LACKAWANNA/LUZERNE TRANSPORTATION STUDY

METROPOLITAN PLANNING ORGANIZATION

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Congestion Management Process – 2015 Methodology Update

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Chapter 1 – Introduction

Background

Lackawanna/Luzerne Transportation Study (LLTS) Metropolitan Planning Organization (MPO) has undertaken an update to the methodology for determining congested corridors and intersections. This update was made to assist the LLTS with their transportation funding and project planning for the region. This update will also bring the Congestion Management Process (CMP) into compliance with both the Safe Accountable Flexible Efficient Transportation Equity Act – A Legacy for Users (SAFETEA-LU), Moving Ahead for Progress in the 21st Century (MAP-21) and Fixing America's Surface Transportation Act (Fast Act) which provided methods for monitoring congestion and performance measurements.

Introduction

As defined in the Federal Highway Administration (FHWA) Congestion Management Process: A Guidebook,

> Congestion management is the application of strategies to improve transportation system performance and reliability by reducing the adverse impacts of congestion on the movement of people and goods. A Congestion Management Process (CMP) is a systematic and regionally-accepted approach for managing congestion that provides accurate, up-to-date information on transportation system performance and assesses alternative strategies for congestion management that meet state and local needs. The CMP is intended to move these congestion management strategies into the funding and implementation stages.[1]

Prior to this 2015 Methodology Update, Lackawanna and Luzerne Counties completed independent CMPs and Reports, with each county using a slightly different method for monitoring congestion. During the development of the 2015 Methodology Update, FHWA requested that the CMP become unified and administered across both counties and the entire Metropolitan Planning Organization (MPO). This approach was supported by both PennDOT and the LLTS to align the CMP with other planning efforts.

The unified CMP will allow all congestion related transportation improvement projects in the two county LLTS to be evaluated with a consistent methodology. This methodology is particularly important since these projects would be added to the Long Range Transportation Plan (LRTP) for the same two-county planning area. The CMP Annual Update and Report and projects listed, therein, will ultimately provide the LLTS with objective guidance for prioritizing projects in the LRTP and ultimately the Transportation Improvement Program (TIP).

Goals and Objectives

The goal of the CMP is to identify, mitigate, and reassess traffic congestion on Federal-Aid System routes throughout the LLTS. This goal will be accomplished by implementing the methodologies and strategies identified in this 2015 Methodology Update. This methodology systematically identifies congestion areas, identifies causes of congestion, evaluates and recommends potential mitigation measures, and monitors and evaluates the implemented mitigation measures.

[1] Grant, Michael, et al. Congestion Management Process: A Guidebook, (Federal Highway Administration, April 2011), 1.

Chapter 2 – Congestion Characteristics

Most drivers in Lackawanna and Luzerne Counties experience some sort of traffic delay in their daily travels. This delay occurs for many different reasons, some of which are recurring and predicable while others are non-recurring and difficult to predict and address. Traffic volumes during the peak hours are the most common causes of congestion while crashes, weather, special events, and work zones also generate traffic delay and congested conditions.

> Congestion - Congestion occurs when roadways or other modes of transportation experience increased demand which results in slower speeds, longer travel times, and loss of reliability. Congestion occurs as the demand for transportation system usage approaches and/or exceeds the capacity of the system. Congestion can be classified into two categories: recurring and non-recurring.
>
> Recurring Congestion - Congestion that occurs due to the demand of traffic being greater than the capacity of the roadway and can be experienced on a daily or consistently-recurring basis.
>
> Non-Recurring Congestion - Congestion that occurs sporadically and often caused by weather, incidents, detours, special events, etc.

The 2015 CMP Annual Report focuses primarily on monitoring and addressing recurring congestion. While the monitoring will focus initially on vehicular delay, the CMP will progress to evaluating other modes of transportation, including transit and bicycle users. These alternate modes of transportation could serve as additional methods for reducing congestion. Improvements that enhance these alternate modes (e.g., add new facilities, connections, capacity, reliability, and safety) can often reduce vehicular congestion as well.

Although the CMP will not directly address non-recurring congestion, it will identify potential congestion mitigation measures that can be used to address problematic locations or corridors. Additionally, the use of Intelligent Transportation Systems (ITS) technology, through the use of dynamic message signs and video cameras monitored and controlled through the PennDOT District 4-0 Traffic Management Center, can be used to identify congestion and alert motorists so that an alternate route can be utilized. This technology is in place on most sections of I-81; however, the deployment of additional ITS devices along other critical corridors could better inform drivers about congested conditions and alternate routes along other critical corridors. Additional ITS devices allow for quick detection, which promotes a quick response and minimizes congestion.

Chapter 3 – Congestion Management Methodology

Introduction

The 2015 Methodology Update is a six-phase systematic approach to selecting and analyzing corridors, planning for implementation, implementing projects, and project evaluation. This methodology ensures that projects are consistently evaluated throughout the entire LLTS and is crucial to inclusion into the Commonwealth's Pre-TIP and TIP Program Development Procedures. The six-phases of the methodology are as follows:

Phase 1 – Preliminary Project Screening

A. High-Level V/C Analysis

Prepare mapping for all Federal Aid highway segments in the LLTS by utilizing the most currently available ArcView shapefiles with traffic count data from the Geographic Information Division of PennDOT's Bureau of Planning and Research. The maps will be populated with volume-to-capacity ratios (V/C) of each highway segment to prioritize traffic congestion. The methodology to calculate the V/C ratios is more thoroughly defined in Chapter 4.

B. Planning Partner Evaluation

Utilizing the V/C mapping prepared, as well as the Congested Corridor Project Listing from the most recent CMP Annual Report, LLTS Staff will develop and revise the Congested Corridor Project Listing with all roadway segments that show V/C ratios greater than or equal to 0.85. As V/C mapping only serves as an indicator of congestion, LLTS Staff will also include projects based on their knowledge of the systems. Corridors and Intersections which may not show on V/C Mapping may be added during this phase.

C. Prepare Congested Corridor Project Listing

With the completion of the High-Level V/C Analysis and Planning Partner Evaluation of the selected corridors and intersections, LLTS Staff will prepare an updated Congested Corridor Project Listing, as well as Project Data Sheets, which will supply a quick reference summary of project data, including route, limits, brief description, alternate modes of transportation, and adjacent pedestrian/bicycle connections.

Phase 2 – Corridor Assessment

A. Travel Time Runs

Perform midweek (Tuesday through Thursday) PM peak period (4-6PM) travel time runs on the corridors and intersections included on the Congested Corridor Project Listings. The travel time runs will be completed using the Modified Maximum Car Method where the driver will travel at five (5) miles per hour above the posted speed limit. This method was chosen for the completion of travel time runs for the corridors because it was found that traveling at the posted speed limit significantly differed from the travel characteristics of the traveling vehicles. By traveling at the posted speed limit it causes vehicles to platoon and increases queuing behind the data collection vehicle. Traveling at five (5) mph over the posted speed limit, in most cases, mimics the 85th percentile speed of the corridor.

B. Field Analysis

Observe peak hour traffic conditions to identify needs and visible causes of congestion. Create or update the Project Data Sheets to include field analysis observations, including the date and the commenter's initials.

C. Data Analysis

Analysis of travel time runs will be performed to determine the delay, percent under posted speed, and the average number and duration of stops per run for each corridor. These performance measure criteria and the appropriate methodologies to analyze the data is more thoroughly defined in Chapter 4. Two metrics will be employed for determination of congestion: V/C ratio and delay. Roadway segments with V/C ratios between 0.85 and 0.90 are considered "acceptable", between 0.90 and 1.00 are considered "approaching congestion", and greater than 1.00 are considered "congested". Intersections with delays, converted to the corresponding levels-of-service, of "D" in urban areas and "C" in suburban and rural areas are considered congested.

D. Identify Potential Congestion Mitigation Measures

The LLTS will identify potential improvements from the Congestion Mitigation Strategies Toolbox in Chapter 5 to address the underlying congestion issues based on data collection and analysis. Mitigation measures will be recorded on the Project Data Sheet, including date and commenter initials.

Phase 3 – Planning for Implementation

A. Owner/Agency Coordination

The LLTS will work with the facility owner to further define the congestion issues and project. The owner may include PennDOT, counties, municipalities, and transit agencies.

B. Project Programming

Once a corridor has been identified as congested and potential mitigation measures have been identified, the project will be placed on the Long Range Transportation Plan (LRTP) for prioritization. From the LRTP prioritization list, projects will be placed on the Twelve Year Transportation Program (TYP). The initial project programming should include design and construction allocations but may also include a study phase when projects are complex or require additional definition. Project programming is a function that is integral to the LRTP and TYP update processes and will be referenced in fulfilling the Project Programming element of the CMP process.

Phase 4 – In-Depth Corridor Analysis

A. Identify Causes of Delay

An in-depth analysis that identifies the specific causes of congestion and vehicular delay will be performed. This analysis will include the data collected in the previous phases of the CMP as well as other pertinent infrastructure information. This information will include roadway functional classification; land use; roadway access; and transit, bicycle, and pedestrian facilities. Any causes identified in the LRTP or other planning processes may be referenced rather than duplicated by the CMP.

B. Identify Mitigation Measures

One or more mitigation measures will be identified and evaluated to resolve the causes of congestion. Wherever possible, the mitigation measures should encompass low-cost/short-term measures and long-term/capital-intensive measures. Complex projects may be implemented in phases which may allow a short-term project to be implemented quickly until a more comprehensive long-term project can be funded and completed. As projects are evaluated as part of the LRTP, incorporate mitigation measures identified as part of CMP.

C. Update Project Funding/Programming

Upon completion of the analysis to identify areas of congestion and delay and the evaluation of mitigation methods, present recommended projects in the LRTP. Projects that may have already been included in the LRTP and/or TIP should be updated to reflect the costs of the evaluated mitigation measures. Large or complex projects may be broken into phases to make scalable improvements that match currently available funds.

Phase 5 – Project Implementation

A. Assist with Design/Construction

Once a project has been funded and prioritized through the LRTP, project funding will be identified on the TIP including Study (if applicable). Funding needs will be assessed and quantified as part of Preliminary Engineering, Final Design, and Construction Phases. PennDOT will manage the design and construction phases of these projects. As a part of the design methodology, the LLTS will participate in the study and scoping field views as appropriate. The LLTS has the option to review documents at will and as the project or PennDOT dictates. The LLTS may provide TIP update considerations, if necessary, throughout Preliminary Engineering and Final Design.

B. Implementation Observation

As the mitigation measures are constructed and implemented, monitor the progress to ensure completion as intended. The LLTS will determine its level of involvement on a project-by-project basis. While there is no minimum level of participation, the LLTS may conduct after study data collection relevant to this task. Alternatively, all observations may be completed as part of PennDOT's project acceptance and reported to the LLTS.

Phase 6 – Project Evaluation

A. Monitor Project

Monitor the success of the implemented mitigation measures by performing travel time runs and data analysis as those described in Phase 2. Once completed, compare the "before" and "after" criteria to determine the congestion reductions, if any. Projects should be evaluated when updating the CMP Annual Report. Projects will continue to be monitored at the discretion of the LLTS.

B. Evaluate Project

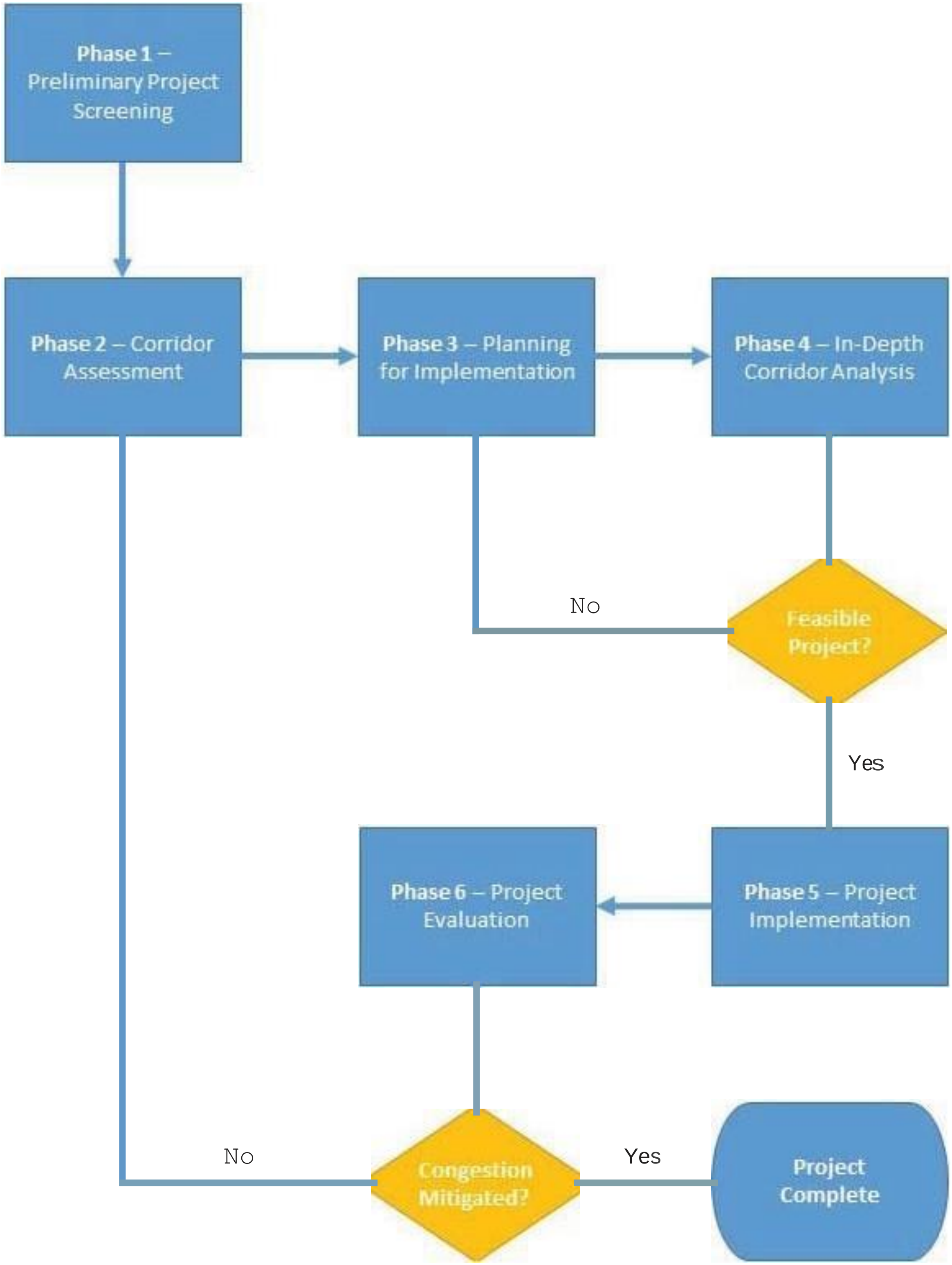
Projects which have successfully mitigated the congestion issue, based on the performance measure criteria discussed in Phase 2C – Data Analysis, can be removed from the Congested Corridor Project Listing.

Projects which have been unsuccessful in mitigating the congestion, based on the performance measure criteria discussed in Phase 2C – Data Analysis, will return to the Congested Corridor Project Listing for further analysis.

In cases where a project has been phased to accommodate available funding, additional phases may be advanced to LLTS for prioritization on the LRTP and additional project funding sought.

For projects where no additional phases have been identified, additional projects will be vetted by the planning partners as part of the next CMP Annual Report. If viable projects exist, the LLTS may choose to advance them through the CMP until the congestion has been successfully mitigated. If no viable projects exist to mitigate the congestion, the LLTS may choose to remove the project from the Congested Corridor Project Listing.

Methodology Flow Chart



Chapter 4 – Performance Measures

Phase 1 – Preliminary Project Screening Performance Measures

Methodology for Evaluating Volume-to-Capacity Ratios

The following "planning-level" methodology for deriving roadway capacity and calculating the volume-to-capacity ratio (V/C) was developed for the purposes of LLTS's long range transportation plan and has been adapted/updated for use in the CMP.

Calculation of Capacity:

Initial assumptions for roadway lane capacity are based on the Maintenance Functional Classification (MFC) defined in PennDOT's Roadway Management System (RMS)[2] and Straight Line Diagrams (SLD). The surrounding land use (rural or urban) and the directional division of the highway (divided or undivided) also play a role in determining the appropriate initial lane capacity (passenger cars per hour per lane - pcphpl) for the roadway segment (Table 4.1). These Initial Lane Capacity values are derived from the information found in Travel Estimation Technique for Urban Planning (NCHRP Report 365)[3] and the Generalized Service Volume techniques found in the 2010 Highway Capacity Manual (HCM 2010)[4].

Table 4.1. Initial Lane Capacity by Facility Type

Maintenance Functional Classification (MFC)		Initial Lane Capacity (pcphpl)	
		Divided	Undivided
1	Rural Principal Arterial --Interstate	1,350	1,150
2	Rural Principal Arterial --Other	1,250	1,200
6	Rural Minor Arterial	900	850
7	Rural Major Collector	850	800
8	Rural Minor Collector	850	800
9	Rural Local	750	700
11	Urban Principal Arterial --Interstate	1,150	1,050
12	Urban Principal Arterial --Other	1,100	1,000
14	Urban Minor Arterial	850	800
16	Urban Major Collector	800	750
17	Urban Minor Collector	800	750
19	Urban Local	700	650
99	Ramp	900	900

To obtain the roadway segment capacity, the initial lane capacity is then multiplied by the number of lanes.

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[2] "Roadway Management System," Pennsylvania Department of Transportation (PennDOT), http://www.dot.state.pa.us/Internet/Bureaus/pdBOMO.nsf/infoRMRIRMS

[3] Martin, William A., McGuckin, Nancy A. NCHRP Report 365: Travel Techniques for Urban Planning (National Cooperative Highway Research Program, 1998), 104-122.

[4] Transportation Research Board, HCM2010: Highway Capacity Manual, Chapters 11, 14, and 15.

Adjustments are then made to the roadway segment capacity to account for roadway width, heavy vehicle presence, and other geometric attributes of the roadway segment. The following adjustment factors are calculated according to the methods described in Chapter 16 of the 2000 Highway Capacity Manual (HCM 2000)[5].

The Lane Width Capacity Adjustment Factor is calculated by using Equation 3-1:

$$F_w = 1 + \frac{W - 12}{30} \quad \text{[Equation 3-1]}$$

where

F_w = Lane Width Capacity Adjustment Factor, and
W = Lane width (ft).

The Heavy Vehicle Capacity Adjustment Factor is calculated by using Equation 3-2:

$$F_{hv} = \frac{100}{100 + HV\% \,(E_t - 1)} \quad \text{[Equation 3-2]}$$

where

F_{hv} = Heavy Vehicle Capacity Adjustment Factor,
HV% = Heavy vehicle percentage of total traffic stream (%), and
E_t = Passenger car equivalent for heavy vehicles = 2.0 pc/HV (HCM default).

When analyzing a Multi-Lane One-Way Street, such as one-way pair city streets and limited access highways, the roadway segment capacity is increased by 100 passenger cars per hour per lane (100 pcphpl) to account for the capacity benefits of these configurations.

The adjusted segment capacity (C) to be used in the V/C formula is calculated in two steps:

1. Multiply the roadway segment capacity by the lane width capacity adjustment (F_w) and the heavy vehicle capacity adjustment (F_{hv}).
2. If applicable, add the multi-lane one-way street capacity adjustment.

Calculation of Design Hour Volume:

The design hour volume (DHV, stated as V here) to be used for each roadway segment is calculated by multiplying the current AADT (provided in the RMS data) by a "K-factor". The K-factor is assigned to each segment according to its MFC as shown in Table 4.2.

[5] Transportation Research Board, HCM2000: Highway Capacity Manual, Chapter 16.

Table 4.2. K-Factor by MFC		
Facility Type		K-Factor
1	Rural Principal Arterial --Interstate	0.09
2	Rural Principal Arterial --Other	0.09
6	Rural Minor Arterial	0.09
7	Rural Major Collector	0.08
8	Rural Minor Collector	0.08
9	Rural Local	0.08
11	Urban Principal Arterial --Interstate	0.10
12	Urban Principal Arterial --Other	0.10
14	Urban Minor Arterial	0.12
16	Urban Major Collector	0.09
17	Urban Minor Collector	0.09
19	Urban Local	0.09
99	Ramp	0.10

Calculation of Volume-to-Capacity (V/C) Ratio:

The Volume-to-Capacity Ratio (V/C) is simply the ratio of the volume (V) to the adjusted segment capacity (C).

Phase 2 – Corridor Assessment

Definitions and Performance Measures for Data Analysis

Travel Time Runs

Travel Time Runs are performed during the midweek (Tuesday through Thursday) PM peak period (4-6 PM). A minimum of 3 runs are to be performed in each direction.

Posted Speed Limit, S_p

The posted speed limit of the segment, in mph, is recorded. If there are different speed limits within a corridor, separate into segments by posted speed limit.

Travel Distance, D

Actual travel distance of the defined segment, as measured by either a vehicular Distance Measuring Instrument (DMI) or Global Positioning System (GPS). Segments should extend at least one intersection past the intersections defined in the project listing.

Average Cumulative Run Time, ACRT

This performance measure is the average of the cumulative run times for each run or the cumulative number of seconds it takes to travel the segment.

Travel Time at Free Flow Speed, TT_{ffs}

This performance measure is the time, in seconds, that it would take to travel the segment at free flow speed. The Travel Time at Free Flow Speed is calculated by using Equation 3-3:

$$TT_{ffs} = \frac{1.467 \text{ x } D}{S_p + 5 \text{ mph}} \qquad \text{[Equation 3-3]}$$

where

TT_{ffs} = Travel Time at Free Flow Speed (sec),
1.467 = Constant to convert to feet per second,
D = Delay (sec), and
S_p = Posted Speed Limit (mph).

Delay, d

Delay is the time spent, in seconds, not traveling at free flow speed or the difference in time between Average Cumulative Run Time and Travel Time at Free Flow Speed. The Delay is calculated by using Equation 3-4:

$$d = ACRT - TT_{ffs} \qquad \text{[Equation 3-4]}$$

where

d = Delay (sec),
ACRT = Average Cumulative Run Time (sec), and
TT_{ffs} = Travel Time at Free Flow Speed (sec).

Percent Time Spent Delayed, T_d

This performance measure is a metric of the percentage of time at which a driver travels at a speed less than the posted speed throughout a corridor. The Percent Time Spent Delayed is calculated by using Equation 3-5:

$$T_d = \frac{D}{ACRT} \qquad \text{[Equation 3-5]}$$

where

T_d = Percent Time Spent Delayed (%),
d = Delay (sec), and
ACRT = Average Cumulative Run Time (sec).

The data is collected using Global Positioning System (GPS) or other travel time methods.

Average Number of Stops per Run, s_n

This performance measure is the number of stops that a driver encounters throughout a corridor during the three travel time runs. Values may be less than 1.0 if stops did not occur during all runs.

Cumulative Duration of Stops, $T_{s\text{-}tot}$

This performance measure is the cumulative duration of stops since beginning of a run, stated in seconds. The "Stopped Delay" is counted from when the speed drops below 5 mph after exceeding 15 mph until it exceeds 15 mph once again.

Average Duration of Stops, $T_{s\text{-}ave}$

This performance measure is the cumulative duration of stops divided by the average number of stops of the three runs, stated in seconds, as shown in Equation 3-6:

$$T_{s\text{-}ave} = \frac{T_{s\text{-}tot}}{S_n} \qquad \text{[Equation 3-6]}$$

where

$T_{s\text{-}ave}$ = Average Duration of Stops (sec),
$T_{s\text{-}tot}$ = Cumulative Duration of Stops (sec), and
Sn = Average Number of Stops per Run.

Phase 4 – In-Depth Corridor Analysis Performance Measures

*The following performance measures are intended to be incorporated into future CMP Annual Reports based on availability of data from the transit agencies. The measure, its parameters, and calculation will be determined in future iterations of the CMP, when ridership data and its exact nature are determined. Both the County of Lackawanna Transit System (COLTS) and the Luzerne County Transportation Authority (LCTA) have implemented automatic vehicle location systems, but data from the systems was not available for incorporation into the 2015 Report.

Transit Utilization*

This performance measure is intended to relate transit ridership to the available capacity on transit routes within a given corridor. As transit data is available for future CMP reports, LLTS will define transit utilization performance measures to accurately reflect the annual changes in ridership.

Transit On-Time Reliability*

This performance measure is intended to quantify the impact of traffic delay on the “on-time” performance of transit vehicles at their scheduled stops. As transit data is available for future CMP reports, LLTS will define performance measures to accurately reflect the annual changes in transit on-time reliability.

Chapter 5 - Congestion Mitigation Strategies Toolbox

Congestion Mitigation Strategies have been identified by several reputable organizations, including the Federal Highway Administration, the Institute of Transportation Engineers, and American Association of State Highway and Transportation Officials. These mitigation strategies can cover a wide variety of situations or congestion issues and are continually evolving and changing. With this in mind, the following sources are providing for identifying potential mitigation measures for corridors and intersections:

- CongestionManagementProcess:AGuidebook by the Federal Highway Administration

  This publication is a guidebook designed to provide information on how to create an objectives-driven, performance-based Congestion Management Process (CMP). This guidebook describes a flexible framework of 8 actions that should be included in the development of a CMP. It also highlights the role of the CMP in addressing multiple objectives, including livability, multimodal transportation, linkages with environmental review, collaboration with partners and stakeholders, demand management and operations strategies, and effective practices for documentation and visualization.

- ShowcasingVisualizationToolsinCongestionManagement by the Federal Highway Administration

  This publication is a summary report describing visualization practices used as part of the Congestion Management Process (CMP), and is a supplement to the CMP Guidebook. These visualizations include maps, charts, graphs, photographs, videos, and computer illustrations and simulations. The report is organized both in terms of the type of visualization and the type/source of data, and includes many examples of visualizations used in CMPs around the nation.

- AToolboxforAlleviatingTrafficCongestionandEnhancingMobility by the Institute of Transportation Engineers

  This publication is a comprehensive summary of all the tools available to “solve” the urban congestion problem. This publication discusses the following congestion mitigation efforts:

  - Intelligent Transportation System (ITS) Technologies,
  - Non-motorized Transportation,
  - Transit-oriented Development and Urban Design,
  - Congestion Pricing,
  - Intermodal Terminals, and
  - Multimodal Corridor Investment.

- CombatingCongestionthroughLeadership,Innovation,andResources by the American Association of State Highway and Transportation Officials

  This report summarizes the 2007 National Congestion Summits, which brought together federal, state, and local transportation experts to identify and share practices to ease delays occurring on the nation's transportation system. The report outlines strategies that state transportation agencies are implementing to reduce congestion and enhance mobility on the nation's highways. Innovative approaches to combat congestion highlighted in the report include the following:

- Pricing,
- Integrated Corridor Operations,
- Multimodal Transportation Corridor Investments, and
- Access and Incident Management.

- "Congestion Reduction Toolbox" by the Federal Highway Administration

This website is a resource that contains information on the various methods for decreasing the effects of congestion on roadways. The FHWA divides the solutions into five major groups aimed at getting as much congestion relief from the current system and using technology and innovative strategies to increase capacity and expand travel options for people and freight. The five major groups pertinent to congestion mitigation include:

- Improve Service on Existing Roads,
- Pricing,
- Adding Capacity,
- Travel Options, and
- Traveler Information.

- "Travel Demand Management" by the Federal Highway Administration

This website provides resources to help manage traffic congestion by better managing demand. These resources include publications, web links, and training offerings. The toolbox is continuously updated as resources become available. Information on the following mitigation efforts include:

- Active Transportation and Demand Management (ATDM),
- Carpool and Vanpool Projects,
- Commuter Choice,
- Integrated Demand Management, and
- Travel Information Services.

Bibliography

- Grant, Michael, et al. Congestion Management Process: A Guidebook. Federal Highway Administration, April 2011. http://www.fhwa.dot.gov/planning/congestion_management_process/cmp_guidebook/

- Grant, Michael, et al. Showcasing Visualization Tools in Congestion Management. Federal Highway Administration, April 2011. http://www.fhwa.dot.gov/planning/congestion_management_process/cmp_visualization_tools /Martin, William A., McGuckin, Nancy A. NCHRP Report 365: Travel Techniques for Urban Planning. National Cooperative Highway Research Program, 1998.

- HCM2010: Highway Capacity Manual. Transportation Research Board, 2010.

- A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility. Institute of Transportation Engineers, 1997. http://www.fhwa.dot.gov/publications/research/operations/its/98436/toolbox.pdf

- Meyer, Michael. Combating Congestion through Leadership, Innovation, and Resources. American Association of State Highway and Transportation Officials, September 2007. http://www.trb.org/Main/Blurbs/159357.aspx

- Federal Highway Administration. “Congestion Reduction Toolbox.” FHWA.DOT.gov. http://www.fhwa.dot.gov/congestion/toolbox/ (accessed September 1, 2015).

- Federal Highway Administration. “Travel Demand Management.” OPS.FHWA.DOT.gov. http://www.ops.fhwa.dot.gov/tdm/ (accessed September 1, 2015).