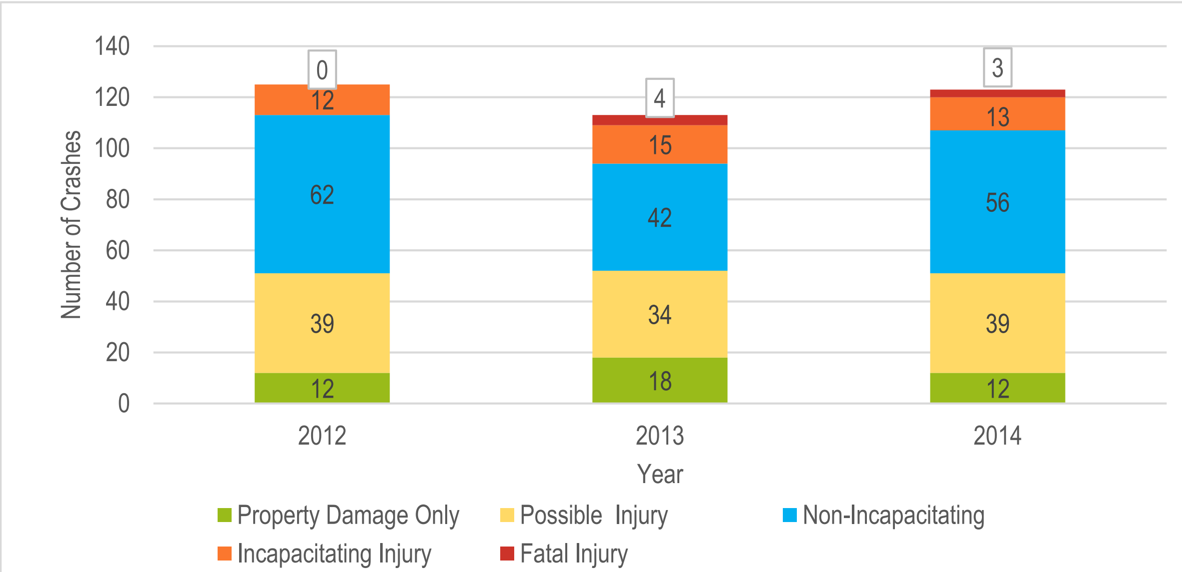
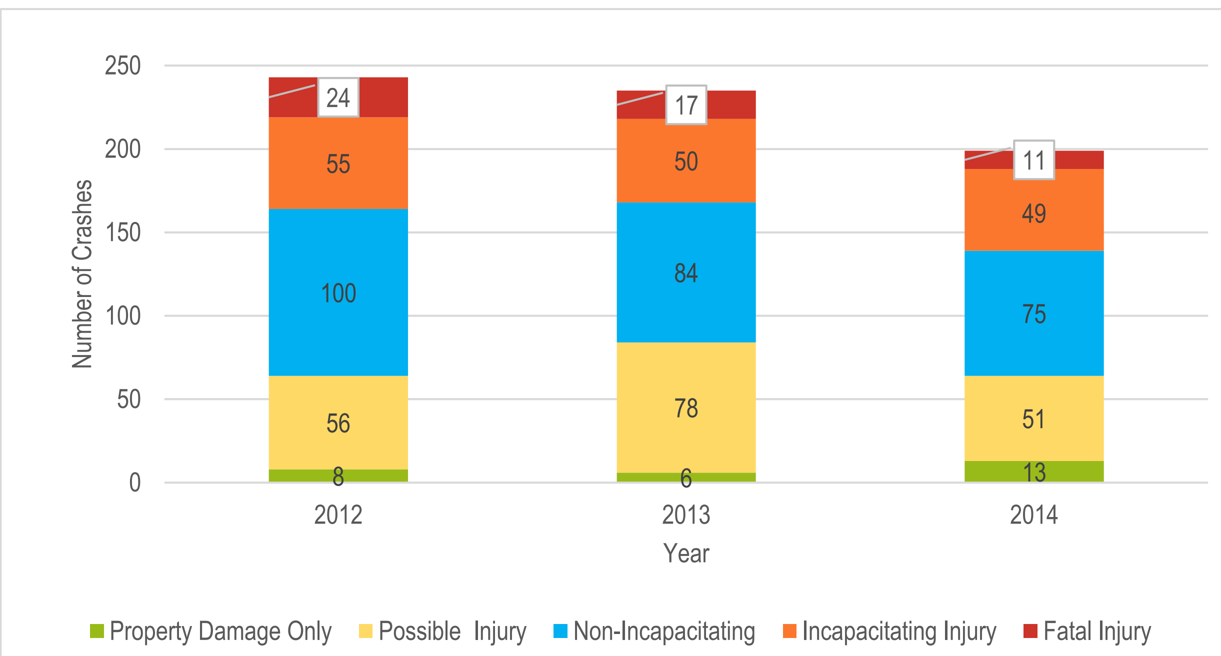


Figure 5-3 shows the number of crashes involving pedestrians by severity during the three-year period. Crashes involving pedestrians generally decreased from 2012 to 2014 for both total crashes and those with incapacitating or fatal injuries.

Figure 5-3 Number of Crashes by Severity for Vehicle-Pedestrian Crashes



Equity and Options

Performance measures pertaining to equity and options evaluate the availability of non-SOV modes in OCARTS area. ACOG has developed two Tier 1 performance measures and a single Tier 2 performance measure for Equity and Options.

Tier 1 Performance Measures

- Miles of sidewalks and bicycle routes
  - Inventory data on the total mileage of pedestrian and bicycle infrastructure for the OCARTS region.
- Percent of population and jobs located within ¼ mile of transit
  - GIS overlay of existing transit services routes onto the population and employment files that can be obtained from the US Census Bureau.

Tier 2 Performance Measure

- Miles of sidewalk and bicycle paths added within ¼ mile of transit stops
  - Measure to evaluate the expansion of the bicycle and pedestrian network's connectivity to transit services.

Table 5-5 summarizes the miles of sidewalks and bicycles routes, and transit service coverage information for population and employment.

Table 5-5 Baseline Tier 1 Performance Measures for the Equity and Options Goal

Goal Area/ Performance Measure	Calculation Method	Existing Results		Source Data System
Equity and Options				
Miles of sidewalks and bicycle routes	GIS tabulation	Miles of sidewalks	3,512.5	ACOG generated shapefile
		Miles of bicycle routes	415.0	
Percent of population and jobs located within ¼ mile of transit.	GIS buffer	Population percent	49.2%	2010 Census data, ACOG generated shapefile
		Employment percent	72.5%	

Figure 5-4 on the following page displays the sidewalks and bicycles facilities within the OCARTS region.

Figure 5-4 Bike Facility and Sidewalks in OCARTS Area

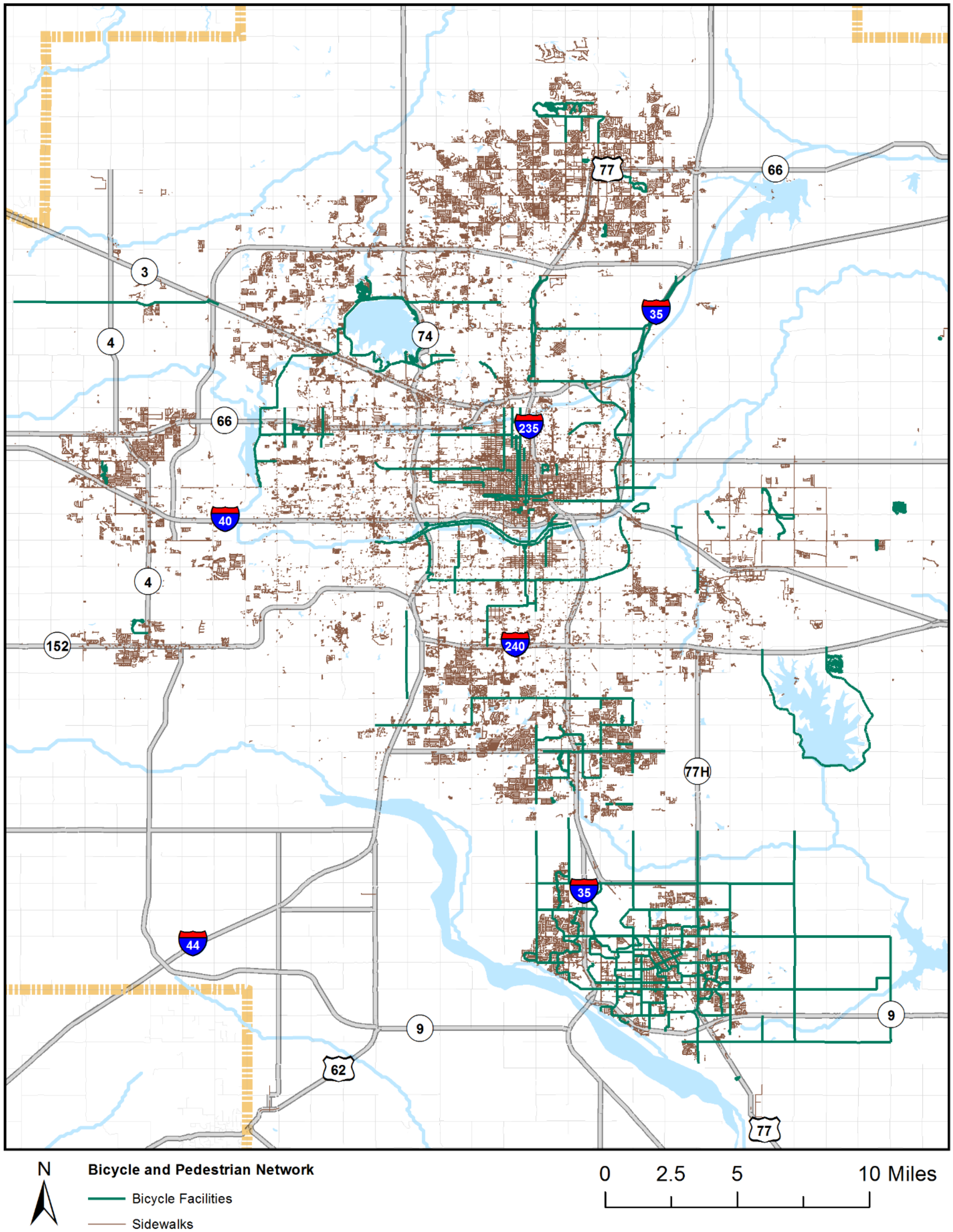
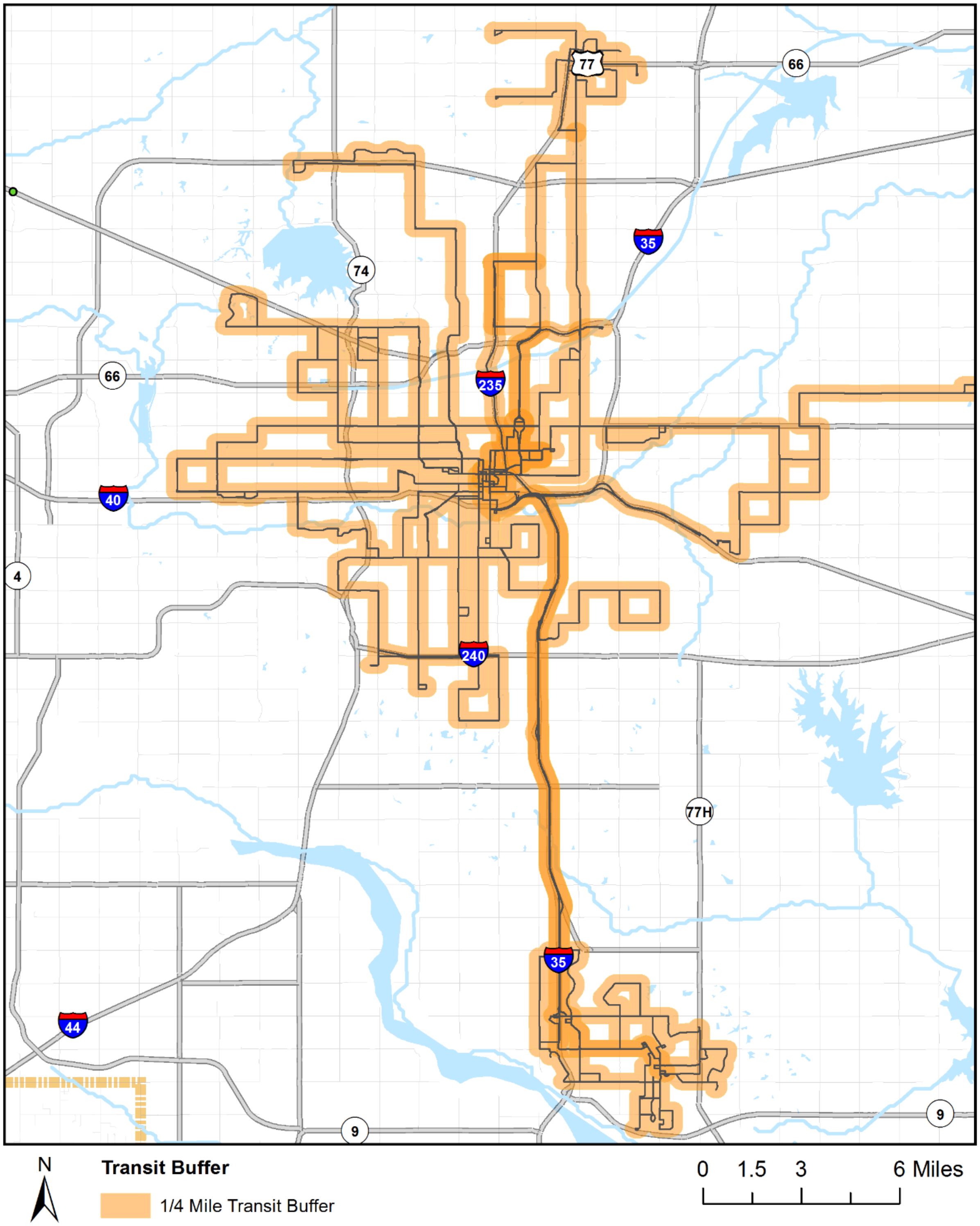


Figure 5-5 displays the area within ¼ mile of transit routes. There are three transit agencies in OCARTS area: Cleveland Area Rapid Transit (CART), Central Oklahoma Transportation and Parking Authority (COTPA) which provides the EMBARK service, and Citylink. Most of the transit routes operate at a 30-minute frequency during peak hours.

Figure 5-5 Transit Coverage in OCARTS Area



Healthy Community

Improving the connection between land use and transportation can be a key factor in positively impacting the health and wellness of a community. **Table 5-6** summarizes the existing results for measurements for the CMP's Healthy Community objectives. Three Tier 1 performance measures are recommended for the OCARTS region.

Tier 1 Performance Measures

- Transit ridership per revenue hour
  - Transit ridership can indicate a shift in the active transportation characteristics of a region. An increase in ridership per revenue hour may indicate a more active population.
- Mode share for commuter trips
  - Mode split for journeys to work or school (when tracked over time) can be used to evaluate the tendency of the population to utilize more active transportation modes.
- Air quality index (AQI)
  - The AQI provides information relating to the level of pollution in the air that can negatively impact sensitive populations. Reducing SOV trips can also increase the quality of the air. The Oklahoma Department of Environmental Quality (DEQ) provides daily forecasts and updates for pollutants and particulate matter in the air. Currently, the OCARTS region is in attainment for all National Ambient Air Quality Standards (NAAQS).

Table 5-6 Baseline Tier 1 Performance Measurements for the Healthy Community Goal

Goal Area/ Performance Measure	Calculation Method	Existing Results		Source Data System
Healthy Communities				
Transit ridership per revenue vehicle hour	Transit ridership / revenue hours	Citylink	15.9	Transit Agencies
		EMBARK (COTPA)	16.9	
		CART	19.3	
Mode share for commuter trips	Look-up	Car, Truck, Van - Drive along	82.20%	2010 Census Journey to Work
		Car, Truck, Van - 2+	10.93%	
		Transit, Railroad	0.50%	
		Bicycle	0.28%	
		Walked	1.54%	
		Taxi, Motorcycle, Others	1.13%	
		Work at home	3.42%	

Annual Air Quality Index	Look Up	Ozone	39.1	Oklahoma DEQ[21]
		Fine Particulates (PM 2.5)	35.8	
		Oxides of Nitrogen (NO_x)	27.8	
		Oxides of Sulfur (SO_x)	1.0	
		Carbon Monoxide (CO)	4.3	
		Coarse Particulates (PM 10)	17.0	

Connectivity

Increasing connections to all types of transportation modes assists in increasing the attractiveness of non-SOV trip-making. A single Tier 1 performance measure and one tier 2 performance measure have been recommended for ACOG.

Tier 1 Performance Measure

- Pedestrian composite index (PCI)
  - Index used to determine the priority of building more walkable facilities. The PCI is a number between 0 and 1, representing the necessity of sidewalks by considering locations of pedestrian generators and pedestrian deterrents.

Tier 2 Performance Measure

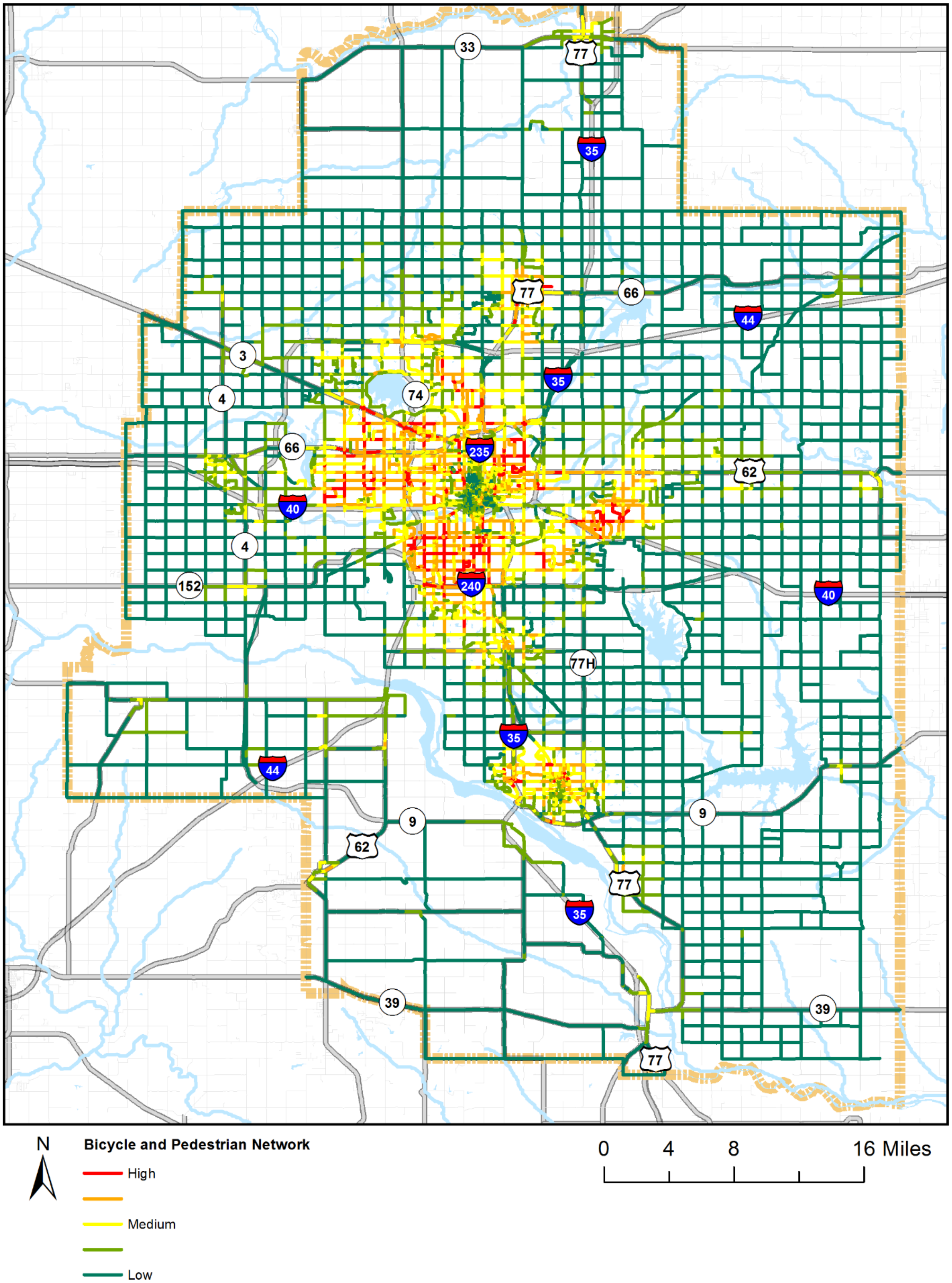
- Miles of area operating under a newly implemented local complete streets policy
  - Inventory of area that has recently adopted or codified a policy to encourage, support or require complete streets (streets that accommodate multiple modes) to be developed during reconstruction or new construction.

Figure 5-6 shows the PCI for the OCARTS network. Both the generator and deterrent scores for each network segment were added together. High scores in red indicate that these are areas that are a higher priority for future investment in sidewalks and pedestrian safety. The green (low) scores mostly represent

1. Rural section line roads that have few attractions and have higher speed roads and do not have a high demand for pedestrian facilities and
2. Urban or suburban areas where there are existing pedestrian facilities serving those pedestrian attractions.

[21] http://www.deq.state.ok.us/AQDNew/AQIndex/archaqi.htm

Figure 5-6 Pedestrian Composite Index (PCI) in OCARTS Area



Performance

Regional objectives for system performance include increasing the efficiency and reliability of the transportation network. The congestion levels for the CMP network are evaluated by both model assignments and real travel time data. The model assignments provide valuable information regarding the overall network performance and congestion problems. However, given all the assumptions of the four-step travel model, the results might not be comprehensive enough to analyze the network in detail. The network performance needs to be evaluated based on real travel data which can capture more realistic traffic condition.

Three Tier 1 performance measures and two Tier 2 performance measures have been recommended for the OCARTS region.

Tier 1 Performance Measures

- Lane miles severely congested
  - Severe congestion is defined as a volume to capacity ratio of greater than 1 with consideration of intersection delay. This information can be derived from the regional travel demand model.
- Travel Time Ratio
  - The ratio of congested travel time to free flow travel time for morning and evening peak periods on the CMP network.
- Lane-miles covered by ITS services and devices
  - Inventory of the existing ITS devices or services that have been deployed in the OCARTS region.

Tier 2 Performance Measures

- Person or vehicle hours of nonrecurring delay
- Duration of congestion

Table 5-7 Baseline Tier 1 Performance Measurements for the Performance Goal

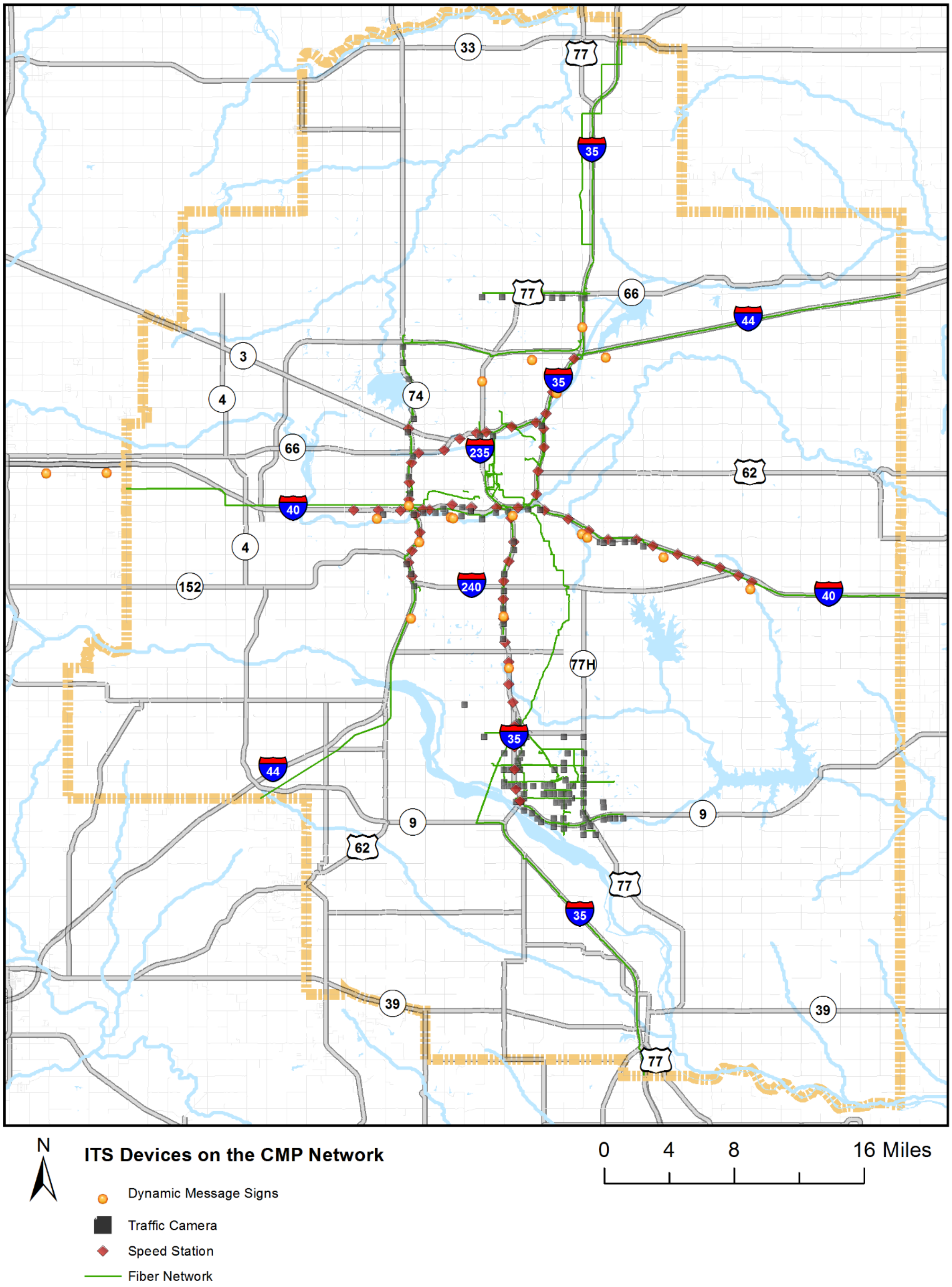
Goal Area/ Performance Measure	Calculation Method	Existing Results		Source Data System
Performance				
Lane miles severely congested	The lane mileage in the CMP network with V/C ratios greater than 1, with consideration of intersection delay.	Interstate & Freeway Miles (%)	AM: 226.32 (24%) PM: 80.87 (9%)	ACOG Traffic model: T_AMVC, T_PMVC (With consideration of intersectional delay)
		Turnpike Miles (%)	AM: 9.46 (4%) PM: 0.43 (0.2%)	
		Principal Arterial Miles (%)	AM: 39.39 (3%) PM: 23.61 (2%)	
		Total Miles (%)	AM: 275.17 (11%) PM: 104.91 (4%)	

Travel time index	Average travel time during congestion period / Free-flow travel time			NPMRDS
	Weighted Average = Segment TTI x Segment Length / Total Length	Weighted Average for CMP Network	1.09	
	Max TTI = Max TTI among all the monitored segments	Max TTI for the CMP network	2.89	
Lane miles covered by ITS devices	GIS measurements	Cameras	249	ACOG/ODOT
		DMS	23	
		Speed stations	60	
		Total Devices	332	
		Total Mileage Covered by ITS Devices	162	

A calculation for the volume to capacity ratios for the morning and evening peak periods relies upon data outputs from the ACOG Travel Demand Model. The travel time index (TTI) is the ratio of peak period travel time to travel time under free-flow conditions. TTI is also used as a measure for the Economic Strength regional goal and was discussed previously in this chapter.

ITS devices support traveler information system and traffic management system through modern communication, computer, and detection technologies. ITS can facilitate the management of traffic during congestion periods, construction and maintenance activities, traffic incidents and can improve safety and mobility. The location of ITS devices in the OCARTS network is shown in **Figure 5-7.** In total nearly 162 miles of the CMP network has some sort of ITS coverage

Figure 5-7 ITS Devices on the CMP Network



6 Congestion Problems and Needs

This section presents an analysis of congestion problems and needs in the OCARTS planning area. The analysis focuses on identifying congested freeway and arterial segments on the CMP Focus Network using the following existing congestion and operations related performance measures: current travel time index (TTI), and a crash hotspot analysis. In the future, it is recommended that ACOG adopt the performance measures recommended for CMP analysis and incorporate them into current monitoring activities and ultimately into the development of project and program solutions.

6.1 Travel Times

Using the NPMRDS, travel time indices were calculated for the CMP network. The focus network discussed in **Chapter 3** was developed based upon a review of these figures. Corridors experiencing substantial congestion (a total of 16) were identified and will be used as the CMP Focus Network for integration into the MTP and TIP project selection processes.

Travel time indices for the Focus Network work developed for the morning peak (6:00am am to 10:59pm) and for the afternoon peak period (PM peak) from 4:00pm to 6:00pm. TTI information for the amount of congestion on the focus network corridors is shown below in **Table 6-1** and in **Table 6-2** on the following page.

Table 6-1 Focus Network Congestion and TTI – AM Peak (June 2013-November 2015)

AM Peak (7:00am – 9:00am)						
Rank	**Name**	**Class**	**Length of Segment (Bidirectional)**	**Miles Congested**	**Percent of Length Congested**	**Average TTI**
1	I-35 (South)	F	9	6.1	68%	**1.3**
2	I-44 (74 Alternate)	F	20.5	3.5	17%	**1.2**
3	Robinson St.	A	11	1.9	18%	**1.2**
4	I-44	F	28.9	3.4	12%	**1.1**
5	Flood Ave.	A	7.8	-	0%	**1.1**
6	I-235 - US-77 - Broadway Ext.	F	23	3.8	17%	**1.1**
7	I-40	F	18.9	-	0%	**1.1**
8	SH-9	F	12.2	-	0%	**1.1**
9	I-35/I-40	F	6.7	-	0%	**1.1**
10	E. Reno Ave.	A	19.7	-	0%	**1.1**
11	SH-4	A	22.9	2.1	9%	**1.0**
12	SH152 - Airport Rd.	F	24	-	0%	**1.0**
13	Douglas Blvd.	A	14.6	-	0%	**1.0**
14	I-240/I40 Interchange	F	9.9	-	0%	**1.0**
15	NE 23rd St.	A	24.8	1	4%	**1.0**
16	NW Expressway - Classen	A	13.5	-	0%	**1.0**

Table 6-2 Focus Network Congestion and TTI – PM Peak (June 2013-November 2015)

PM Peak (4:00pm – 6:00)						
Rank	**Name**	**Class**	**Length of Segment (Bidirectional)**	**Miles Congested**	**Percent of Length Congested**	**Average TTI**
1	I-35 (South)	F	9	5.9	66%	**1.6**
2	I-44 (74 Alternate)	F	20.5	13.2	64%	**1.6**
3	I-44	F	28.9	13.6	47%	**1.5**
4	Robinson St.	A	11	3	27%	**1.4**
5	I-35/I-40	F	6.7	2.4	35%	**1.4**
6	I-240/I40 Interchange	F	9.9	3.4	35%	**1.4**
7	I-235 - US-77 - Broadway Ext.	F	23	7	31%	**1.4**
8	I-40	F	18.9	3.9	20%	**1.3**
9	SH-9	F	12.2	3.7	31%	**1.2**
10	Flood Ave.	A	7.8	1.3	16%	**1.2**
11	SH152 - Airport Rd.	F	24	4.1	17%	**1.2**
12	E. Reno Ave.	A	19.7	4	20%	**1.1**
13	SH-4	A	22.9	1	4%	**1.1**
14	Douglas Blvd.	A	14.6	1	7%	**1.1**
15	NE 23rd St.	A	24.8	2	8%	**1.0**
16	NW Expressway - Classen	A	13.5	0.1	1%	**1.0**

The focus network experiences more congestion during the PM peak period as compared to the AM peak. When examining the corridors by travel time index, the most congested corridors remain fairly consistent for both time periods with higher levels of congestion occurring on the Interstate and Expressway system in the evening. **Figure 6-1** on the following page displays the travel time index by route for the Focus Network from 6:00am to 9:00pm. As shown, the highest intensity of congestion in the OCARTS region occurs during the traditional evening peak commute period.

It should be noted that the TTI figures above have been aggregated to the entire corridor. There are locations in each corridor that display travel time indices of higher and lower values. The detailed TTI information for each corridor segment is displayed in the maps in **Figure 6-2** and **Figure 6-3** on the following pages**.**

Figure 6-1 CMP Focus Network Severity of Congestion by Time of Day

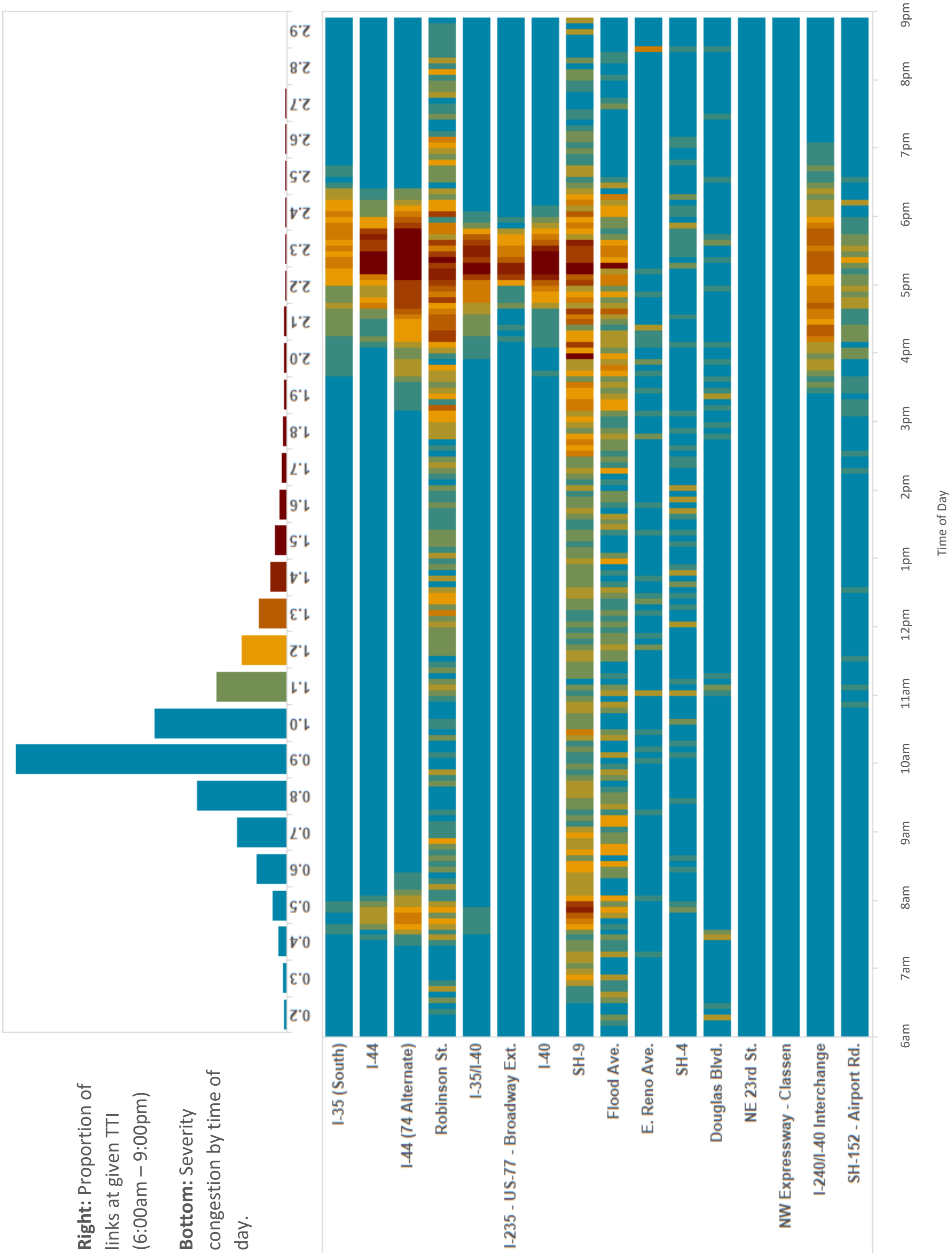


Figure 6-2 CMP Focus Network: AM Peak TTI (7:00am – 9:00am)

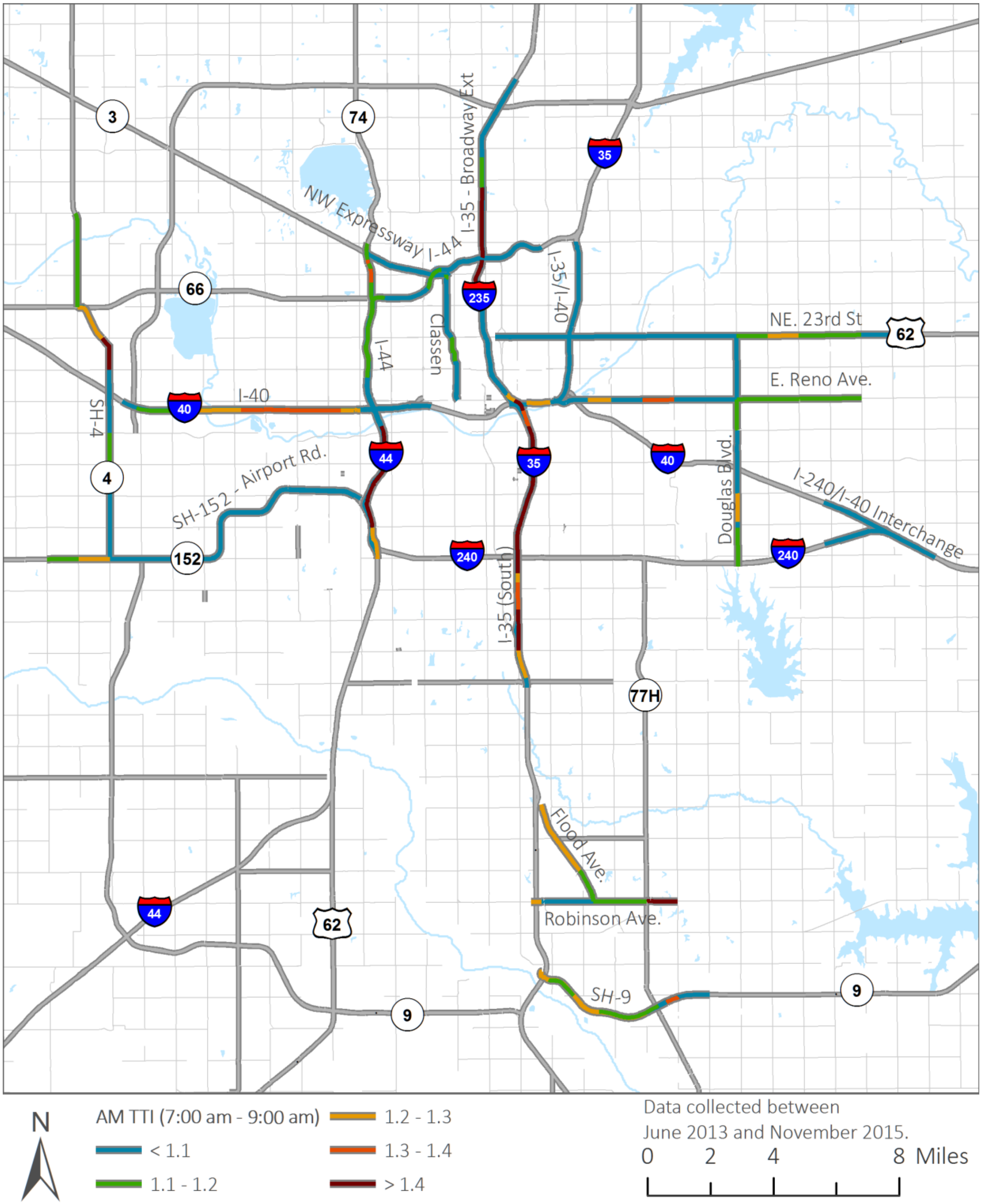
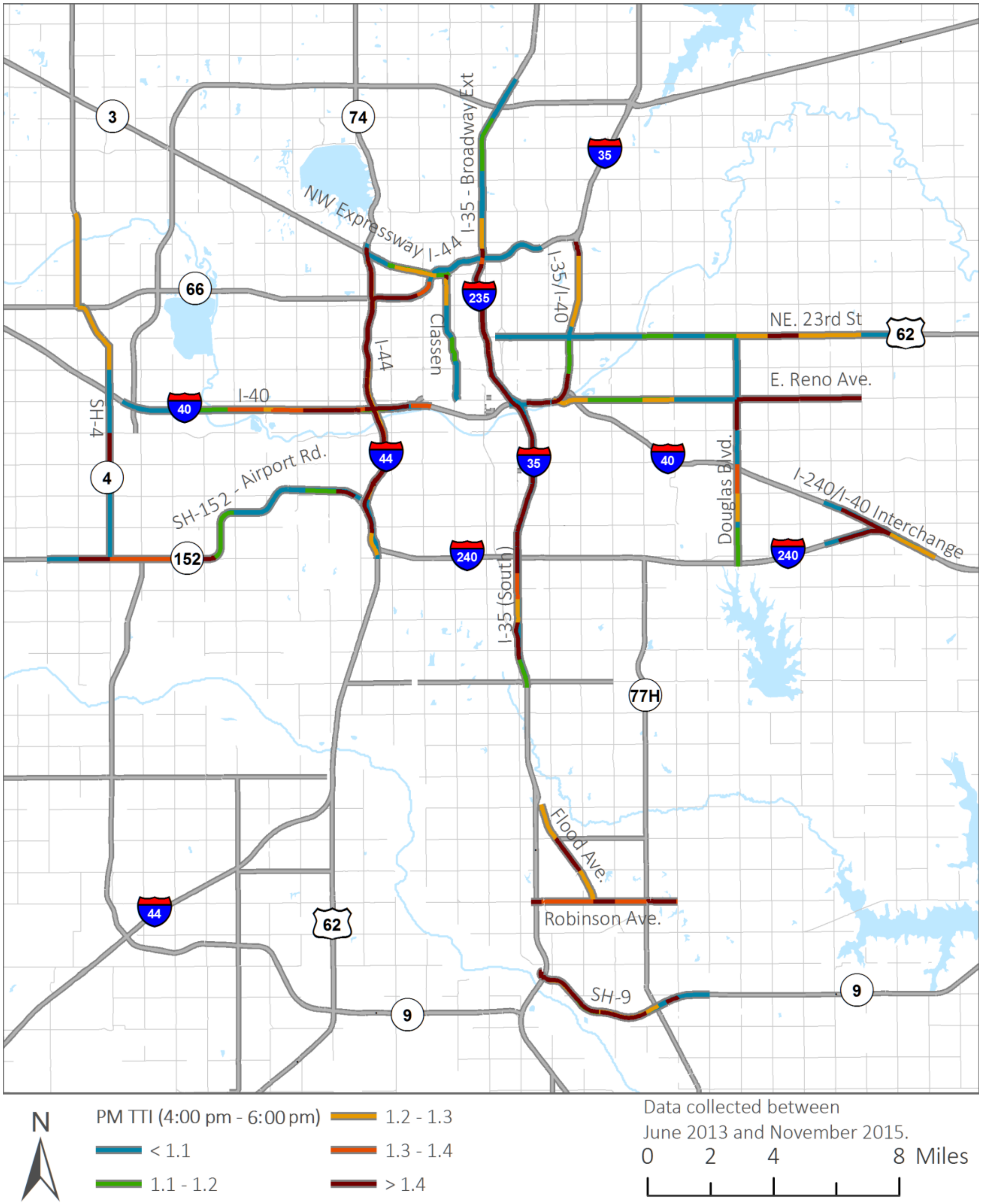


Figure 6-3 CMP Focus Network: PM Peak TTI (4:00pm – 6:00pm)



6.2 Crash Hotspots

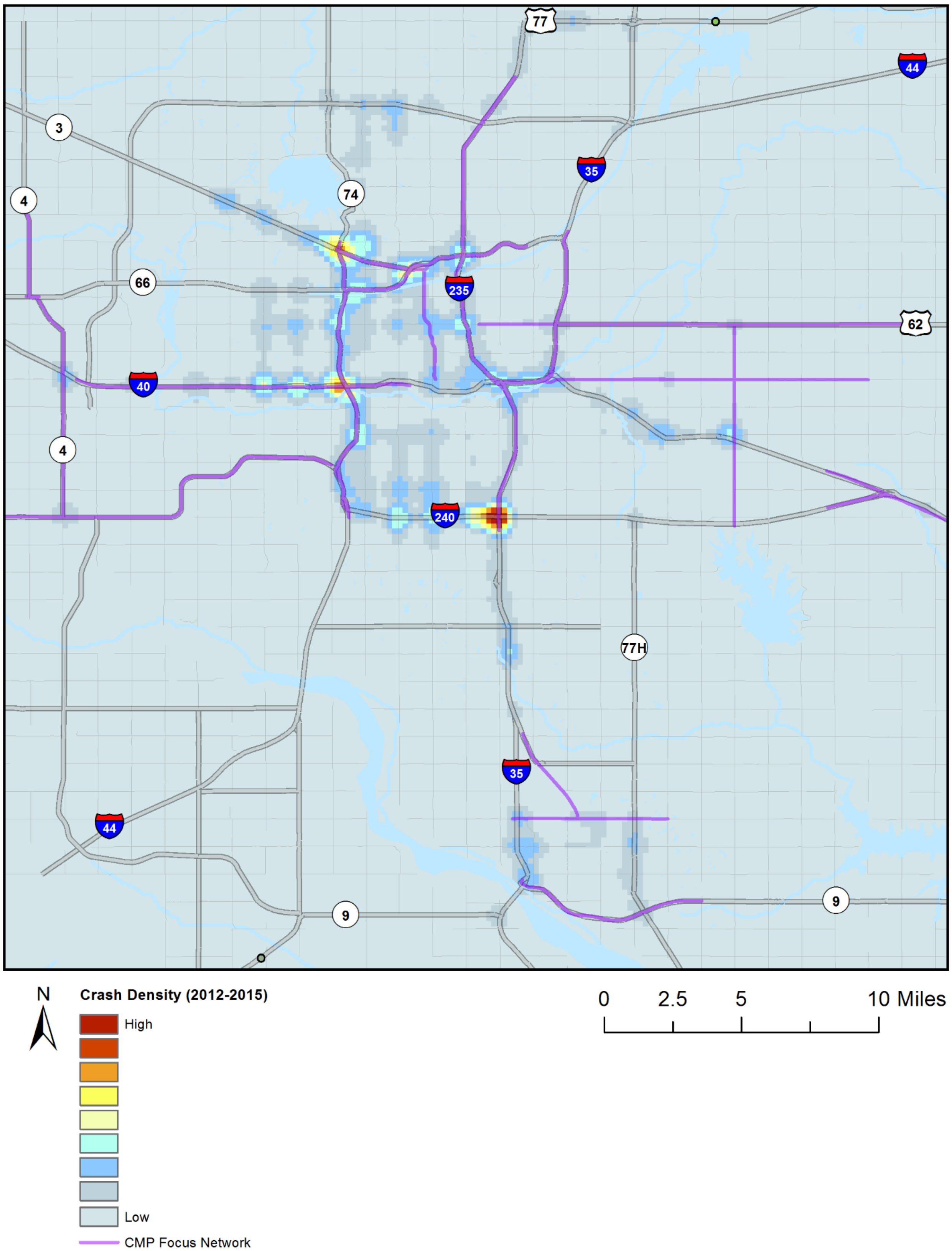
Crash information was collected and reviewed for the 2012-2015 period as discussed in **Chapter 5**. Crashes are generally considered to cause non-recurring congestion. However, where crashes occur in large amounts over consistent time periods, the congestion can become recurring congestion. System interchanges, junctions, and intersections are typically locations of higher crash frequency. A heat map of crash locations on the CMP Focus Network was developed showing crash hotspots for this 2012-2015 time period as in **Figure 6-4**. A hotspot analysis provides a quick screening that identifies high crash locations. The scale used in this graphic provides a simple relative comparison of the crash locations.

Crash hotspots show the locations where a number of crashes have occurred over time in close proximity to one another. The hotspots displayed are not coded to show any particular crash severity; they merely show locations where crashes have occurred. Using geographic information systems (GIS) a buffer is placed around each crash location. Overlapping buffers create a higher intensity in the heat map and can be seen as hotspots.

Seven higher crash frequency hotspots exist on the CMP focus network that may require further study. The largest hotspot is located at the I-240/I-35 system interchange. The I-35 (South) corridor has the highest TTI of any of the focus network corridors, the crash concentration at the southern end of this corridor (the system interchange) potentially presents an opportunity for improvement of the CMP Focus Network.

Additional hotspots of note include the I-44/I-40 system interchange, the connection of the NW Expressway and State Highway 74, the NW Expressway connection to I-44, the I-40/MacArthur interchange, and the I-40/Meridian interchange.

Figure 6-4 CMP Focus Network Crash Hotspots (2012-2015)



6.3 Summary

Substantial congestion exists on the CMP Focus Network during the PM Peak period. In particular, six corridors on the OCARTS interstate/expressway system show travel time indices of over 1.3 for the entire corridor during the evening commute. Segments are considered to be substantially congested if they exhibit a TTI value of over 1.4. This means that the congested travel time of 140 percent of the free flow travel time. Areas that exhibit both a high level of crash concentration from the heat map and a high travel time index should be high priority areas when developing system improvements. Focus Network corridor segments that exhibit an evening TTI greater than 1.4 and are located inside a crash hotspot include the following:

- I-44/I-40 System Interchange
- I-35 from the I-240 System Interchange to the SE 59th Street interchange
- I-40 from the MacArthur interchange to the Meridian interchange
- NW Expressway/SH-74 Interchange

7 Congestion Management Strategies

Congestion management strategies include a variety of projects, actions, programs and policies that can be used to alleviate traffic congestion on the transportation network. Presented in this chapter are a customized range of strategies that can be used to address the regional congestion problems, bottlenecks, and mobility needs identified using collected data.

The recommended strategies are consistent with the *Encompass 2040* goals and proposed CMP objectives. Although a large universe of CMP strategies exists and may be recommended, only those strategies that meet the unique context and requirements of the Central Oklahoma region are included. The included strategies are thought to be achievable and implementable through close coordination of sponsoring and administering partners.

This chapter provides a framework for identifying and evaluating congestion management strategies, presents a customized toolbox of potential CMP strategies for ACOG, and describes potential evaluation methods and the expected effectiveness and impact of the strategies. Sketch planning models and tools that provide state-of-the-practice analysis capabilities to this planning process are also described. Results of best practices, the previous ACOG CMP, and stakeholder input have been used to refine the categories and list of strategies within each category.

7.1 Identifying Strategies

One of the key components of the CMP is to identify a set of recommended solutions to effectively manage congestion and achieve regional congestion management goals and objectives. Federal guidance recommends that the identification of strategies be based on their ability to support regional congestion management objectives, meet local context, contribute to other regional goals and objectives, and consider the coordination and collaboration that will be needed to assign jurisdictional responsibility for implementing the strategies. The CMP goals, objectives, and actions provide additional context for identifying appropriate strategies to resolve specific congestion issues.

Agencies must also have an understanding of the current operating characteristics of the system, corridor or specific project location as well as an understanding of future needs and problem areas. Congestion management strategies may vary depending on:

1. The specific congestion issue or dimension that needs to be addressed,
2. The objectives to be accomplished by the deployed strategy,
3. Whether the strategy is to be implemented on a new or an existing facility,
4. The availability of right-of-way,
5. The current operational characteristics, and
6. Environmental and societal concerns.

7.2 Congestion Management Toolbox

The guiding principles for ACOG's metropolitan transportation plan (*Encompass 2040*) and CMP suggest that preference be given to demand management strategies that eliminate or reduce travel. Federal policy directs the use of a structured response to congestion management where high-cost strategies that primarily increase capacity for single occupant vehicles should only be used after more cost effective strategies have been considered.

In accordance with 23 CFR 450.320 (c) 4[22], the following list of congestion management strategy types has been developed for the OCARTS region in concert with the *Encompass 2040* and CMP guiding principles.

1. Travel demand management (TDM) strategies that eliminate or reduce the need to make trips by motor vehicle.
2. Transportation and land use cohesion strategies and policies that encourage mixed-use and transit oriented development to increase density and reduce the need for motor vehicle trips.
3. Technology solutions through the use of transportation systems management and operations (TSM&O) and intelligent transportation systems (ITS) to maximize the efficiency of the existing infrastructure.
4. Public transit enhancements and projects to make transit a more attractive and competitive mode of transportation in the OCARTS region.
5. Bicycle and pedestrian improvements to enhance the reach of the public transportation system and encourage trips by modes other than single occupancy vehicle.
6. Improvements to roadways that include access consolidation and control, complete streets policies, restriping, and finally the addition of lanes or construction of new facilities where no other solutions can minimize or alleviate congestion effectively.

Each strategy type is described in greater detail below. **Table 7-1** shows the congestion management toolbox that identifies strategies within each of the hierarchical categories. Some of the strategies are more regional or system wide in application, while others are corridor or project specific. For each of the projects and strategies, the potential for congestion reduction benefits is indicated, along with a recommended analysis method to help with location-specific assessment and prioritization. Costs to implement strategies are identified based upon a low, medium, high scale due to the variability in application and location. Timeframes for implementation are also included based upon a review of how quickly these strategies can be develop and executed by a sponsoring agency. The toolbox also identifies companion strategies that are complementary and should be used together in order to maximize benefits.

7.3 The Six Congestion Management Strategy Types

Travel Demand Management

Seven different TDM strategies are identified including

1. Alternative work schedules,
2. Telecommuting,
3. Ridesharing,

[22] http://www.ecfr.gov/cgi-bin/text-idx?SID=23148b2cfe6d719ae63493c2cedad5f1&mc=true&node=se23.1.450_1320&rgn=div8

4. Alternative mode events,
5. Employer incentive programs,
6. Carsharing, and
7. Pricing strategies.

The costs of these strategies tend to be low to moderate and have benefits such as reducing peak period travel and reducing single occupant vehicle miles traveled (VMT). These, in turn can provide a number of environmental benefits including improved air quality and reduce greenhouse gas emissions. The effectiveness of these strategies is difficult to measure at a regional level, but can be more effective at specific districts, business parks or subareas. TDM strategies can be grouped well with various public transportation services, park and ride lots, as well as land use and bicycle and pedestrian strategies.

Transportation and Land Use Cohesion

Transportation and land use cohesion strategies focus on effectively managing the land adjacent to and accessing major transportation facilities. These strategies address and modify planning and zoning requirements in order to encourage land use developments that meet the context of the transportation network that they link to.

Three strategies selected for the OCARTS region include

1. Encouraging infill development and densification,
2. Promoting mixed-use development, and
3. Creating guidelines to promote transit-oriented development.

The effective implementation of land use policies decreases the need for single occupant vehicle trips by reducing the distance to commercial and activity centers for individuals living or working in such a location.

The development of these strategies are generally low to moderate in cost for the implementing agency or jurisdiction. The timeframe for the implementation and/or completion of these strategies is medium- to long-term. The development of the policies can be accomplished in the short term but the change in land use and transportation cohesion can take much longer as development and redevelopment occurs. Partnering with private enterprise, public transportation and bicycle and pedestrian planning are complementary steps to ensure successful land use and transportation cohesion. Generally, land use strategies have low to moderate costs and tend to involve the establishment of ordinances and the potential need for economic incentives that will encourage developer buy-in.

Transportation Systems Management and Operations (TSM&O) and Intelligent Transportation Systems (ITS)

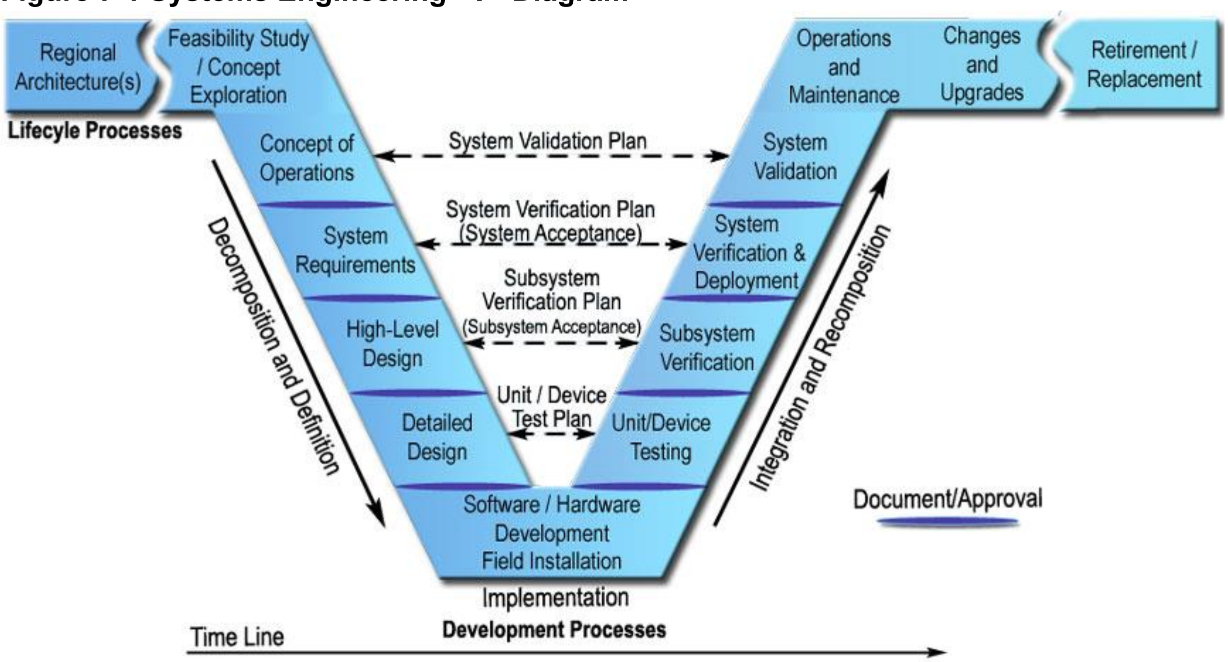
Transportation system management and operations (TSM&O) and intelligent transportation systems (ITS) are a set of strategies that leverage advancement in technologies to enhance the efficiency of the existing transportation infrastructure. Largely, these strategies are used to maximize the throughput of the existing transportation network without adding additional physical capacity (lanes).

Fourteen TSM&O/ITS strategies have been identified for the OCARTS region. It should be noted that these strategies are more dependent upon the implementation of their companion strategies in order to achieve the maximum benefit than strategies from other focus areas. A robust and overlapping network of ITS and TSM&O strategies provide major benefits to a region's congestion reduction efforts.

Examples of the strategies recommended for ACOG and the OCARTS region include enhanced traffic enforcement, developing work zone management principles, enhancing the parking management program, speed harmonization, ramp metering, managed lanes, intersection enhancements for bicycles and pedestrians, formalizing a traffic incident management program and various communications and traffic monitoring improvements.

Costs for these improvements tend to be low to moderate. Regional deployments of ITS infrastructure involves some additional requirements that must be met in order to utilize federal funding. ITS deployments that involve new technology or that include multiple jurisdictions/agencies are required to undergo a systems engineering process. This exercise can add additional time to the process but assists in ensuring that the technology that is deployed meets the needs of the community. A diagram of the systems engineering process is shown below in **Figure 7-1.**

Figure 7-1 Systems Engineering "V" Diagram



Source: Systems Engineering for Intelligent Transportation Systems, FHWA, January 2007

Transit

The Central Oklahoma region is served by three major transit systems, the Cleveland Area Rapid Transit system (CART), the Central Oklahoma Transportation and Parking Authority (COPTA) operates transit service under the name EMBARK, and Citylink. Most of these transit routes operate with 30-minute frequency during peak hours (below the level to support spontaneous transit usage). Increasing the share of person trips taken on public transportation would lessen the number of vehicle trips and reduce congestion.

Seven public transportation strategies are identified including:

1. Developing improved transit stations or stops,
2. Expanding express bus services,
3. Developing intersection queue jumps to improve transit travel times,
4. Providing enhanced amenities on vehicles or stops,
5. Increasing bus route coverage or frequency,
6. Developing new fixed guideway travelways, and
7. Implementing dedicated transit rights-of-way.

These strategies range in cost from low to high. Constructing new transit travelways and dedicating transit right-of-way is often costlier than improving service frequencies or enhancing bus stops. Additionally, operating costs must be factored into the ultimate program solution, often capital costs can be provided for through grant opportunities but dedicating revenue to the operational cost of expanding and continuing service can be more difficult. Predominant benefits include shifting mode share, increasing transit ridership, reducing VMT, and improving air quality. Transit strategies work well alongside bicycle and pedestrian strategies and transportation and land use cohesion strategies that aim to further shift mode share away from automobiles.

Bicycle and Pedestrian

The bicycle and pedestrian network provides an extension of the main public transportation system. This strategy approach examines ways to encourage higher use of bicycles and encourage walk trips. Three bicycle and pedestrian strategies are identified including the development of new sidewalks and bicycle lanes on local streets, creating regional design guidelines for bicycle and pedestrian friendly developments, and expanding bicycle sharing programs. These tend to be low to moderate in cost. Bicycle and pedestrian policies work well when grouped with other strategies such as implementation of a complete streets policy, land use and transportation cohesion strategies that promote densification, and improved safety strategies such as enhanced enforcement.

Benefits of bicycle and pedestrian strategies are related to decreasing auto mode share, which in turn reduces VMT and improves regional air quality and congestion. Costs of bicycle and pedestrian strategies tend to be low to moderate.

Roadway Improvements

Federal policy directs the use of a structured response to congestion management where high-cost strategies that primarily increase capacity for single occupant vehicles should only be used after more cost effective strategies have been considered. That said, there are times when capacity improvement through the addition of new lanes or even new facilities is necessary and warranted. Improvements to the roadway network should be paired with complementary companion strategies.

Eight roadway improvement strategies are listed for the OCARTS region. These strategies are designed to help improve operations and relieve bottlenecks on existing facilities and to support the efficiency of other modes where applicable. Strategies include:

1. Improved signage,
2. Access management improvements,
3. Turn restrictions at key intersections,
4. Adopting local complete streets policies,
5. Geometric design improvements to intersections and interchanges,
6. Adding capacity through restriping activities or widening (if appropriate),
7. Addition of acceleration or deceleration lanes, and
8. The development of new arterials or expressways.

Roadway improvements range in cost based on the type and complexity of the strategy implemented. These strategies tend to address localized problem locations rather than corridor or regional needs. Roadway improvements should be grouped with companion strategies in order to maximize the impact of a localized enhancement. For example, roadway widenings or intersection improvements should be reviewed for the potential for future transit expansions and right-of-way should be reserved for enhanced future bus operations, etc.

The cost and timeframe for the implementation of strategies are represented below according to the following symbols.

Table 7-1 Cost Key

Symbol	Meaning
$	Low Cost
$+	Low to Moderate Cost
$$	Moderate Cost
$$+	Moderate to High Cost
$$$	High Cost

Table 7-2 Congestion Management Toolbox

1. Travel Demand Management (TDM)						
Project/Program	**Congestion Impacts**	**Cost**	**Timeframe**	**Data Sources/ Analysis Tools**	**Companion Strategies**	***Encompass 2040* Connection**
Alternative Work Schedules - Continue/expand existing programs to work with employers and employees to leave home and arrive at work locations outside traditional peak demand periods.	Reduced peak period VMT Improved travel time	$	Existing	Traffic counts Participant surveys	Telecommuting Ridesharing Park and Ride Lots	Economic Strength, Equity and Options, Performance
Telecommuting - Continue/expand existing programs to work with employers and employees to allow for remote work, work-from-home, and other telecommuting options.	Reduced peak period VMT Reduced overall VMT Reduced overall VHT Reduced parking demand	$	Existing	Traffic counts Participant surveys	Alternative Work Schedules Ridesharing Park and Ride Lots	Economic Strength, Equity and Options, Performance
Alternative Mode Events - Continue/expand existing programs to develop additional events that promote non-SOV work trips (e.g. Bike to Work Day, Carpool Day, Vanpool Day, etc.).	Reduced peak period VMT Reduced overall VMT Reduced overall VHT Reduced parking demand Increased demand for walking, biking and transit	$	Existing	Participant surveys Boarding and alighting data	Ridesharing Managed Lanes Park and Ride Lots Transit Programs	Economic Strength, Equity and Options, Performance
Ridesharing - Continue/expand existing programs to work with users to register and regularly utilize carpooling and vanpooling. Ridesharing programs are most effective when coupled with a guaranteed ride home program to allow for commuters who may have emergencies to know that they can respond immediately should their plans or ride partners' plans change.	Reduced peak period VMT Reduced peak period SOV trips Reduced parking demand Increased use of alternative modes	$	Existing	Traffic counts User logs Participant surveys	Alternative Work Schedules Telecommuting Guaranteed Ride Home Programs Managed Lanes	Economic Strength, Equity and Options, Performance

Carsharing - Continue/expand existing programs to deploy carsharing stations in the ACOG region. Currently, Enterprise Carshare, Zipcar, and TimeCar are operating in the ACOG region at limited locations.	Reduced parking demand Increased demand for walking, biking and transit	$	Existing	Traffic counts User logs Participant surveys	Ridesharing Managed Lanes Park and Ride Lots	Economic Strength, Equity and Options, Performance
Employer Incentive Programs - Marketing and reward program partnerships between transit operators and employers to encourage existing staff's use of transit through subsidies of transit fares provided to employees	Increased transit ridership Reduced VMT Enhanced travel time reliability	$	Short term (1-5 years)	Boarding and alighting data	Alternative Work Schedules Alternative Mode Events	Economic Strength, Equity and Options, Performance, Connectivity
Pricing Strategies - Consider the use of peak period and/or congestion pricing on the turnpike system in the OCARTS region to assist in demand reduction on the network. Consider toll price reductions or free trips for HOV vehicles.	Reduced peak period VMT Reduced travel time for turnpike users	$$	Existing	Toll revenue Traffic counts on tollway	Managed lanes Ridesharing	Performance
2. Transportation and Land Use Cohesion						
Project/Program	**Congestion Impacts**	**Cost**	**Timeframe**	**Data Sources/ Analysis Tools**	**Companion Strategies**	***Encompass 2040* Connection**
Design Guidelines for Transit-Oriented Development (TOD) - Land use and development guidelines that encourage clustering housing units, employment and service centers around transit stations in walkable areas.	Reduced VMT	$	Short term (1-5 years)	Site impact analysis Land use changes over time	Design Guidelines for Bicycle/Pedestrian Friendly Development	Economic Strength, Performance, Connectivity, System Preservation
Infill and Densification - Focus new development in the footprint of existing infrastructure rather than building new infrastructure in greenfield locations.	Reduced VMT Increased use of alternative modes	$$	Short term (1-5 years)	Travel Demand Model Site impact analysis	Improved Transit Stations/Stops Enhanced transit amenities Bike Sharing Programs Carsharing	Economic Strength, Performance, Connectivity, System Preservation
Mixed-use Development - Comingling of residential, commercial and other service land uses in order to reduce the need for people to use vehicles to access goods and services.	Reduced of VMT Increased use of alternative modes	$$	Short term (1-5 years)	Travel Demand Model Site impact analysis	Improved Transit Stations/Stops Enhanced transit amenities Bike Sharing Programs Carsharing	Economic Strength, Performance, Connectivity, System Preservation

3. Transportation Systems Management and Operations (TSM&O) and Intelligent Transportation Systems (ITS)						
Project/Program	**Congestion Impacts**	**Cost**	**Timeframe**	**Data Sources/ Analysis Tools**	**Companion Strategies**	***Encompass 2040* Connection**
Partnership with Private Commercial Traffic/Travel Applications - Identify and partner with commercial truck GPS/electronic logbook developers (Garmin, Rand McNally, Waze, etc.) to ensure accurate truck routing/alternate routing during road work/congestion/incident times.	Increased travel time reliability Reduction in work zone related incidents Reduced delay due to incidents	**$**	Short term (1-5 years)	Inventory of partnerships	Traffic Incident Management (TIM) Program Regional Traffic Management Center (TMC) Enhanced enforcement	Performance, Economic Strength, Safety and Security
Enhanced Enforcement- Targeted deployment of enforcement personnel in areas that are prone to congestion and incidents.	Increased travel time reliability	**$**	Short term (1-5 years)	Crash data	Speed Harmonization Work Zone Management Service Patrols Regional Traffic Management Center (TMC) Traffic Incident Management (TIM) Program	Performance, Economic Strength, Safety and Security
Work Zone Management - ITS, Smart Work Zones and enforcement supported work zones for projects located on heavily traveled and/or incident prone roadways	Increased travel time reliability Reduced VHT Reduction in work zone related incidents	**$**	Short term (1-5 years)	Crash Data TOPS-BC	Traffic Incident Management (TIM Program) Enhanced Enforcement	Performance, Economic Strength, Safety and Security
Parking Management Program- Examination and revisions to parking policies, prices and lot/garage locations to encourage efficient use of parking resources in high parking demand areas. May include mobile applications, electronic payment, wayfinding and other signage.	Reduced VMT Reduced CBD congestion Reduced event based parking congestion	**$**	Short term (1-5 years)	Parking surveys Parking utilization rates	Regional Traffic Management Center (TMC) Traffic Incident Management (TIM) Program	Performance, Economic Strength, Safety and Security

Project/Program	Congestion Impacts	Cost	Timeframe	Data Sources/ Analysis Tools	Companion Strategies	*Encompass 2040* Connection
Bicycle and Pedestrian Intersection Enhancements - Enhancements to the detection and signalization of bicycle and pedestrian crossing devices including but not limited to video, infrared, radar, and/or magnetic detection and visual and/or auditory signals for both motorized and non-motorized users.	Increased mobility and access Increased use of alternative modes Increased bicycle/pedestrian safety	**$+**	Short term (1-5 years)	Bicycle/pedestrian specific crash data	Traffic Signal Coordination and Modernization Communications Networks and Roadway Monitoring Coverage	Economic Strength, Equity and Options, Connectivity
Speed Harmonization - Variable speed limits on segments of the network that approach areas of recurring congestion, bottlenecks, incidents, special events and other conditions that affect traffic flow.	Reduced VHT Reduction in traffic incidents	**$+**	Short term (1-5 years)	NMPRDS Crash data TOPS-BC Simulation Models	Regional Traffic Management Center (TMC) Traffic Incident Management Program Enhanced Enforcement Communications Networks and Roadway Monitoring Coverage	Performance, Economic Strength, Safety and Security
Service Patrols - Roving or stationed and immediately deployable service vehicles to patrol heavily traveled or incident prone segments of the CMP network to provide faster and anticipatory responses to traffic incidents and disabled vehicles.	Reduced vehicle delay due to incidents Reduction in secondary crashes Increased travel time reliability	**$+**	Short term (1-5 years)	Incident duration Crash data Number of responses, vehicles tagged and removed TOPS-BC	Traffic Incident Management (TIM Program) Enhanced Enforcement	Performance, Economic Strength, Safety and Security
Ramp Metering - Develop and implement ramp metering (non-tolled) to control the flow of new traffic onto controlled access facilities.	Reduced VHT Increased travel time reliability	**$+**	Short term (1-5 years)	NPMRDS TOPS-BC Simulation Models	Traffic Incident Management (TIM Program) Traffic Signal Coordination and Modernization	Performance, Economic Strength

Project/Program	Congestion Impacts	Cost	Timeframe	Data Sources/ Analysis Tools	Companion Strategies	*Encompass 2040* Connection
Managed Lanes - conversion of general purpose lanes into high occupancy vehicle (HOV)/high occupancy toll (HOT) lanes to provide incentives for carpool/vanpool users.	Travel time improvements for participants Reduced parking demand Increased demand for walking, biking and transit	**$$**	Short term (1-5 years)	NPMRDS TOPS-BC Simulation Models	Enhanced Enforcement Ridesharing Carsharing Transit Programs Park and Ride Lots	Performance, Economic Strength
Traffic Incident Management (TIM) Program - expand and formalize existing response frameworks to traffic incidents on the CMP network. Engage first responders, tow operators and owner agencies to develop unified response strategies and methods to clear incidents in a timely manner. May also include planned special event management.	Reduced vehicle delay due to incidents Reduction in secondary crashes	**$$**	Short term (1-5 years)	Incident duration Crash data TOPS-BC	Communications Networks and Roadway Monitoring Coverage Enhanced enforcement Traffic Signal Coordination and Modernization	Performance, Economic Strength, Safety and Security
Traveler Information Systems- Incident, congestion, and weather related detection and communication networks to provide accurate and current information to network users.	Increased travel time reliability Reduction in work zone related incidents Reduced delay due to incidents	**$$**	Short term (1-5 years)	Incident duration Crash data TOPS-BC	Traffic Incident Management (TIM) Program Regional Traffic Management Center (TMC) Enhanced Enforcement	Performance, Economic Strength, Safety and Security

Project/Program	Congestion Impacts	Cost	Timeframe	Data Sources/ Analysis Tools	Companion Strategies	*Encompass 2040* Connection
Communications Networks and Roadway Monitoring Coverage - Communications and monitoring infrastructure (fiber, wireless, cameras, speed detectors, etc.) required to support operational activities. Communications networks allow remote monitoring and surveillance of the CMP network and provide date for real time management of the transportation system. Information may also be provided to the media and public to assist in TDM and incident routing.	Increased operational capability to monitor and respond to incidents on the network and provide traveler information.	**$+**	Short term (1-5 years)	Network Monitoring Inventory (data)	Regional Traffic Management Center (TMC) Traffic Signal Coordination and Modernization Traffic Incident Management (TIM) Program Transit Programs	Performance, Economic Strength, Safety and Security
Regional Traffic Management Center (TMC) - consider enhancing the existing control center for monitoring, communication and control of the CMP network. TMCs facilitate situational awareness, communication among owner agencies, response partners, execution of responses and coordination.	Reduction in incident response time Reduced delay due to incidents Increased travel time reliability	**$+**	Medium term (6-10 years)	Incident duration Incident response time Incident reduction TOPS-BC Miles of network covered by ITS devices	Traffic Incident Management (TIM Program) Communications Networks and Roadway Monitoring Coverage Enhanced Enforcement Traffic Signal Coordination and Modernization Managed Lanes	Performance, Economic Strength, Safety and Security
Traffic Signal Coordination and Modernization - Enhance signal detection and controller ability to respond to changes in traffic flow either in real time or by developing new signal timing plans. May also include transit signal priority to enhance transit system reliability and travel times.	Reduced VHT Reduced intersection delay Increased travel time reliability Improved travel time	**$$**	Medium term (6-10 years)	NPMRDS Simulation Models Travel time surveys TOPS-BC	Regional Traffic Management Center (TMC) Traffic Incident Management (TIM) Program	Performance, Economic Strength

4. Transit						
Project/Program	**Congestion Impacts**	**Cost**	**Timeframe**	**Data Sources/ Analysis Tools**	**Companion Strategies**	***Encompass 2040* Connection**
Improved Transit Stations/Stops- Includes improvements in real-time scheduling, location of vehicles, arrival time, alternate routes and modes. Also included addition of bicycle and pedestrian infrastructure and amenities (bike lockers, bike racks, etc.) and connection to existing networks.	Increased transit ridership Reduced VMT Increased travel time reliability Increased use of alternative modes	**$+**	Medium term (6-10 years)	Bicycle rack/locker usage information Boarding/ alighting data	New Sidewalks and Designated Bicycle Lanes on Local Streets Bike Sharing Programs	Economic Strength, Equity and Options, Performance, Connectivity
Express Bus Service Expansion - Additional high speed, limited stop operations between two commuter points.	Improved travel time Reduced VMT Enhanced travel time reliability Increased transit ridership	**$+**	Short term (1-5 years)	Network Monitoring Inventory (data) Boarding/ alighting data Mode split Transit elasticity model	Traffic Signal Coordination and Modernization Regional Traffic Management Center (TMC) Communications Networks and Roadway Monitoring Coverage	Economic Strength, Equity and Options, Performance, Connectivity
Transit Intersection Queue Jump Lanes and Signal Priority- Addition of travel lanes at signalized intersections that allow buses to proceed before other vehicles (May require additional ROW).	Improved travel time Reduced VMT Enhanced travel time reliability	**$+**	Short term (1-5 years)	Network Monitoring Inventory (data) Boarding/ alighting data Mode split TOPS-BC	Traffic Signal Coordination and Modernization Regional Traffic Management Center (TMC) Communications Networks and Roadway Monitoring Coverage	Economic Strength, Equity and Options, Performance, Connectivity
Enhanced Transit Amenities - Transit vehicle/transit shelter upgrades and replacements to provide users with a better rider experience to encourage more transit use.	Increased transit ridership Reduced VMT Enhanced travel time reliability	**$$+**	Short term (1-5 years)	Boarding/ alighting data	New Sidewalks and Designated Bicycle Lanes on Local Streets Bike Sharing Programs	Economic Strength, Equity and Options, Performance, Connectivity

Project/Program	Congestion Impacts	Cost	Timeframe	Data Sources/ Analysis Tools	Companion Strategies	*Encompass 2040* Connection
Increasing Bus Route Coverage or Frequencies - Examine route structure for opportunities to enhance transit frequencies on primary transit corridors and/or expand transit service to areas that do not have transit coverage but are suitable for transit operation. May require investment in new buses (capital cost).	Increased transit ridership Reduced VMT Enhanced travel time reliability Increased transit ridership	**$$+**	Short term (1-5 years)	Travel time reliability Boarding/ alighting data Travel Demand Model Simulation Models Transit elasticity model	Regional Traffic Management Center (TMC) Traffic Signal Coordination and Modernization	Economic Strength, Equity and Options, Performance, Connectivity
New/Expanded Fixed Guideway Transit Travelways - Exclusive street travelways (e.g. bus rapid transit) devoted to increasing the person-capacity of a travel corridor	Increased travel time reliability Reduced VMT Increased person throughput Stimulation of mixed-use and high density land uses adjacent to corridor	**$$+**	Medium term (6-10 years)	Boarding/ alighting data Travel Demand Model Simulation models TOPS-BC Transit elasticity model	Regional Traffic Management Center (TMC) Traffic Signal Coordination and Modernization	Economic Strength, Equity and Options, Performance, Connectivity
Dedicated Transit Rights-of-Way - Reservation of travel lanes for transit operation. This may include bus-on-shoulder (BOS) operation during peak periods to enhance travel corridor throughput.	Increased travel time reliability Reduced VMT Increased person throughput Stimulation of mixed use and high density land uses adjacent to corridor	**$$+**	Medium term (6-10 years)	Boarding/ alighting data Travel Demand Model Simulation models TOPS-BC Transit elasticity model	Traffic Signal Coordination and Modernization Regional Traffic Management Center (TMC)	Economic Strength, Equity and Options, Performance, Connectivity

5. Bicycle and Pedestrian						
Project/Program	**Congestion Impacts**	**Cost**	**Timeframe**	**Data Sources/ Analysis Tools**	**Companion Strategies**	***Encompass 2040* Connection**
Design Guidelines for Bicycle/Pedestrian Friendly Development - Regional land use guidelines to specify maximum block lengths, building setback restrictions, streetscape examples and circulation patterns that can be easily codified into local land use ordinances to encourage alternative mode use.	Increased mobility Increased use of alternative modes Increased bicycle/pedestrian safety	**$**	Short term (1-5 years)	Network Monitoring Inventory (data)	Design Guidelines for Transit Oriented Development (TOD) Adoption of Local Complete Streets Policies	Economic Strength, Equity and Options, Connectivity
Bike Sharing Programs - Expand the coverage of the Spokies system to encourage additional use of bicycle transportation.	Increased mobility Increased use of alternative modes Increased bicycle/pedestrian safety	**$**	Short term (1-5 years)	Network Monitoring Inventory (data)	Improved Transit Stations/Stops Enhanced Transit Amenities Alternative Mode Events	Economic Strength, Equity and Options, Performance, Connectivity
New Sidewalks and Designated Bicycle Lanes on Local Streets - Enhance the visibility of bicycle and pedestrian infrastructure to increase the perception of safety. Restriping and potential use of cycle tracks and other enhanced bicycle ways should be considered in order to make bicycle travel more attractive to users.	Increased mobility Increased use of alternative modes Increased bicycle/pedestrian safety	**$+**	Short term (1-5 years)	Network Monitoring Inventory (data)	Improved Transit Stations/Stops Enhanced Transit Amenities Alternative Mode Events	Economic Strength, Equity and Options, Performance, Connectivity

6. Roadway Improvements						
Project/Program	**Congestion Impacts**	**Cost**	**Timeframe**	**Data Sources/ Analysis Tools**	**Companion Strategies**	***Encompass 2040* Connection**
Development of Access Management Policies - Planning and design principles that identify and restrict the access of adjacent parcels to a major thoroughfare to maximize traffic safety and mobility.	Reduction of traffic incidents Improved travel times Decreased delay	**$**	Short term (1-5 years)	Crash data NMPRDS Travel Demand Model	Design Guidelines for Bicycle/Pedestrian Friendly Development Design guidelines for transit oriented development	Economic Strength, Performance, System Preservation
Adoption of Local Complete Streets Policies - Planning and design principles that encourage the development of a roadway network that accommodates all users.	Increased bicycle/pedestrian safety Increased use of alternative modes	**$**	Short term (1-5 years)	Crash Data Travel Demand Model	Design Guidelines for Bicycle/Pedestrian Friendly Development Design Guidelines for transit oriented development	Economic Strength, Performance, System Preservation
Roadway Signage Improvements - Enhancing wayfinding through the region with enhanced signage that complements the decision-making ability of the roadway user.	Reduced delay due to indecision Reduction in erratic lane changes and potential for crashes	**$**	Short term (1-5 years)	Network Monitoring Inventory (data) Crash Data	Acceleration/Deceleration Lanes Enhanced Enforcement	Performance, System Preservation
Increasing Lanes without Widening - Restriping existing facilities to take advantage of excess width in the highway cross-section.	Increased throughput through additional capacity Reduced congestion due to removal of bottlenecks	**$+**	Medium term (6-10 years)	Travel Demand Model NPMRDS	Intersection and Interchange Improvements	Economic Strength, Performance, System Preservation
Acceleration/Deceleration Lanes- Allowing vehicles (especially large vehicles) extra room to reach the proper speed prior to entering or exiting a high speed facility.	Reduction of traffic incidents Reduced vehicle delay due to slow moving vehicles in through lanes	**$+**	Medium term (6-10 years)	Travel Demand Model	Roadway Signage Improvements	Performance, System Preservation
Intersection and Interchange Improvements - Redesign of existing intersections and interchanges to allow for easier movement through the reduction of conflicts or the addition of through lanes.	Increased throughput via additional vehicle capacity Reduced congestion due to removal of bottlenecks	**$+**	Medium term (6-10 years)	Travel Demand Model Simulation models NPMRDS Intersection Capacity Analysis Tools	Increasing lanes without widening. Roadway Signage Improvements	Economic Strength, Performance, System Preservation

Project/Program	Congestion Impacts	Cost	Timeframe	Data Sources/ Analysis Tools	Companion Strategies	*Encompass 2040* Connection
Increasing lanes with Roadway Widening - Strategic expansion of roadway capacity by the addition of through lanes.	Increased throughput via additional vehicle capacity Reduced congestion due to removal of bottlenecks	**$$+**	Medium term (6-10 years)	Travel Demand Model Simulation models NPMRDS	Traffic Signal Coordination and Modernization Increasing Lanes Without Widening Roadway Signage Improvements	Economic Strength, Performance, System Preservation
New Arterials or Expressways - Addition of new major traffic moving routes to the regional transportation network.	Increased in throughput via additional vehicle capacity Reduction in congestion due to removal of bottlenecks	**$$$**	Long term (10+ years)	Travel Demand Model Simulation models NPMRDS	Traffic Signal Coordination and Modernization Increasing Lanes Without Widening Roadway Signage Improvements	Economic Strength, Performance, System Preservation

Sources: Adapted from Denver Regional Council of Governments CMP Toolkit 2.5 (June 2008), Maricopa Association of Governments Baseline Congestion Management Process Report (October 2010), Mid-American Regional Council Congestion Management Toolbox Update (December 2013), and Houston – Galveston Area Council Congestion Management Process Update (January, 2015).

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7.4 Using the Toolbox

The toolbox can be used by ACOG, ODOT, and other project sponsors to identify strategies for addressing congestion issues on the CMP network and to select the most appropriate strategy (or combination of strategies) that potentially can benefit the location being evaluated. If a strategy shows promise, it can be evaluated in detail using the regional travel demand model and/or applicable analysis tools suggested in the toolbox.

For larger projects (particularly high cost, capacity-adding projects), the toolbox should be used to identify alternative strategies that can be incorporated as part of the project development process. CMP strategies usually will not result in the large capacity gains typical of capacity expansion projects; however, demand management and operational strategies could be incorporated into the capacity improvement project to potentially extend the number of productive years of the facility before additional capacity is needed.

The toolbox can also be used to inform the project selection methodologies and metrics for *Encompass 2040* and the OCARTS Transportation Improvement Program. Providing additional emphasis for alternative modes in the selection of future projects is an important part of the planning process and would provide a solid foundation for the ultimate implementation of the CMP.

As technology and industry practice change over time, it is recommended that ACOG review the toolbox periodically. The strategies and approaches contained in the toolbox should be updated regularly as a part of this process.

7.5 Evaluating Strategies

A variety of analysis tools are available to ACOG, ODOT and local partners to help evaluate the effectiveness (or potential effectiveness) of congestion management strategies. These tools are designed to assess the congestion reduction potential of the projects and strategies carried forward for analysis and screening in ACOG's congestion management process. These tools, or combinations of tools, can be used to identify the impacts of the different strategies identified in the toolbox (e.g., transportation demand management, transportation and land use cohesion, TSM&O and ITS, etc.). A summary of each analysis tool is presented below.

Regional Travel Demand Model

ACOG's traditional four-step Regional Travel Demand Model is currently being updated and may be used in the future to support a variety of analytical needs such as preparation of various system and subarea analyses, including the Long-range Transportation Plan, transit projects, some ITS deployments, and other technical analyses.

Regional travel demand model outputs (VMT, VHT, and other measures) can be used to illustrate the location, duration, and extent of congestion for the region at baseline conditions. The travel demand model can then be used to forecast conditions for the future network including programmed TIP projects. A review of the forecast conditions allows ACOG and its partners to identify locations for the application of CMP toolbox strategies. Regional travel demand model outputs can also be used to assess the impact of alternative strategies such as the targeting of densified development to specific areas or corridors and the addition of capacity or a new roadway to the existing network.

Travel demand model outputs can be used as inputs into the Tool for Operations Benefit/Cost (TOPS-BC), and/or other tools to calculate a variety of performance measures, to evaluate the impacts of many of the types of the toolbox strategies and to help allocate benefits to subregions. Data outputs can include changes in travel times, speed, mode share or a reduction in trips.

Simulation Models

Micro- and meso-scale simulation models are designed to assess the travel impacts of specific multimodal and roadway projects. Meso-simulation models provide more detailed subarea analysis that than can be provided by the regional travel demand model but not as specific as a microsimulation model. Meso-scale traffic simulation produces fluid-like models of traffic flow that can provide information on speed and density but not individual movements of specific vehicles. Microsimulation can be used to evaluate specific intersections, roadway segments and strategies. Specifically, the speed, flow, traffic density, and delay time can be reported from microsimulation models. The use of microsimulation models requires that the analysis area be relatively constrained to a relatively small subarea of the regional network, usually a corridor or specific project area.

Simulation models are effective in evaluating the buildup, dissipation, and duration of traffic congestion, and model outputs can be used to calculate measures of effectiveness such as vehicle/person miles traveled, vehicle/person hours of travel, travel time/queue length, throughput/delay, emissions, and fuel consumption. Simulation results can be used to conduct a benefit valuation of individual strategies or set of strategies. Information on calculation of various measures of effectiveness using simulation outputs is available in FHWA's Traffic Analysis Toolbox[23]. Emerging methods for using simulation model outputs to calculate travel time reliability impacts are detailed in SHRP 2 projects L04, L05 (Technical Reference), and L08.

Tool for Operations Benefit Cost Analysis (TOPS-BC)

TOPS-BC is one of several benefit/cost tools that can be used to evaluate transportation systems management and operations (TSM&O) strategies. TOPS-BC functions as a spreadsheet and may be simpler to operate for a wider range of users. TOPS-BC allows for quick assessments of TSM&O projects with a limited dataset and can provide order of magnitude benefit/cost analysis. TOPS-BC draws information from the US DOT's benefit and cost databases allowing users to pull national results into local decisions. US DOT also maintains the ITS Benefits, Costs and Lessons Learned database[24] to assist industry professionals in assessing the benefit and cost of ITS deployments.

The TOPS-BC spreadsheet and user guide are both available for download from FHWA's Planning for Operations website.[25]

[23] http://ops.fhwa.dot.gov/trafficanalysistools/

[24] http://www.itskrs.its.dot.gov/

[25] http://www.ops.fhwa.dot.gov/plan4ops/topsbctool/index.htm

Due to the characteristics described above, TOPS-BC is recommended as a key congestion management toolbox component for ACOG and its planning partners. TOPS-BC provides users with:

- The ability to investigate the expected range of impacts associated with previous deployments and analyze many TSM&O strategies;
- A screening mechanism to help identify tools and methodologies for conducting a benefit-cost analysis based on analysis needs;
- A framework and cost data to estimate the life-cycle costs of various TSM&O strategies; and
- A framework and suggested impact values for conducting simple sketch planning level benefit-cost analysis for TSM&O strategies.

Vehicle Emissions Modeling Software

The U.S. Environmental Protection Agency (EPA) has developed several spreadsheet-based analysis models to evaluate the potential travel and emissions impacts of TDM strategies, including land use, demand management, and transit-based transportation projects. These models are designed to assist an agency in identifying the impacts of these programs at a systemwide, corridor, subarea, and employer-specific level. The MOBILE6 vehicle emission factor model, initially developed in 1978 and last updated in 2004, calculates emissions of hydrocarbons (HC), oxides of nitrogen (NOx), and carbon monoxide (CO) from passenger cars, motorcycles, light- and heavy-duty trucks. In 2010, the MOBILE series of models was replaced by the Motor Vehicle Emission Simulator (MOVES) model as EPA's official model for estimating emissions from cars, trucks, and motorcycles. The full modeling system and documentation are available from the U.S. EPA Modeling and Inventories[26]. ACOG is currently MOVES to assist in the development of *Encompass 2040*.

Transportation Demand Management (TDM) Evaluation Models

Vehicle emissions models are often used in conjunction with the Regional Travel Model (for regionally significant programs) or other tools such as the Center for Urban Transportation Research Trip Reduction Impacts of Mobility Management Strategies (TRIMMS)[27] tool or the TDM Effectiveness Evaluation Model[28] (for non-regionally significant strategies) to estimate the number of commuters who would change their mode of travel or trip-making behavior through participation in the program and calculate the resultant changes in vehicle activity (e.g., reduction in VMT). This information can then be used with the emissions model to estimate the reduction in emissions that would result from the commuter program. Additional guidance can be found in the EPA publication, *Commuter Programs: Quantifying and Using Their Emission Benefits in SIPs and Conformity.*

Intersection Capacity Analysis Tools

Intersection capacity analysis tools can be used to identify performance issues at specific intersections or corridors. Throughput, signal timing, and turning movements can be examined

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[26] http://www.epa.gov/otaq/models/moves/index.htm

[27] http://trimms.com/

[28] http://mctrans.ce.ufl.edu/store/description.asp?itemID=149

to develop and/or evaluate potential solutions to intersection or corridor focused issues. These tools can be used to develop new signal timing plans or to evaluate geometric changes.

Transit Elasticity Models

One quantitative method of forecasting transit demand is transit elasticity modeling. An elasticity is a measure of sensitivity of demand relative to a particular variable. A wide variety of tools are used to estimate changes in demand. For a short term planning horizon and with only one variable change, elasticities work reasonably well and have widespread use in transit planning. For longer term projections with multiple variables at play, more sophisticated models may be needed.

Several transit industry rules of thumb for the elasticity of transit ridership with respect to transit service hours is 1.5, a 10 percent increase in service hours would cause a 15 percent increase in ridership. Others include non-commute trips tend to be more price sensitive than commute trips. Elasticities for off-peak transit travel are typically 1.5-2 times higher than peak period elasticities, because peak-period travel largely consists of commute trips.

8 Implementing CMP Strategies

8.1 Introduction

This report is part of the Congestion Management Process (CMP) Update. This section documents the programming and implementation process for the CMP. It describes how CMP projects are implemented through inclusion of CMP strategies in various components of the metropolitan transportation planning process, including the Metropolitan Transportation Plan (MTP), Transportation Improvement Program (TIP), and the Regional ITS Architecture. It also presents a process for conducting a CMP analysis for various transportation investment types.

8.2 Integration with the Metropolitan Transportation Planning Process

The CMP both informs and receives information from the elements of the metropolitan transportation planning process. Specifics of the relationship to the general planning process are described below.

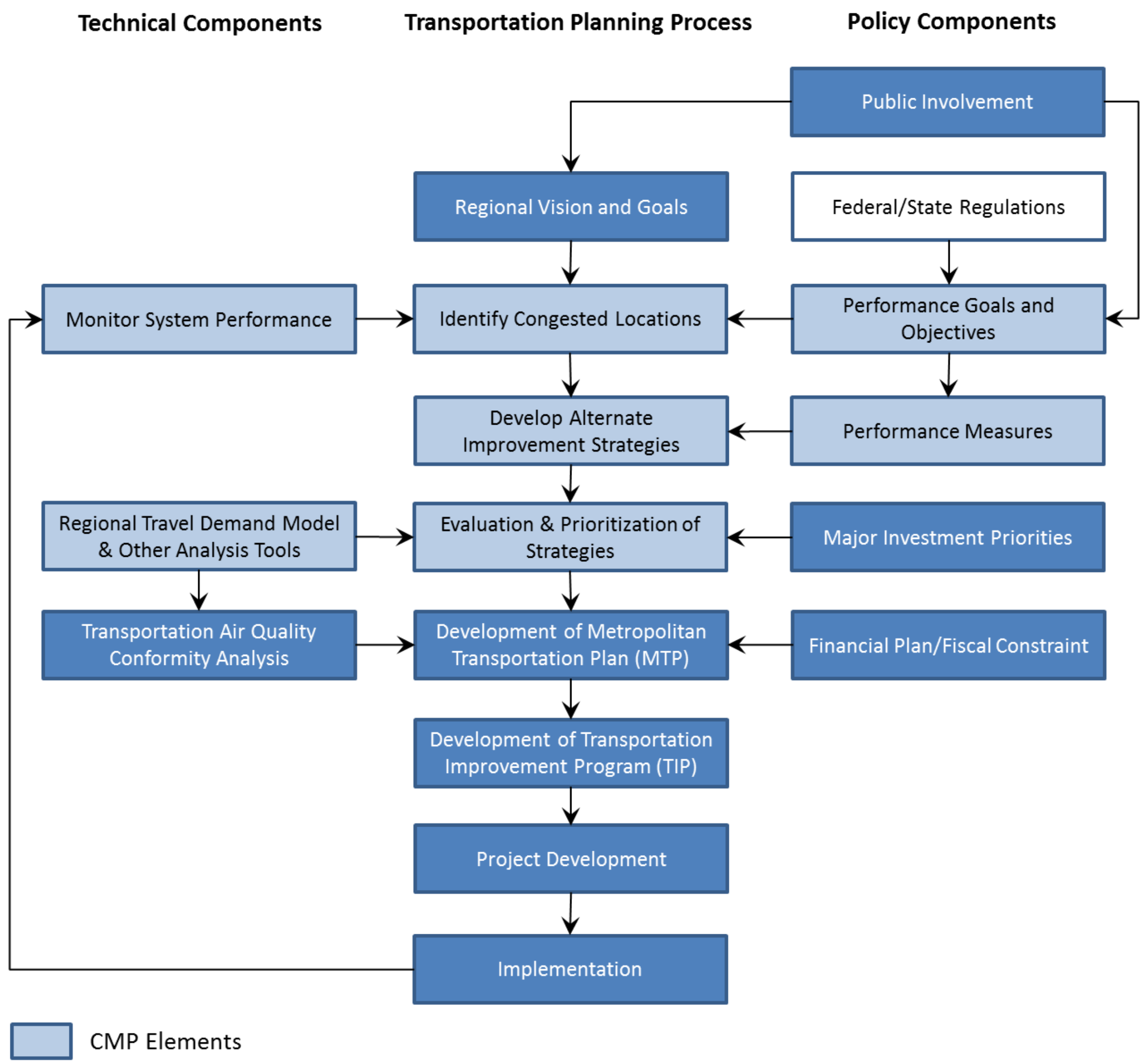
Relationship *to Encompass 2040*

Encompass 2040, the region's MTP, provides a framework for the OCARTS area transportation system by identifying the goals, strategies, and priorities for meeting the region's transportation needs through the year 2040. The MTP is a multimodal plan that identifies regionally significant projects and programs planned for the region using local, state, federal and private funds. Once a project is consistent with the MTP, it may be selected for implementation by inclusion in the region's TIP, where it proceeds through the project development process, including environmental review, preliminary engineering, and right-of-way acquisition and construction/implementation. The CMP is an integral part of the long-range planning process and relates to the MTP in the following ways:

- The MTP's vision statement and goals provide a foundation for the development of congestion management objectives and performance measures that are applied through the CMP.
- The CMP provides information on congestion in the region, which can be used by ACOG to identify congested corridors or segments in need of detailed analysis as part of further corridor studies.
- The CMP Toolbox provides a framework for evaluating transportation projects and programs that maintain or reduce recurring and non-recurring congestion. The suggested analysis tools are intended to be used to assess how congestion mitigation strategies contribute to achieving regional goals and objectives.
- The CMP defines a process for programming and implementing the most cost-effective strategies by introducing them into the MTP project evaluation and programming process and subsequently for programming into the TIP. The CMP does not directly obligate funds, but rather it presents a set of strategies that can be implemented independently or as part of larger projects and programmed in future MTPs and TIPs.
- Following implementation, the CMP provides a mechanism for ongoing system monitoring, both to assess the performance of the system and to evaluate the effectiveness of the congestion management strategies that have been implemented.

Figure 8-1 shows how the CMP is integrated into various technical and policy components of the transportation planning process.

Figure 8-1 Integration of the Congestion Management Process in the Transportation Planning Process



Source: Adapted from *The Transportation Planning Process: Key Issues - A Briefing Book for Transportation Decision makers, Officials, and Staff*, Updated September 2007, Publication No. FHWA-HEP-07-039, http://www.planning.dot.gov/documents/BriefingBook/BBook.htm

Relationship to the Regional Intelligent Transportation Systems (ITS) Architecture

The OCARTS Regional ITS Architecture was completed in May 2003. The ITS Architecture provides an institutional and operational framework for the integration of systems across agency boundaries. Since that time, ACOG and ODOT have developed ITS status reports to guide the implementation of ITS strategy and project deployment. The CMP relates to this Regional Intelligent Transportation System (ITS) Architecture in the following ways:

- The Regional ITS Architecture and ITS Status Reports provide an important resource for identifying sources of data in the region that can support monitoring and reporting of congestion using CMP performance measures.
- The Regional ITS Architecture can identify technology-related solutions to some of the needs and deficiencies identified in the CMP. Furthermore, the Architecture's framework, including stakeholder and service packages involved, can provide a strategy for smooth deployment and integration of ITS related projects to address congestion.
- All ITS strategies implemented from the CMP Toolbox should be consistent with the Regional ITS Architecture. The Regional ITS Architecture and the CMP Toolbox should be reviewed for consistency and reconciled as necessary when updated.
- The integration of Regional ITS Architecture to different planning products can be defined as a separate process.

Relationship to the Transportation Improvement Program (TIP)

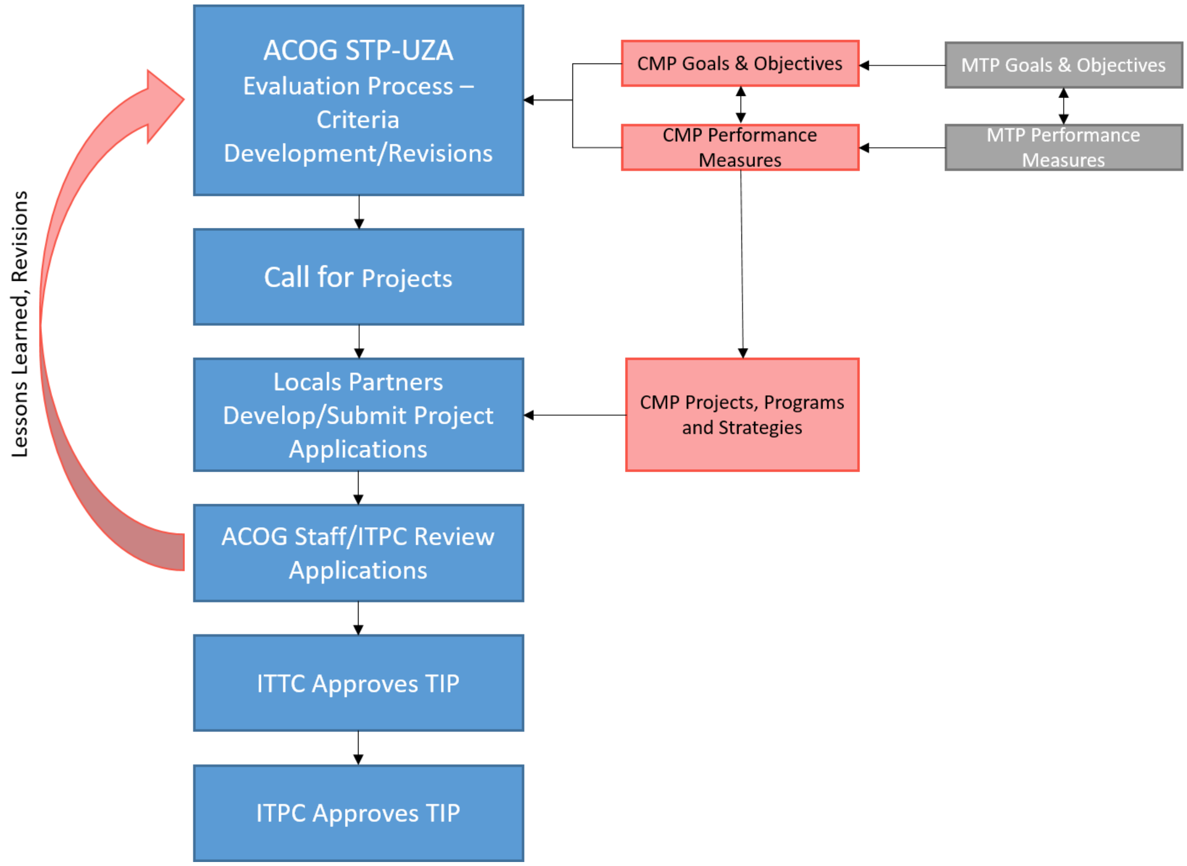
The TIP is a short-range program that contains the highest priority MTP projects and programs to be funded and implemented in the OCARTS region over the next four years. The program identifies federal, state, and local funding for transportation projects that will be implemented within the TIP's four-year timeframe and is developed every two years.

To assist in project prioritization, ACOG has developed a project selection process for the TIP for projects that will utilize the region's suballocation of federal Surface Transportation Program funds, known as STP-UZA funds. ACOG staff and the Intermodal Transportation Technical Committee (ITTC) score, evaluate and prioritize transportation improvement projects based on project evaluation criteria approved by the ACOG Intermodal Transportation Policy Committee (ITPC). **Figure 8-2** identifies how the CMP can be integrated into existing TIP processes. The CMP relates to the TIP in the following ways:

- Providing system performance information for use by ACOG in evaluating projects nominated for inclusion in the TIP.
- Providing system performance information for project sponsors, which may influence their project applications for the TIP.
- The CMP Toolbox identifies alternative congestion management strategies that can be used to advance transportation projects through the selection process.
- The CMP Toolbox identifies potential analysis tools for evaluating project effectiveness in terms of their contribution to a reduction in congestion levels in the region.
- The current Surface Transportation Program Urbanized Area funding (STP-UZA) project evaluation criteria for the OCARTS region includes components that relate to CMP performance measures, objectives and goals.

It is recommended that the STP-UZA evaluation criteria and selection process strengthen the TIP's relationship to the CMP by providing additional and meaningful information on the operational state of the OCARTS transportation system. Possible approaches to update the existing TIP process and criteria are outlined in the following sections of this chapter. The CMP serves as an additional tool to be used by ACOG and its partners by providing information relating to congestion issues and potential solutions in the OCARTS region.

Figure 8-2 Integration of the Congestion Management Process in the Transportation Improvement Program (TIP)



Existing STP-UZA Criteria

The existing criteria used by ACOG and the Intermodal Transportation Technical Committee (ITTC) to evaluate and select STP-UZA projects in the OCARTS region include several measures that are linked to the Congestion Management Process. The CMP can be directly linked to five of the seven current evaluation criteria. These five criteria include the following:

- **Average Daily Traffic (ADT) –** ADT figures are evaluated for project location based upon the type of project that is being proposed. For projects that propose to widen, reconstruct, or resurface a roadway, build a new roadway or construct a new bridge, ADT is to be reported by the project sponsor for each mile of the project. Traffic signal coordination project sponsors must report ADT at each signal. An average of the overall project ADT is then used to evaluate the project. Scoring is assigned as a percentage of the ADT for the project location's functional class (Principal Arterial, Minor Arterial or Collector/Local).
- **Volume-to-Capacity Ratio –** Proposed projects locations are evaluated based upon their existing volume-to-capacity ratio. The STP-UZA selection criteria awards 3 points to projects in locations with a V/C ratio of 1.3 and above. For locations with a V/C ratio of

0.49 or lower, no points are awarded. Project locations that exhibit a V/C ratio between these two levels are awarded points according to the following formula:

Let the proposed project V/C ratio = R

Subtract R from 1.3, and multiply by 100. The result = D

Multiply D x .037. The results = N

Subtract N from 3.0

The above formula is used to evaluate both segment and intersection projects for inclusion in the TIP. For intersection projects a one-hour peak volume is used to determine the V/C ratio. Segment projects utilize the 24-hour ADT.

- **Accident Severity Rate –** ACOG uses the most recent three years of crash data from ODOT or the appropriate local police department to determine the severity index for intersection and mid-block (to be used for street improvements) locations. Locations with an accident severity rate of 12.0 or greater are awarded 3 points while locations exhibiting a severity rate of 3.0 or less are awarded 0 points. Locations exhibiting accident severity indices between 3.0 and 12.0 are awarded points based upon the following formula:

  Determine the proposed project's Accident Severity Rate. Subtract that Rate from 12.0. Multiply by 10. The result is A. Multiply A by .033 and subtract from 3.000 to determine the Accident Severity Rate points for the project.

- **Air Quality –** A project's air quality impacts are evaluated based upon a qualitative assessment of the potential impact on the region's ambient air quality. Projects are grouped into four general scoring categories:
  - **3 High –** Transportation System Management (TSM), transit vehicles, park and ride lots, pedestrian/bicycle facilities, signal improvements, and intersection improvements.
  - **2 Moderate –** Resurfacing of streets or bridges with poor surface condition.
  - **1 Low –** New construction, widening, resurfacing of streets or bridges with fair or good surface condition, administration of carpool/vanpool programs, or other projects.
  - **0 Neutral –** Resurfacing for streets or bridges with very good surface condition, administrative and maintenance activities, non-construction bicycle projects to enhance the safe use of bicycles for transportation purposes.
- **CMP Congestion Corridor –** This criterion provides the most direct linkage to the existing CMP. Projects that occur on an identified CMP Congestion Corridor with an approach that will alleviate existing congestion issues by reducing demand, improving safety, improving operation and/or reducing SOV trips receive two points. Projects that have minor congestion impacts but do not directly reduce demand or SOV travel receive one point. Projects that have no impact or are not on a congested corridor receive no points.

8.3 Analysis of CMP Strategies

This section discusses how the CMP can be used to assess the congestion reduction potential of CMP strategies in terms of established congestion management objectives and performance measures. Proposed projects on the CMP network and especially the CMP Focus Network outlined in **Chapter 3** should be evaluated for their potential to improve travel characteristics of the OCARTS transportation network. The CMP analysis process involves conducting either a quantitative or qualitative assessment of the extent to which congestion mitigation strategies can alleviate travel demand and congestion.

- As a minimum, the analysis process for proposed projects on the CMP network should consist of a qualitative analysis to assess the extent to which congestion mitigation strategies can alleviate travel demand and congestion. Congestion mitigation strategies should be considered as an alternative to capacity. Where possible, quantitative analysis should be conducted using the tools recommended in **Chapter 7.**
- Future iterations of the MTP and TIP project evaluation and selection processes may include enhanced linkages to the CMP. For example, project sponsors could qualitatively report on the benefits of specific strategies that will be implemented as part of the project, as well as quantitatively document the project's ability to relieve congestion, improve trip reliability, and/or to define how it meets one or more of the CMP goals and objectives.

Qualitative Strategy Analysis

The CMP analysis process consists of an assessment of the congestion reduction impacts of the project in terms of CMP objectives and performance measures. Completing the CMP analysis for investments will assist ACOG in determining a project or programs expected ability to meet congestion management goals and objectives for the OCARTS region.

The CMP Toolbox can be used to identify strategies to solve a specific problem or to identify an appropriate analysis tool for evaluating the benefits of a specific project or program type. The congestion reduction impacts of the various projects may be qualitatively assessed using the questions in **Table 8-4.**

Table 8-1 Qualitative Assessment for Transportation Investments

Strategy Type	Qualitative Criteria
Transportation Demand Management Strategies	– Does the project strongly support or enhance travel demand management programs that are already in place and that have regional significance? If yes, please explain. – Will the project reduce traffic congestion by reducing vehicle trips or VMT? If yes, please explain. – Will the project reduce vehicle emissions? If yes, please explain. – Does the project include marketing, education and incentive programs that encourage shift to alternative modes? If yes, please explain.
Land Use Improvements	– Does the project provide or demonstrate the potential for a transit connection? If yes, please explain. – Does the project provide an accessible pedestrian/bicyclist environment for Bicycle and Pedestrian Accommodation? If yes, please explain.
Public Transportation Improvements	– Does the project provide connection to other transit services? If yes, please explain. – Does the project include pedestrian and bicycle accommodations? If yes, please explain. – Is the project an intrinsic part or demonstrate the potential for Transit Oriented Development? If yes, please explain. – Does the project provide access to job opportunities, unmet or enhanced needs? If yes, please explain. – Does the project use Intelligent Transportation Systems and other operation/ service enhancing technologies? If yes, please explain. – Does the project address a need for expanded transit service capacity? If yes, please explain.
Bicycle/ Pedestrian Improvements	– Does the proposed facility meet or exceed local policies for bicycle and pedestrian accommodation and AASHTO/NACTO design guidelines for pedestrian and/or bicycle facilities? If yes, please explain. – Does the proposed facility provide safe and convenient routes across barriers, such as freeways, railroads, and waterways, or does it close a gap in the existing bicycle network? If yes, please explain. – Does the proposed facility provide or demonstrate the potential for a transit connection? If yes, please explain. – Does the proposed facility provide connections to regional destinations? If yes, please explain.

Intelligent Transportation Systems (ITS) and Operations Strategies	– Will the project contribute to a reduction in incident clearance time? If yes, please explain. – Does the project improve accuracy, timeliness, and availability of real-time information to the public? If yes, please explain. – Does the project improve automated traffic data collection and archiving ability? If yes, please explain. – Will the project give priority to emergency vehicles, transit, or high-occupancy vehicles? If yes, please explain. – Is the project consistent with the Regional ITS Architecture? If yes, please explain.
Roadway/ Mobility Improvements (Non-ITS)	– Will the project improve operational efficiency/reliability on a designated freight corridor? If yes, please explain. – Will the project improve a roadway on which fixed route transit service is being provided or otherwise used by other transit services outside of a fixed route service area? If yes, please explain. – Does the project incorporate access management principles such as raised medians, turn lanes, sharing/combining access points between businesses, or innovative intersections to reduce conflict points (e.g., roundabout, diverging diamond, single point urban interchange, etc.)? If yes, please explain. – Does the project include pedestrian/bicycle accommodations that meet or exceed local policies for bicycle and pedestrian accommodation and AASHTO/NACTO design guidelines? If yes, please explain. – Does the project integrate complete streets design principles? If yes, please explain.
Roadway Capacity Expansion (off the CMP Network)	– Does the project include segments of high congestion, and will the project help to mitigate this congestion? If yes, please explain. – Does the project provide access to existing and/or future business and job activity centers, shopping, educational, cultural, and recreational opportunities? If yes, please explain. – Will the project accommodate or create significant benefits to at least two additional modes of travel, or complete a link to intermodal or freight facilities of regional importance? If yes, please explain. – Does the project impact a network-level change in congestion? If yes, please explain.

Quantitative Strategy Analysis

With the passage of MAP-21 in 2012 and the newly developed FAST Act, quantitative assessments of transportation system performance and methods to calculate performance are being developed and implemented by USDOT. State DOTs and MPOs will be required to report on and make satisfactory progress toward national and local performance goals for the National Highway System (NHS). The OCARTS CMP Network is largely comprised of NHS routes and the goals and objectives of the CMP mirror the national performance goals to the extent possible at this time.

The process also includes quantitatively documenting the benefits of the project's ability to relieve congestion, improve trip reliability, and/or to define how it meets one or more of the CMP goals and objectives. The CMP analysis can be conducted as part of a mobility study, traffic operations analysis, or other local/regional study.

As mentioned in Chapter 7 of this document, several tools are available for ACOG and its member jurisdictions to use when evaluating potential improvements to the CMP network. The travel demand model and FHWA's Tools for Benefit Cost Analysis (TOPS-BC) are both readily available for analysis by ACOG. TOPS-BC can be used to evaluate the effectiveness and benefit-cost ratio of a proposed TSM&O or ITS improvement. Simulation models can be used when additional detail is required to evaluate a project or program. Transit elasticity models can be used to evaluate the pricing and availability of transit system changes.

Data derived from these tools can be evaluated for inclusion as a part of the ACOG STP-UZA project evaluation and selection methodology.

8.4 Recommended Planning Process Enhancements

Recent legislation and the availability of new, robust data sources for system evaluation allow for enhanced decision-making when allocating major funding to projects in the ACOG region. The current STP-UZA project evaluation and selection methodology provides several linkages to the CMP goals and objectives including congestion measures (ADT, V/C ratio), safety measures (Accident Severity Rates), air quality impacts, and the direct link to the previous CMP network locations.

Of the available linkages in the project evaluation and selection methodology, the Air Quality category provides the highest level of support to the alternative project and program approaches outlined in the CMP Toolbox in Chapter 7. This metric could be enhanced to add higher weighting to non-SOV project types in the final analysis. Alternatively, ACOG could consider separating the Air Quality category into multiple categories. This approach would allow for alternative mode/technology focused projects to compete more directly with traditional roadway projects in the scoring methodology.

As a result of the overall CMP update, OCARTS CMP network has been significantly expanded. The current STP-UZA project selection methodology assigns additional points to projects that are located on the CMP network and have some level of impact on the congestion in the region. It is recommended that ACOG update the existing STP-UZA methodology to utilize the CMP Focus network as the target location for this selection criteria to avoid reducing the effectiveness of the metric.

Aligning evaluation methodology to target improvement projects to the CMP Focus Network offers challenges for ACOG. Much of the CMP Focus network is comprised of ODOT facilities that are not directly controlled, operated or maintained by ACOG's local jurisdictions. ODOT does not typically apply for funding through the STP-UZA process as the DOT has its own dedicated funding sources that can be used to program and implement projects. Therefore, the STP-UZA criteria do not directly impact the selection, programming and implementation of projects on much of the CMP Focus Network.

It is recommended that ACOG work closely with ODOT during the identification and development of ODOT projects located on the CMP Focus network. In order to assist in the understanding of the impacts, benefits and costs of projects on the CMP network and to more directly link the CMP to the TIP, ACOG should consider scoring ODOT projects according to the same metrics that are used for the STP-UZA funding. This will allow for ACOG, ODOT and their partner jurisdictions to better understand the impacts of ODOT projects on the CMP Focus Network and the region as a whole. This may also assist ODOT in identifying more cost effective alternatives to traditional roadway projects as a part of their program development.

It is recommended that ACOG include the results of the CMP screening analysis in the project pages of the Transportation Improvement Program for all projects located on the CMP network. Providing documentation of the estimated benefits and impacts that a project will have on the CMP Network and the overall OCARTS will increase the linkage between the TIP, CMP and MTP. Additionally, documenting the region’s attempts to improve the performance of the CMP network is an important step ultimately meeting the goals and objectives of the CMP and MTP.

9 CMP Strategy Effectiveness

9.1 Introduction

This section documents an example process for quantitative evaluation of CMP Implementation Strategies. The purpose of this final task is to determine the effectiveness of congestion management strategies implemented, to keep track of congestion levels on the CMP network, and consider future strategies to address congestion in the region.

This section identifies two approaches for evaluating strategies: ***a system-level performance evaluation***, and ***an individual strategy effectiveness evaluation***. The system-level performance evaluation approach involves monitoring the performance measures that measure regional level performance of the transportation system to determine improvement or degradation of congestion levels in the region as a whole. The individual strategy effectiveness evaluation approach seeks to evaluate the potential effectiveness of an individual strategy or group of strategies on an individual corridor. The second approach will identify the effect of specific congestion mitigation projects or programs. The examples presented in this section show how quantitative measures can be prepared.

As a final product of this section, two proposed projects are presented and evaluated as an example of how to use the strategy effectiveness methodologies for future improvements in the OCARTS area.

9.2 Strategy Effectiveness Evaluation Methods

Evaluating the effectiveness of congestion management strategies is an essential step in the CMP process. The purpose of the evaluation is to estimate and assess the ability of a proposed strategy to alleviate congestion. Evaluating strategies will also allow ACOG, ODOT and their partners to understand the projects and programs that can effectively and efficiently be used to address congestion issues in the OCARTS region. Following an assessment of strategies, the CMP Toolbox should be updated and revised to reflect the new information relating to their effectiveness.

Evaluations of CMP project or program effectiveness can be conducted in the following ways based upon the desires of ACOG and their project sponsors:

- **System-Level Performance Evaluation** - A regional analysis of historical trends to identify improvement or degradation of system performance for the region as a whole, using the region's established performance measures. **Chapter 4** identified a preferred set of system-wide performance measures for the OCARTS region. **Chapter 5** provided a data management plan for collection, storage and processing of this information.

- **Strategy Effectiveness Evaluation –**Testing the potential impacts of a specific congestion management project or program using quantitative or qualitative measures as outlined in **Chapter 8**.

System-level monitoring provides feedback on the system-wide effectiveness of congestion management strategies and projects that have been implemented in the region. By collecting, presenting, and comparing data for the performance measures defined, ACOG will be able to determine the overall effectiveness of the transportation projects implemented through the Congestion Management Process.

Strategy effectiveness can be assessed using either quantitative or non-quantitative measures. The tools and methods that can be used for each performance measure were described in **Chapter 5**. To demonstrate the use of quantitative analysis, two strategy effectiveness evaluation examples using FHWA's Tool for Operations Benefit Cost Analysis (TOPS-BC) is provided in the following sections.

TOPS-BC

TOPS-BC was developed by the FHWA Operations Office to provide benefit and cost estimates for a variety of ITS and operational alternatives. TOPS-BC builds on the ITS Deployment Analysis System (IDAS) tool, a network model that evaluated ITS and operational options using regional travel demand model outputs. IDAS is no longer supported by FHWA.

TOPS-BC is a sketch-planning tool that is a companion resource to the FHWA Operations Benefit/Cost Desk Reference - a document that outlines the purpose and methodology for evaluating operational improvements using ITS devices. The TOPS-BC analysis tool operates as a spreadsheet that may be downloaded from the FHWA Planning for Operations website (http://www.ops.fhwa.dot.gov/plan4ops/topsbctool/index.htm). A user guide is also available on the website and additional support is available from FHWA upon request.

The tool provides decision makers with order of magnitude estimates for the benefits and costs related to TSM&O strategy deployment. TOPS-BC, is easy to learn and uses assumptions and methods that are highly-transparent. It provides users with the ability to conduct numerous "what-if" analyses of different assumptions related to both benefits and costs. The program contains a range of default values for both benefits and costs and provides documentation of various studies used to derive those values. Default values and assumptions may also be altered to reflect local conditions.

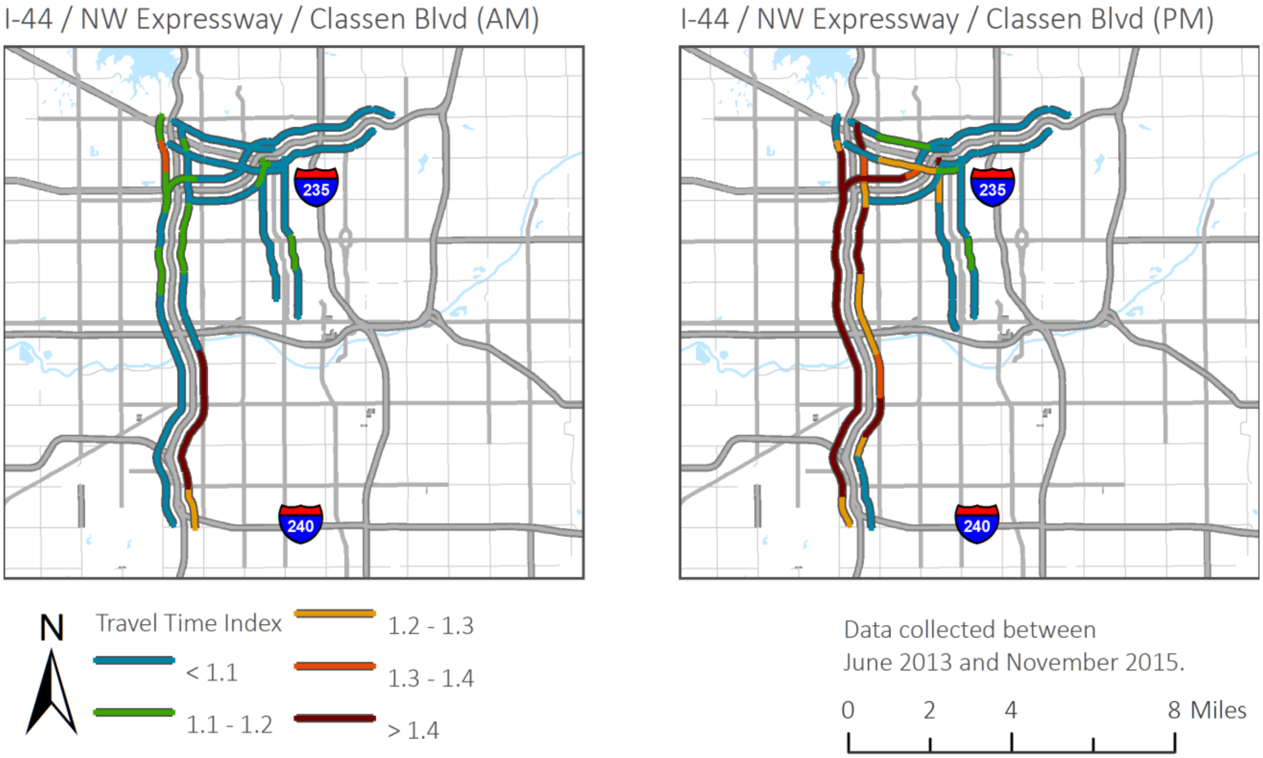
9.3 Example Corridors

Two corridors were selected from the CMP Focus Network as examples locations to display how the CMP Toolbox strategies could be evaluated using the TOPS-BC analysis tool. The selected corridors include one arterial and one expressway.

- Arterial Corridor - North Classen Boulevard combined with the Northwest Expressway
- Expressway Corridor - I-44 from I-240 to the Northwest Expressway

The location of the corridors and the Travel Time Index for the AM and PM peak periods are shown in Figure 9-1 on the following page.

Figure 9-1 Corridors for Strategy Assessment



9.4 Arterial Example: North Classen Boulevard/Northwest Expressway

This section describes using the TOPS-BC analysis tool to assess strategy effectiveness for an urban arterial. The North Classen Boulevard/Northwest Expressway corridor provides a connection from the northwest suburbs to the downtown area in the Oklahoma City area. The corridor is fully developed with housing, commercial, retail, and office land uses located adjacent to the corridor.

The corridor extends on Classen Boulevard from NW 23rd Street to the connection with the Northwest Expressway and then continues west on the Northwest Expressway to State Highway 74. Currently there are traffic signals at the following intersections;

- Classen Boulevard Signal Locations:
  - NW 23rd Street
  - NW 30th Street
  - NW 36th Street
  - NW 39th Street
  - Northwest Expressway
- Northwest Expressway Signal Locations
  - N. Blackwelder Avenue
  - Belle Isle Boulevard
  - a shopping center entrance,
  - N. Pennsylvania Avenue.,
  - N. Villa Avenue
  - N. Independence Avenue

After reviewing the corridor characteristics and strategies contained in the CMP Toolbox, the following project options were identified as examples for the evaluation of benefits and costs:

1. Traffic signal coordination
2. Transit signal priority and transit amenities

Traffic Signal Coordination

This option evaluates the cost and benefits of implementing the coordinated timing of traffic signals using a centralized control center along the Classen Boulevard/Northwest Expressway corridor. TOPS-BC requires certain inputs to provide cost and benefits estimates. For this purpose, the following assumptions were made for this option project:

Cost assumptions:

- Installation of traffic actuated traffic signals
- Installation of system across 11 intersections
- Installation of a Local Area Network between intersections

Benefit assumptions:

- Corridor length: 4.7 miles
- Number of lanes: 6 lanes total
- Analysis Period: 3 Hours in the pm peak period
- Number of analysis periods per year: 250
- Link Volume: 11,400 vehicles/hour
- Change in speed: 10%
- Reduction in Crash Rate: 2%
- Reduction in Fuel Use: 5%
- Value of Time: $22/hour/person
- Fuel Cost: $2.50/gal

Transit Signal Priority

This option evaluates a transit signal priority for the signal system. Any increase in ridership from the changes was not estimated or included in the benefit – cost calculations. TOPS-BC requires certain inputs to provide cost and benefits estimates. For this purpose, the following assumptions were made for this option project:

Cost assumptions:

- Installation of system across 11 intersections

Benefit assumptions:

- Corridor length: 4.7 miles
- Bus free flow speed: 35mph
- Analysis Period: Peak period
- Number of analysis periods per year: 250
- Peak Period Ridership: 937
- Change in speed: 15%
- Value of Time: $22/hour/person

Benefit – Cost Results

The results from TOPS-BC are summarized in **Table 9-1.** The resulting spreadsheet outputs from the TOPS-BC analysis tool are shown in **Appendix A**. Based on these assumptions, the total average annual cost of signal coordination would add up to $160,646, and the total annual expected benefits would be $984,729. The annual project net benefit is $824,083, yielding a benefit-cost ratio of 6.13. This result shows that signal coordination would provide a positive effect for congestion measures.

For transit signal preemption the total average annual cost is estimated to be $16,060, and the total annual expected benefits would be $ 91,245. Considering these calculations, the project net benefit is $75,185, with a benefit-cost ratio of 5.68. This result shows that signal coordination would provide a positive effect for congestion measures.

Table 9-1 Major Arterial Benefit – Cost Summary

	Signal Coordination	Transit Signal Preemption
Daily Value		
Person Hours Saved/day	228	16
Travel Time Saved/day	$3,267	$361
Fuel Savings/day	$315	$3.92
Crash Savings/day	$356	
Average Annual Benefit	$984,729	$91,245
Average Annual Cost	$160,600	$16,060
Benefit – Cost Ratio	**6.13**	**5.68**

9.5 Expressway Example: Interstate 44

This section describes using TOPS-BC to evaluate strategy effectiveness for a congested interstate. Two CMP Toolbox strategies were tested: Ramp Metering System and Traffic Incident Management.

The Interstate 44 (I-44) Corridor is an urban 6 to 8 lane freeway located within the central urban area. This corridor is defined to extend between SH-152 and the Northwest Expressway, for a length of approximately 8.5 miles. Interchange spacing varies along the corridor from half-mile to 1.5 miles apart. The corridor has system interchanges at SH-152, Interstate 40, and SH-66/I-

44. With interchanges at SW 40th/41st Street, SW 29th Street, SW 15th Street, NW 10th Street, NW 23rd Street, NW 36th Street, NW 50th Street, and Northwest Expressway.

The corridor is fully developed with residential, commercial, and office land uses and the Oklahoma City airport at the south end of the corridor. Major traffic generators along the corridor include the Will Rogers World Airport, Dell, and Oklahoma State University-Oklahoma City. The limited availability of right-of-way along the corridor would add considerable difficulty to a potential widening of the corridor.

After reviewing the corridor characteristics and strategies contained in the CMP Toolbox, the following project/program options were identified as examples for the evaluation of benefits and costs:

1. Ramp metering
2. Traffic Incident Management

Ramp Metering

The following proposed option aims to evaluate a congestion management project on an interstate using ramp metering in the region. Ramp metering systems consist of basic infrastructure equipment, like surveillance, ramp metering software, and traffic signal hardware. These systems restrict the free flow of vehicles onto a congested corridor to optimize the flow of the mainline expressway. The purpose of this example is to determine the benefits of implementing ramp metering on this corridor from State Highway 152 (SH-152) to the Northwest Expressway.

To evaluate the impact of this project, the TOPS-BC tool is used. For this option in particular, the following assumptions were made:

Cost assumptions:

- Installation of Central Control ramp metering system
- Number of Ramp Metering software packages for Transportation Management Center: 1
- Number of Ramp Locations: 15
- Year of deployment: 2016

Benefit assumptions:

- Installation of Central Control ramp metering system
- Link length: 8.5 miles
- Total number of lanes: 6 lanes
- Length Analysis Period: Peak Period
- Number of analysis periods per year: 250
- Freeway Volume per period: 34,600 vehicles

- Ramp Volume per period: 2,900 vehicles

Traffic Incident Management

The following proposed option aims to evaluate a congestion management project on an interstate using Traffic Incident Management program. This option assumes that two Traffic Incident Management trucks equipped to remove breakdowns and crashes where there are no injuries would be stationed along the interstate during weekday peak hours. The purpose of this option is to determine the benefits of implementing a Traffic Incident Management Program on this corridor from SH-152 to the Northwest Expressway.

To evaluate the impact of this project, the TOPS-BC tool is used. For this option in particular, the following assumptions were made:

Cost assumptions:

- Video Monitors/Wall for Incident Detection
- TMC Incident Response Hardware
- TMC System Integration
- TMC Incident Response Software
- Emergency Management Center Hardware
- Emergency Management Center Software

Benefit assumptions:

- Incident Management Patrol during peak period
- Link length: 8.5 miles
- Total number of lanes: 6 lanes
- Length Analysis Period: 3 hours
- Number of analysis periods per year: 250
- Reduction in Non-Fatality Crash Rate: 5%
- Percent time device is disseminating information: 10%
- Percent time Drivers using information: 25%
- Volume per period: 34.600 vehicles
- Value of Time: $22.00

Benefit – Cost Results

The results from TOPS-BC are summarized in Table 7.2. The TOPS-BC spreadsheets are shown in the Appendix. For the ramp metering strategy, the total average annual cost would accumulate to $547,600. The total average annual benefits would add up to $3,958,964. With these results, the net benefit of this project would be $3,411,364, with a benefit cost ratio of 7.23. This implies that ramp metering would provide a positive effect on Interstate 44 congestion measures. As a sketch planning tool, TOPS-BC provides a general assessment of the effectiveness of the deployment. Actual benefits will depend on the ability of the surface network to absorb traffic that diverts to avoid the metering. TOPS-BC does not have the ability to evaluate the effectiveness of the surrounding network. A more robust modeling effort would be needed to fully assess the ability of the surrounding roadway network prior to implementation of a ramp metering system.

For incident management, the total average annual cost of the project would accumulate to $491,233. The total average annual benefits would add up to $715,642. With these results, the net benefit of this project would be $224,409, with a benefit cost ratio of 1.46. This implies that the incident management would provide a positive effect on Interstate 44 congestion measures.

Table 9-2 Expressway Benefit – Cost Summary

	Ramp Metering	Traffic Incident Management
Daily Value		
Person Hours Saved	639	72
Travel Time Saved	$9,136	$1,035
Fuel Savings	$2,922	-
Crash Savings	$3,777	$1,827
Average Annual Benefit ($)	$3,958,964	$715,642
Average Annual Cost ($)	$547,600	$491,233
Benefit/Cost Ratio	**7.20**	**1.46**

9.6 Strategy Evaluation Summary

An important part of the CMP process is to evaluate strategies implemented, determining their effect on the performance measures defined in the CMP process. Both the system-level performance evaluation and strategy effectiveness evaluation were described.

The system-level evaluation requires continuous collection of system-wide data and the use of performance measures mentioned in **Chapter 4**. **Chapter 5** of this report provided a data management plan that described collecting, storing and processing the data required to develop these system-wide performance measures. A base year condition of the system performance measures was provided in **Chapter 5**. By implementing this process, ACOG will be able to measure and operationalize performance in the OCARTS region and evaluate whether the transportation system is achieving the desired goals and objectives described in **Chapter 2.**

Quantitative and qualitative methods can also be used to evaluate specific CMP Toolbox strategy effectiveness. The previous sections present two examples of quantitative strategy evaluation processes. The example projects were evaluated through the use of the TOPS-BC analysis tool. This tool is useful because it provides a structured, transparent analysis that can be used to estimate project performance and evaluate whether the investment has a positive benefit/cost ratio.

The life cycle cost capabilities of TOPS-BC are a unique feature that allows costs to be annualized based on their expected life. A list of additional tools for evaluation processes was presented in **Chapter 7** of this report. With these tools, ACOG will be able to determine specific project impacts, and guide the development of the OCARTS regional transportation system toward an efficient and sustainable future.