RHODE ISLAND
STATEWIDE
PLANNING
PROGRAM

Rhode Island Congestion Management Process

Final Plan

prepared for

Rhode Island Department of Administration

prepared by

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Executive Summary

What is the Congestion Management Process?

A congestion management process (CMP) is a systematic process for identifying congestion and its causes, developing monitoring processes to measure transportation system performance and reliability, and developing congestion management strategies and moving them into the funding and implementation stages. Federal law requires all metropolitan areas with populations greater than 200,000 residents to develop a Congestion Management Process. In Rhode Island the Division of Statewide Planning is responsible for metropolitan planning, and this CMP document serves as the required CMP for the Providence metropolitan area.

The previous CMP for Rhode Island was developed and adopted as part of the 2035 Long-Range Transportation Plan (LRTP) in 2012. This 2020 CMP update addresses the congestion management needs of the State that have emerged since 2012. It incorporates statewide goals from the draft 2040 LRTP, RI Moving Forward 2040; new Federally required performance measures along with additional multimodal measures consistent with the statewide goals; and potential projects already identified in more recent modal plans for freight, transit, and bicycles, as well as the latest State Transportation Improvement Program (STIP) that would contribute towards congestion management. It helps identify bottlenecks and congested corridors that do not have any projects identified and require implementation of additional congestion management strategies.

Consistent with Federal requirements, this CMP:

- Defines congestion management objectives and multimodal performance measures.
- Defines data collection activities and responsibilities and system performance monitoring efforts.
- Identifies causes of recurring and nonrecurring congestion.
- Identifies potential congestion management strategies and potential performance and benefits.
- Defines how the CMP integrates with other planning processes, including development of the LRTP, STIP, and modal plans.
- Identifies a schedule and responsibilities for implementing priority actions identified in the plan.

Congestion Management and COVID-19

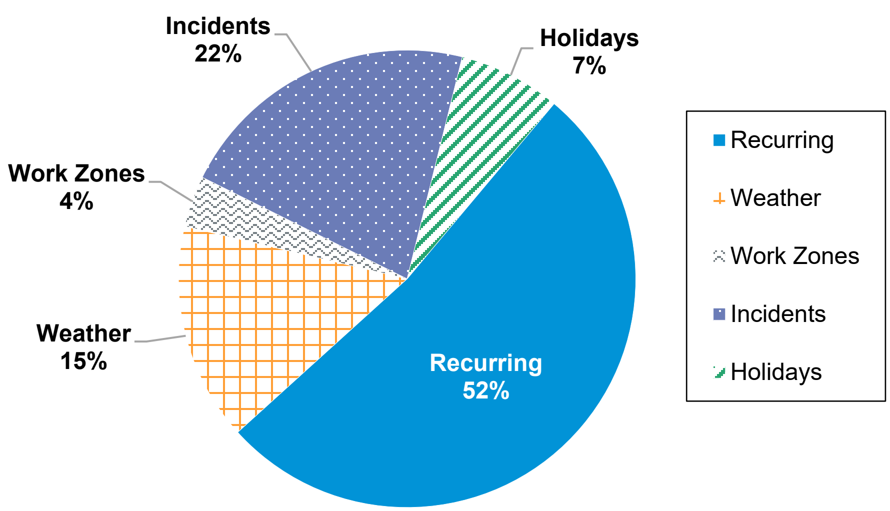
The State of Rhode Island faced unprecedented challenges with COVID-19 in 2020 which has had significant impacts to overall economic activity and to the levels of congestion on the transportation system. This report reflects the levels of congestion and transportation system conditions that existed prior to the onset of COVID-19. The report recommends performance measures to help track congestion levels on an ongoing basis and strategies to address congestion impacts as the level of economic activity increases. While the baselines observed for the year 2018 will be drastically different than those in 2020, the methodology remains sound and will be vital for the tracking of congestion in the upcoming years. The lessons learned during the COVID-19 pandemic also suggest that strategies such as working from home and otherwise substituting travel with electronically mediated activity could play an important role in helping to manage congestion in the future.

Congestion in Rhode Island Today

The CMP network includes all roadways within the State that are functionally classified as minor arterial or a higher class; as well as public transportation routes (bus, rail, and ferry) and off-road bicycle facilities. A total of 1,073 road-miles are included in the network. Congestion indicators were calculated for every road segment of the CMP. Based on total delay experienced, the top 30 bottlenecks and the top 20 freight bottlenecks were identified, as well as the top 20 congested corridors.

The contributing factors to congestion were identified. As shown in Figure ES.1, about half of all congestion is "recurring" and related to traffic demand that exceeds the capacity of the roadway. Nearly one-quarter is due to incidents, 15 percent is related to weather, and the remainder is related mainly to holiday traffic or work zones. It is notable that the state has managed to contain the delays from work zones through time restriction and nighttime work.

Figure ES.1 Sources of Congestion in Rhode Island
January to December 2018



Most of the congestion in the state is centered around the metropolitan Providence region, with the greatest congestion on the highways within the City of Providence. In fact, 50 percent of all highways within the City are considered congested during weekday evening peak commute periods. The Providence region experiences typical variation in congestion during a typical weekday with a sharp increase in congestion during the morning peak commute period, a slight increase during the afternoon lunch hours, and the highest and more prolonged congestion during the evening peak commute period.

After the metropolitan Providence region, the next most congested region in the state is the East Bay and Aquidneck Island, followed by the South County. The more recreational areas within these regions show an increase in congestion during the summer months. In general; however, the recurring congestion resulting from weekday commuting is more severe than congestion resulting from recreational travel.

CMP Objectives and Performance Measures

RI Moving Forward 2040, through an extensive public involvement process, identified five major goal areas: Connect People and Places; Reinvent the Transportation Network; Strengthen Communities; Promote Environmental Sustainability; and Support Economic Growth. This CMP defines eight congestion management objectives that support these goal areas:

- Improve Reliability of the Transportation System.
- Reduce Recurring Congestion.
- Improve Freight and Goods Movement.
- Increase Modal Choice and Competitiveness.
- Improve Intermodal Connectivity.
- Promote and Invest in Innovative Congestion Management Technologies.
- Promote Land Development and Infill Development /Redevelopment in Transportation-Efficient Locations.
- Reduce Emissions and Improve Air Quality.

The CMP further defines 40 performance measures that relate to these objectives and presents baseline (2018) data on nearly all of these measures. A few measures require collection of data that does not yet exist and will need to be developed in the future. Tracking and annually reporting these performance measures will allow the State to evaluate the success of its efforts to manage congestion.

Congestion Management Strategies

A wide variety of potential strategies are available to mitigate congestion in Rhode Island, many of which already have been implemented or studied through statewide plans, modal plans, and other State and local studies. The potential strategies are presented in a congestion management “toolbox” that is based on best practices throughout the United States. The State’s preference is to first implement lower-cost demand management strategies that reduce travel and operational strategies that make more efficient use of roadway capacity. Consistent with Federal guidance, high-cost capacity increases that primarily serve single occupant vehicle are left as a last resort. The plan also identifies additional strategies that the State should consider. Some of these are statewide strategies (e.g., travel demand management or pedestrian networkplanning), while others are focused on specific congested corridors.

CMP Analysis Process

The CMP process is designed to interface with existing long-range planning and programming processes, as well as other modal plans and major corridor plans. Information from the CMP performance monitoring should be used to consider priorities in long-range planning and programming and to monitor performance over time. Congestion management strategies from the CMP should be considered in the long-range plan and modal and corridor studies, particularly those on identified bottlenecks and congested corridors. A series of questions is provided that should be documented for all STIP projects, to ensure that congestion management is adequately considered for each funded project and to help prioritize projects.

This plan also identifies a set of analysis tools that are available to quantify the impacts of potential projects and strategies on congestion. Quantitative analysis should be conducted for projects addressing a top bottleneck or congested corridor on the CMP network that add single-occupancy vehicle roadway capacity. For other projects, qualitative consideration should be given to congestion mitigation effects.

Congestion Management Strategic Action Plan

The final section of the plan is an action plan that details activities that Rhode Island agencies should undertake collaboratively over the next five or more years to implement the Congestion Management Plan. Actions are divided into the following groups:

- Data Collection, Evaluation, and Monitoring—Developing better information and data to track the success of efforts to mitigate congestion. Actions include:
  - Preparing an annual congestion performance monitoring report.
  - Conducting pre and post evaluation of implemented projects.
  - Expanding specific data sources needed to monitor congestion and management strategies.
- Planning Activities—Actions to more fully develop congestion management strategies in specific focus areas. Actions include:
  - Developing STIP project selection criteria that incorporate factors related to each of the CMP objectives.
  - Conduct congestion mitigation studies on bottlenecks priority corridors listed in the CMP.
  - Develop more detailed plans on specific strategies, including a transportation demand management (TDM) strategic plan, a shared mobility and curb management strategic plan, a statewide pedestrian plan, access management guidelines, and pricing options.
- Implementation Activities—Actions to implement projects to directly reduce congestion, including:
  - Expanding the Rhode Island Strategically Targeted Affordable Roadway Solutions (RI*STARS) program to work with municipalities to retime traffic signals on arterial streets at least every five years.
  - Implementing remote monitoring and advanced signal control systems on top congested corridors.
  - Developing a service patrols program to rapidly respond to and help clear incidents and reduce secondary incidents.
  - Create a funding/incentive program to assist municipalities in implementing Complete Streets concepts.
- Coordination Activities—Ongoing intra and interagency coordination to implement the CMP.

The State should also implement specific congestion management actions already recommended in other planning documents, including the Transit Master Plan, Statewide Bicycle Plan, and Freight and Goods Movement Plan. Implementing congestion-reducing projects listed in the STIP also is a critical action element to implement the CMP.

1.0 Introduction

1.1 Overview of the Congestion Management Process

A CMP is a systematic process for identifying congestion and its causes, developing monitoring processes to measure transportation system performance and reliability, and developing congestion management strategies and moving them into the funding and implementation stages.

The Federal Highway Administration's (FHWA) Congestion Management Process Guidebook (2008) describes an eight-step process model that is to be used as guidance when developing a Congestion Management Process.[1] The model provides comprehensive guidance in implementing the CMP using an objectives-driven, performance-based approach. The following eight actions and associated questions represent critical elements to a successful CMP:

1. **Develop Objectives for Congestion Management—**First, it is important to consider, "What is the desired outcome?" and "What do we want to achieve?" It may not be feasible or desirable to try to eliminate all congestion, and so it is important to define objectives for congestion management that achieve the desired outcome. Some metropolitan planning organizations (MPO) also define congestion management principles, which shape how congestion is addressed from a policy perspective.

2. **Define CMP Network—**This action involves answering the question, "What components of the transportation system are the focus?" and involves defining both the geographic scope and system elements (e.g., freeways, major arterials, transit routes) that will be analyzed in the CMP.

3. **Develop Multimodal Performance Measures—**The CMP should address, "How do we define and measure congestion?" This action involves developing performance measures that will be used to measure congestion on both a regional and local scale. These performance measures should relate to, and support, regional objectives.

4. **Collect Data/Monitor System Performance—**After performance measures are defined, data should be collected and analyzed to determine, "How does the transportation system perform?" Data collection may be ongoing and involve a wide range of data sources and partners.

5. **Analyze Congestion Problems and Needs—**Using data and analysis techniques, the CMP should address the questions, "What congestion problems are present in the State or region, or are anticipated?" and "What are the sources of unacceptable congestion?"

6. **Identify and Assess Strategies—**Working together with partners, the CMP should address the question, "What strategies are appropriate to mitigate congestion?" This action involves identifying and assessing potential strategies and may include efforts conducted as part of the LRTP, corridor studies, or project studies.[2]

[1] https://www.fhwa.dot.gov/planning/congestion_management_process/cmp_guidebook/cmpguidebk.pdf.

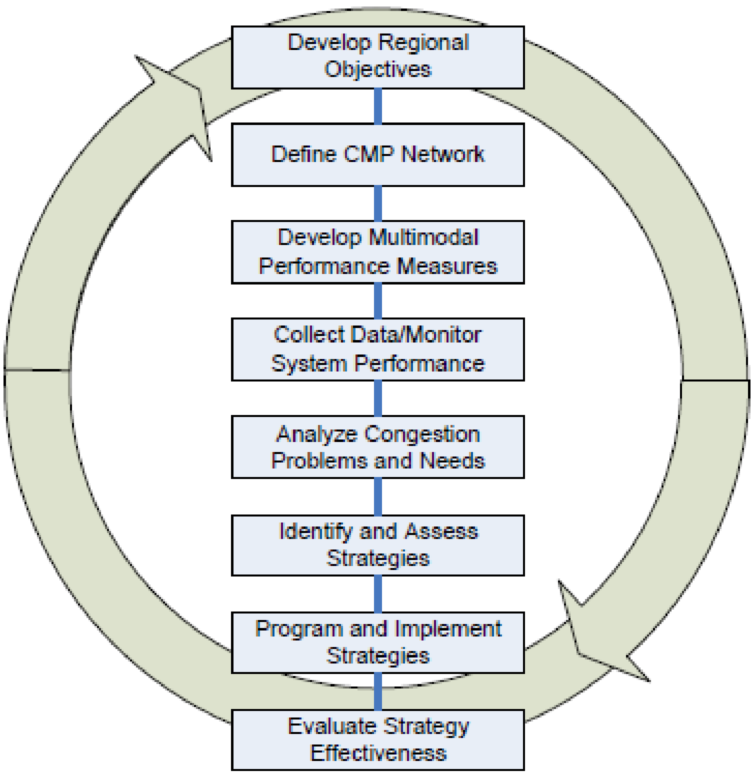
[2] Rhode Island's CMP is being developed on a statewide basis using similar principles as for a metropolitan area CMP.

7. **Program and Implement Strategies—**This action involves answering the question, "How and when will solutions be implemented?" It typically involves, including strategies in the LRTP, determining funding sources, prioritizing strategies, allocating funding in the STIP, and ultimately, implementing these strategies.

8. **Evaluate Strategy Effectiveness—**Finally, efforts should be undertaken to assess, "What have we learned about implemented strategies?" This action may be tied closely to monitoring system performance under Action 4, and is designed to inform future decision-making about the effectiveness of transportation strategies

These actions are depicted in Figure 1.1, which highlights the cyclical nature of the process model. The CMP should be an ongoing process, continuously progressing and adjusting over time as goals and objectives change, new congestion issues arise, new information sources become available, and new strategies are identified and evaluated.

Figure 1.1 Elements of the CMP Process



Source: FHWA (2008).

1.2 Need for a Congestion Management Process

All metropolitan areas with populations greater than 200,000 residents, known as Transportation Management Areas, are required by Federal regulations (23 U.S.C. 134(k)(3)) to develop a Congestion Management Process. The original Federal regulations on the Congestion Management Process date back to the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. These regulations were retained and largely unchanged by subsequent Federal legislation, including the Moving Ahead for Progress in the 21st Century Act (MAP-21) and the Fixing America's Surface Transportation (FAST) Act.

The Federal regulations define the CMP components as follows:

- Performance monitoring and evaluation, identification of causes of recurring and nonrecurring congestion, and strategy identification and effectiveness.
- Definition of congestion management objectives and performance measures.
- Coordinated data collection and system performance monitoring efforts.
- Identification of anticipated performance and benefits of congestion management strategies.
- Implementation schedule, responsibilities, and potential funding for strategies.
- Implementation of a process for assessment of strategies, in terms of established performance measures.

The changes that were made in the FAST Act include:

- Adding examples of travel demand reduction strategies for congestion management in a Transportation Management Associations (TMA).
- Allowing an MPO that serves a TMA to develop a congestion management plan (distinct from the CMP) that will be considered in the MPO's TIP. Any such plan must include regional goals for reducing peak hour vehicle miles traveled and improving transportation connections, must identify existing services and programs that support access to jobs in the region, and must identify proposed projects and programs to reduce congestion and increase job access opportunities.
- Specifies that in developing a congestion management plan, MPOs shall consult with employers, private and nonprofit providers of public transportation, transportation management organizations, and organizations that provide job access reverse commute projects or job-related services to low-income individuals.

In Rhode Island the Department of Administration's Division of Statewide Planning serves as staff to the State Planning Council, which serves as Rhode Island's MPO. All Federal MPO rules and regulations flow through the State Planning Council. The previous CMP for Rhode Island was developed and adopted as part of the 2035 LRTP in 2012. This 2020 CMP update addresses the congestion management needs of the State that have emerged since 2012. It incorporates statewide goals from the draft 2040 LRTP, RI Moving Forward 2040; new Federally required performance measures along with additional multimodal measures consistent with the statewide goals; and potential projects already identified in more recent modal plans for freight, transit, and bicycles, as well as the latest STIP that would contribute towards congestion management. It helps identify bottlenecks and congested corridors that do not have any projects identified and require implementation of additional congestion management strategies.

1.3 Organization of the CMP

The remainder of this report is structured according to the eight steps of the CMP from the FHWA CMP Guidebook:

- Section 2.0 describes the CMP objectives (Action 1).
- Section 3.0 defines the CMP network (Action 2).

- Section 4.0 identifies the multimodal performance measures (Action 3).
- Section 5.0 identifies data collection activities, needs, and monitoring activities (Action 4).
- Section 6.0 describes congestion in Rhode Island today (Action 5).
- Section 7.0 identifies currently planned congestion management strategies and additional strategies for consideration (Action 6).
- Section 8.0 provides a strategic action plan for implementing the congestion management process (Actions 7 and 8).

1.4 Congestion Management Task Force

The Congestion Management Task Force (CMTF) is the primary vehicle for implementing Rhode Island's Congestion Management Process. The Task Force is an existing body of State and Federal agency staff charged with monitoring and addressing recurring and non-recurring congestion.

1.4.1 *Membership*

The Task Force is a multidisciplinary group of Federal and State officials consisting of the following representatives, each with a particular area of expertise as noted in Table 1.1.

Table 1.1 Congestion Management Task Force

Agency	Expertise	Expectations	Benefits
Rhode Island Department of Administration, Division of Statewide Planning (RIDSP)	Travel demand modeling. Land use. Corridor planning. TDM strategies.	Cochair meetings. Run TransCAD based travel demand model in response to request from CMTF.	Plan, STIP, and CMP connectivity and operational compatibility.
Rhode Island Department of Transportation (RIDOT)/ Transportation Management Center (TMC)	Incident management. Communication with responders. Communication with general public. Traffic data collection. Intelligent Transportation Systems (ITS).	Cochair and convene meetings. Report TMC data. Provide update on Incident Management Task Force.	TMC assumes proactive role in congestion relief and shows increased return on investment and greater value to the taxpayer.
Rhode Island Public Transit Authority (RIPTA)	Transit operations (bus). Rideshare. Site design for bus accessibility. Travel demand management.	Provide route and ridership information for Task Force in vicinity of projects, congested corridors.	Better information on future construction activities. Greater ridership.
RIDOT / Design	Design for access management, roundabouts, and intersection capacity enhancements. Traffic safety.	Present project design solutions. Supply relevant Physical Alteration Permit Applications for CMTF input.	Feedback loop on completed projects. Have improvements produced the desired results?
RIDOT / Office of Transit	Coordinate/liaison with RIPTA on RIDOT construction projects. Serve on RIPTA Strategic Planning Committee. Commuter Rail Program Manager. TOD funding grants.	Provide regular Park n' Ride lot data. Provide commuter rail lot information and usage data.	Minimize impacts on RIPTA service due to congestion. Expansion of commuter rail system.

Agency	Expertise	Expectations	Benefits
RIDOT / Construction and Maintenance	Upcoming projects and activities requiring use of travel surface. Safe Work Zone requirements.	Provide specific days, dates, times, and location of lane and road closures.	Improved operational performance and a better informed motoring public.
RI Department of Environmental Management	Monitoring environmental quality, particularly related to air quality and greenhouse gas (GHG) emissions.	Assist with measuring emission reductions and air quality improvements from congestion management strategies.	Improvement in air quality and maintenance of the state's air quality attainment status.
FHWA	Best practices. Federal requirements for CMP.	Contribute knowledge or case studies of other State/ MPO efforts in CM.	Positive return on Federal investments.

1.4.2 *Structure and Function*

The Task Force generally meets on a quarterly basis and discusses a variety of issues related to recurring and nonrecurring congestion, as well as monitoring and reporting out the status of Rhode Island's management of congestion. RIDSP and the RIDOT TMC cochair this Task Force. Its activities are part of the TMC budget.

Through work performed by its members, the CMTF identifies Rhode Island's congested roadways and may recommend the undertaking of detailed corridor plans to address congestion causes and prioritize solutions within those corridors. This group also makes recommendations to be implemented immediately through the TMC, short term through RIPTA or active design of projects, or long term through STIP projects and land use regulations.

Applying congestion mitigation strategies is particularly important for Rhode Island's roadways because most of the corridors are physically and politically constrained from major capacity expansions (such as adding travel lanes). Accordingly, congestion mitigation strategies must focus on expanding travel choices to improve operation of the transportation system and encourage the use of other transportation modes more than promoting the use of single-occupant vehicles. Studies of congestion management strategies should evaluate traffic patterns, land use and socioeconomic information, incident data, and trends within the study area to identify the location, causes, and severity of congestion, and identify current and future congestion management needs and strategies.

The effectiveness of the CMTF relies on the system of data collection, data monitoring and travel forecasting to identify the existing locations of congestion in the State and to forecast the locations where congestion is likely to exist in the future.

1.5 Congestion Management Plan Working Group

The Congestion Management Process Working Group (CMP WG) was formed to provide input to the development of this Congestion Management Plan. The working group includes staff from RIDOT, RIDSP, and RIPTA and its membership has some overlap with the CMTF. The Working Group met monthly to guide the development of this plan and draft materials for CMTF review.

1.6 The Congestion Management Process and COVID-19

The State of Rhode Island faced unprecedented challenges with COVID-19 in 2020 which has had significant impacts to overall economic activity and to the levels of congestion on the transportation system. This report reflects the levels of congestion and transportation system conditions that existed prior to the onset of COVID-19. The report recommends performance measures to help track congestion levels on an ongoing basis and strategies to address congestion impacts as the level of economic activity increases. While the baselines observed for the year 2018 will be drastically different than those in 2020, the methodology remains sound and will be vital for the tracking of congestion in the upcoming years. The lessons learned during the COVID-19 pandemic also suggest that strategies such as working from home and otherwise substituting travel with electronically mediated activity could play an important role in helping to manage congestion in the future.

2.0 CMP Objectives

Rhode Island's CMP objectives define what the State wants to achieve regarding congestion management and are an essential part of an objectives-driven, performance-based approach to Rhode Island's transportation planning process. This section provides an overview of how the CMP objectives were designed to be reflective of what Rhode Island wants to achieve in terms of congestion management and links the CMP with Federal requirements and RI Moving Forward 2040, the state's long-range transportation plan.

2.1 Federal Requirements

Federal regulation (23 CFR 450.320 (c) 2) requires congestion management objectives as part of the CMP. The FHWA Congestion Management Process Guidebook provides guidance on how to develop these objectives and provides a framework known as Specific, Measurable, Agreed, Realistic, and Time-bound (S.M.A.R.T.) to use when developing them. S.M.A.R.T. characteristics are defined as:

- Specific—The objective provides sufficient specificity to guide formulation of viable approaches to achieve the objective without dictating the approach.
- Measurable—The objective facilitates quantitative evaluation, saying how many or how much should be accomplished. Tracking progress against the objective enables an assessment of effectiveness of actions.
- Agreed—Planners, operators, and relevant planning participants come to a consensus on a common objective. This is most effective when the planning process involves a wide range of stakeholders to facilitate regional collaboration and coordination.
- Realistic—The objective can reasonably be accomplished within the limitations of resources and other demands. The objective may require substantial coordination, collaboration, and investment to achieve. Factors such as population growth, economic development, and land use may also have an impact on the feasibility of the objective and should be considered. Based on data on system performance and analysis, the objective may need to be adjusted to be achievable.
- Time bound—The objective identifies a timeframe within which it will be achieved.

Rhode Island's CMP objectives were established with a set of more specific S.M.A.R.T. performance measures that allow performance at achieving these objectives to be measured. Target-setting (identifying specific targets for each measure and timeframes to achieve those targets) was not addressed as part of this CMP but will be considered in the future by the CMTF. Some measures are consistent with Federal performance management reporting requirements and therefore already have targets established.

2.2 Rhode Island CMP Objectives

RI Moving Forward 2040, through an extensive public involvement process, identified five major goal areas, with specific objectives within each goal area. These goal areas were used as the basis for the development of the CMP objectives by the CMTF and CMP Working Group. To show this relationship, the CMP objectives were crosswalked, as shown in Table 2.1, with the Moving RI Forward 2040 goal areas to show a direct, indirect, or no link/impact on the goal areas.

This crosswalk was originally presented in RI Moving Forward 2040 showing the relationship between the 2012 CMP objectives. For this 2020 CMP, the crosswalk was updated with the new CMP objectives, to ensure that the new CMP objectives are consistent with the overall congestion management-related goal areas and objectives in RI Moving Forward 2040. As the crosswalk shows, all of the draft objectives are directly or indirectly linked to a 2040 LRTP goal area.

Table 2.1 CMP Objectives and RI Moving Forward 2040 Goal Areas Crosswalk

	Moving RI Forward Goal Areas				
RI CMP Objectives	Connect People and Places	Reinvent the Transportation Network	Strengthen Communities	Promote Environmental Sustainability	Support Economic Growth
Improve Reliability of the Transportation System	●	■			■
Reduce Recurring Congestion	●	■			■
Improve Freight and Goods Movement					●
Increase Modal Choice and Competitiveness	●	●	■		
Improve Intermodal Connectivity	●	●	■	■	●
Promote and Invest in Innovative Congestion Management Technologies	■	■			
Promote Land Development and Infill Development/Redevelopment in Transportation-Efficient Locations		■	■	■	
Reduce Emissions and Improve Air Quality		■		●	

● Direct Link/Impact on Goal Area.
■ Indirect Link/Impact on Goal Area.

A brief discussion of each of the objectives is provided below.

2.2.1 *Improve Reliability of the Transportation System*

Traffic congestion has become a common occurrence within most major cities in the United States including the City of Providence and surrounding areas. Most drivers have come to accept a certain level of congestion during the peak commute periods. However, what frustrates most drivers is any unexpected delay that is more significant than what they are typically used to. Travel time reliability is a measure of the extent of this unexpected delay. It is of importance to users of all transportation modes. State DOTs around the country have started placing a greater importance in managing the reliability of the transportation system. This objective is an attempt to improve the reliability of the transportation system in the State of Rhode Island.

2.2.2 *Reduce Recurring Congestion*

Roughly half of all congestion with the State of Rhode Island is a result of everyday recurring congestion that occurs during the peak commute periods during the morning and afternoon hours. Recurring congestion occurs when the capacity of the transportation system is unable to meet the normal everyday peak travel demands resulting in delays and long queues with stop-and-go traffic. The point where the transportation system capacity is constrained is referred to as a bottleneck. Bottlenecks are points where the recurring congestion is initiated but the congestion can extend several miles upstream resulting in an entire corridor being congested. This objective seeks to reduce recurring congestion through the identification and mitigation of bottlenecks and congested corridors.

2.2.3 *Improve Freight and Goods Movement*

One of the goals of the Nation's National Highway System (NHS) is to promote freight movement for economic vitality. The RI Moving Forward 2040 long-range plan also identifies supporting economic growth as a goal area. This objective is intended to promote strategies to improve freight and goods movement throughout the State of Rhode Island. The progress towards improving freight and goods movements can be measures through truck travel time reliability on the State's primary freight corridors as well as through the identification and mitigation of freight bottlenecks.

2.2.4 *Increase Modal Choice and Competitiveness*

A key focus of the RI Moving Forward 2040 is to increase mode choice. Alternatives to single-occupant vehicle (SOV) travel need to be prevalent and competitive to SOV travel. Otherwise commuters are unlikely to choose a mode that results in significantly longer travel times and/or higher costs. This objective is intended to promote strategies that result in greater choices of modes that are operationally competitive to the SOV mode. Shifting travelers away from SOV travel would reduce vehicular demand on the highway network and help reduce congestion in the state.

2.2.5 *Improve Intermodal Connectivity*

While the above objective sought to increase the number of modes available to choose from, this objective recognizes the importance of having greater connectivity between modes. It is unlikely and cost-prohibitive as well as unnecessary to have every mode of transportation available between every origin and destination. It is more cost-effective to provide a network of inter-connected transportation modes, thereby providing commuters a choice in transportation modes not only at the origin but also along the route to the destination at intermodal hubs. Greater intermodal connectivity will further encourage a shift away from SOV travel which in turn will help reduce congestion in the state.

2.2.6 *Promote and Invest in Innovative Congestion Management Technologies*

Given ever-present budgetary constraints, and the difficulties in implementing traditional "brick-and-mortar" transportation solutions, State DOTs are looking to solve many of the congestion issues using innovations in technology. The State of Rhode Island has made effective use of ITS to better manage transportation operations. ITS-based incident management systems help address non-recurring congestion, while traveler information and advance traffic management systems help address recurring as well as nonrecurring congestion. In addition, Rhode Island has been a pioneer in the deployment of innovative technologies that will ultimately lead to the deployment of connected and autonomous vehicles. These state-of-the-art technologies can help address congestion in a cost-effective manner without the need for costly capacity expansion.

2.2.7 Promote Land Development and Infill Development/Redevelopment in Transportation-Efficient Locations

The CMP WG recognized the importance of land use in the context of congestion management. Strategies discussed above to increase mode choice and intermodal connectivity need to go hand-in-glove with land use strategies. Increasing transit-oriented development (TOD) in the vicinity of high-frequency transit service will increase transit ridership. Directing housing and job growth into already developed areas where destinations are nearby also shortens trip lengths and makes walking and bicycling more feasible. All these effects help reduce SOV travel and vehicle-miles traveled (VMT), thereby reducing congestion in the State. This objective seeks to promote land development in areas that have multiple transportation options, referred to as “transportation-efficient” locations.

2.2.8 Reduce Emissions and Improve Air Quality

Reducing congestion reduces emissions and thereby helps to improve air quality. This objective recognizes the fact that many congestion management strategies can also improve air quality and reduce GHG emissions by reducing vehicular travel or smoothing traffic flow. This objective reflects the importance of strategies that help to improve air quality in the state as well as help the state meet its GHG reduction goals established in the Resilient Rhode Island Act of 2014.

3.0 Definition of the CMP Network

In consultation with the CMP Working Group, the CMP network was defined for evaluation as part of the CMP both in terms of geographic boundaries and the system components of surface transportation facilities. The CMP network provides a framework for performance monitoring on an ongoing basis and analyzing congestion problems by identifying bottlenecks and congested corridors for which detailed congestion management strategies will be developed. As travel patterns change and develop throughout the State and as new data sources become available, it may be useful to revisit the system components being analyzed as part of the CMP.

3.1 Criteria to Define the CMP Network

Since the Rhode Island Department of Administration's Division of Statewide Planning is the sole MPO in the State, the geographic boundary of the CMP will be the State of Rhode Island, which corresponds to the full planning area of the RIDSP.

Although CMPs have traditionally focused primarily on the road network, multimodal transportation elements are important factors for addressing congestion in any urban area. Thus, as discussed in FHWA's CMP Guidebook, a CMP should consider elements of a multimodal network, including not only freeways or Interstate highways and arterial roadways but also transit services (e.g., rail, bus) and bicycle and pedestrian networks as well as their interface with the highway network. Doing so can help take advantage of strategies that rely upon other modes to reduce SOV travel. Typically, collectors and local roadways are not included in the roadway analysis of the CMP since it would be time-consuming to address these roadways and they generally have relatively low traffic volumes and congestion levels; however, these roadways should still be considered as potential bicycle, pedestrian, or transit corridors. The CMP analysis network will often include major intersections along arterials, given that intersections are often points where travel delay occurs.

The RIDSP currently procures travel time data collected by INRIX, a private information provider, which is available through the Probe Data Analytics (PDA) Suite by the Regional Integrated Transportation Information System (RITIS) and is managed by the University of Maryland (UMD) Center for Advanced Transportation Technology (CATT) laboratory.

Based on the guidance discussed above, and the current availability of data through the PDA Suite, the road inventory data layer within RI Geographic Information System (RIGIS) was obtained and overlaid with a shapefile from INRIX showing their coverage of the existing roadway network within Rhode Island. Based on this comparison, it became apparent that the RI CMP network should encompasses all roadways within the State that are functionally classified as minor arterial or a higher class, based on the FHWA-approved classification. The decision to use functional classification as the basis for the CMP network rather than the INRIX network itself was because functional classification is an easily measured attribute which RIDSP has the ability to manage and change, if needed. INRIX data, procured from a private information provider, may not always be available to the RIDSP, or another company with a different network may be the provider to RIDSP in the future.

3.2 CMP Network

The CMP network, shown in Figure 3.1, was created using the RIDOT Roads (2016) shapefile, which is available on the RIGIS website. This includes functional classifications 1 through 4 (1—Interstates, 2—

Principal Arterials—Other Freeways and Expressways, 3—Principal Arterials—Other, and 4—Minor Arterials) and excludes functional classifications 5 through 7 (5—Major Collector, 6—Minor Collector, and 7—Local). Table 3.1 summarizes the number of directional miles by functional classification of the highway network included in the CMP network.

Table 3.1 Mileage of CMP Network

Functional Classification	Miles
1—Interstate	90
2—Principal Arterials—Other Freeways and Expressways	125.1
3—Principal Arterials—Other	435.9
4—Minor Arterials	421.9
Total	1,072.9

The travel time data collected by INRIX and available through the Probe Data Analytics Suite for each month needs to be manually downloaded using the PDA Suite and is stored on one of Rhode Island Department of Information Technology's (DoIT) Microsoft Structured Query Language (SQL) servers. The RIDOT TMC has created predefined SQL queries to allow RIDSP to store the data and to compute performance measures. This is the primary data source that will be used to evaluate the CMP network.

As shown in Figure 3.2, a small amount of the CMP network is not covered within the INRIX data. It is recommended that RIDSP work with INRIX and the UMD CATT Lab to expand their coverage to include these roadways in the INRIX network. Similarly, as shown in Figure 3.3, there are a small number of roadways that are included in the INRIX network that are not functionally classified as minor arterial or above and thus are not on the CMP network. RIDSP should review these roadways and decide whether their functional classification should be changed.

As shown in Figure 3.4, a CMP network also has been established for public transportation services. This network includes the RIPTA bus routes, the Providence/Newport Ferry shuttle service, and the Massachusetts Bay Transportation Authority (MBTA) Providence commuter rail line.

As shown in Figure 3.5, a CMP network also has been established for bicycle infrastructure. Due to data availability, the CMP bicycle network is being limited to shared use paths and does not include bike lanes or sharrrows on roadways. Furthermore, a pedestrian network is not being established at this time due to the lack of data available on pedestrians. It is recommended that this be revisited in the future.

RIDSP already had established a freight corridor network prior to the CMP (Figure 3.6). This network will be used as the basis to compute freight performance measures as well as identify freight bottlenecks. The main corridors for trucks include Interstate 95, Interstate 295, Interstate 195, Route 4, Route 146, Route 6, and Route 44.[3]

[3] http://www.planning.ri.gov/planning-areas/transportation/freight-planning.php.

Figure 3.1 CMP Network

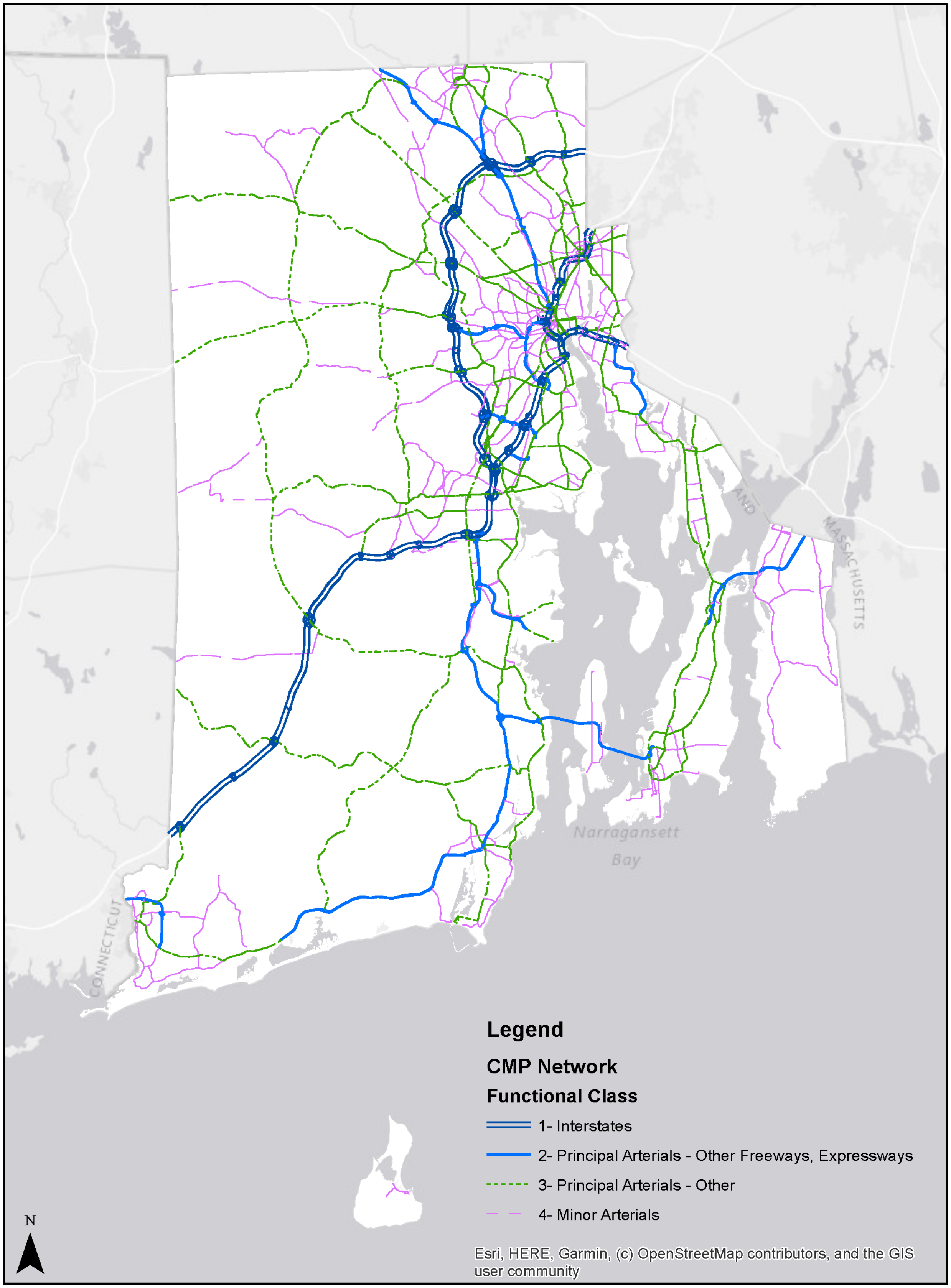


Figure 3.2 CMP Network not Covered with INRIX Data

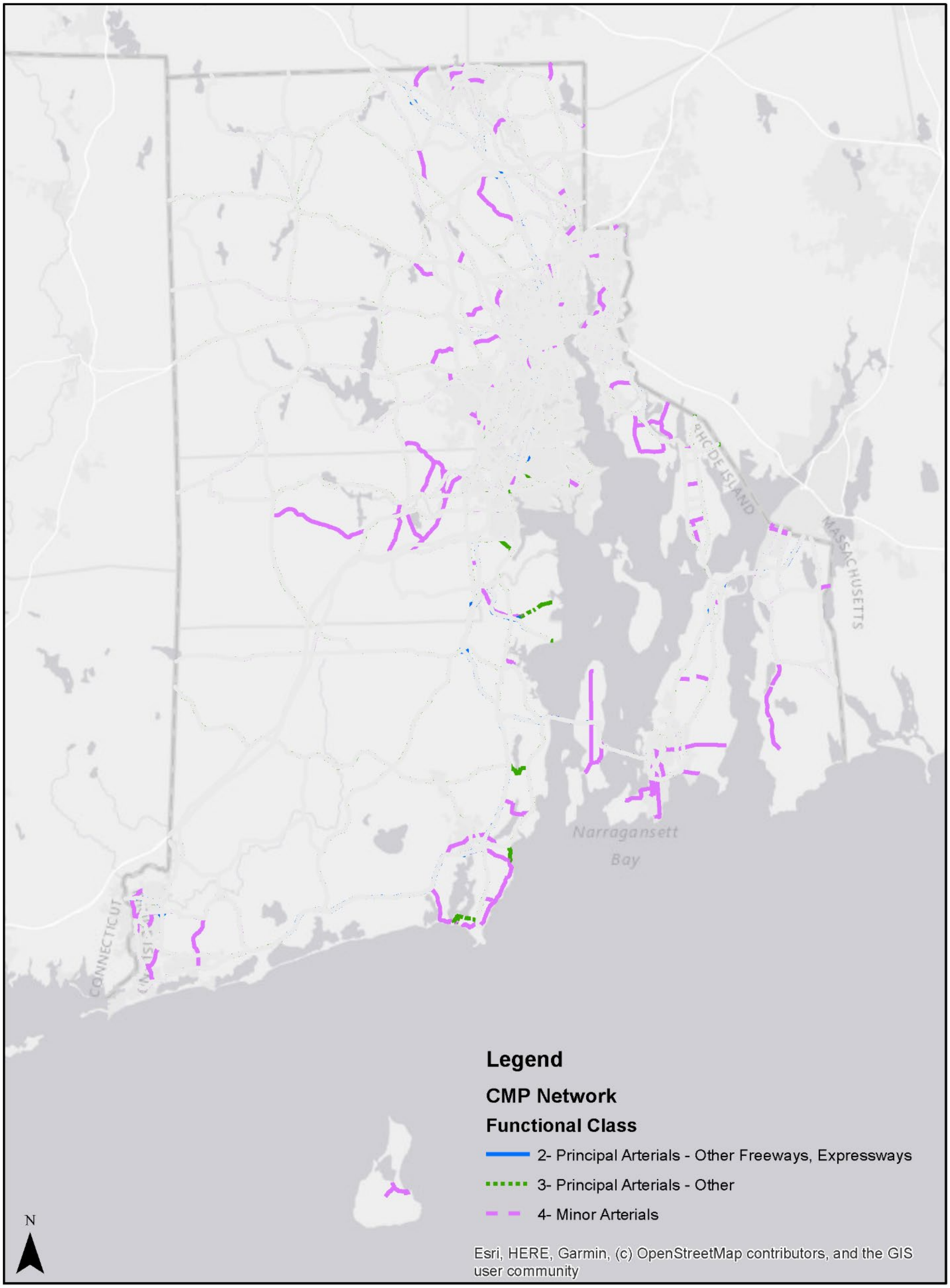


Figure 3.3 INRIX Data not Included in CMP Network

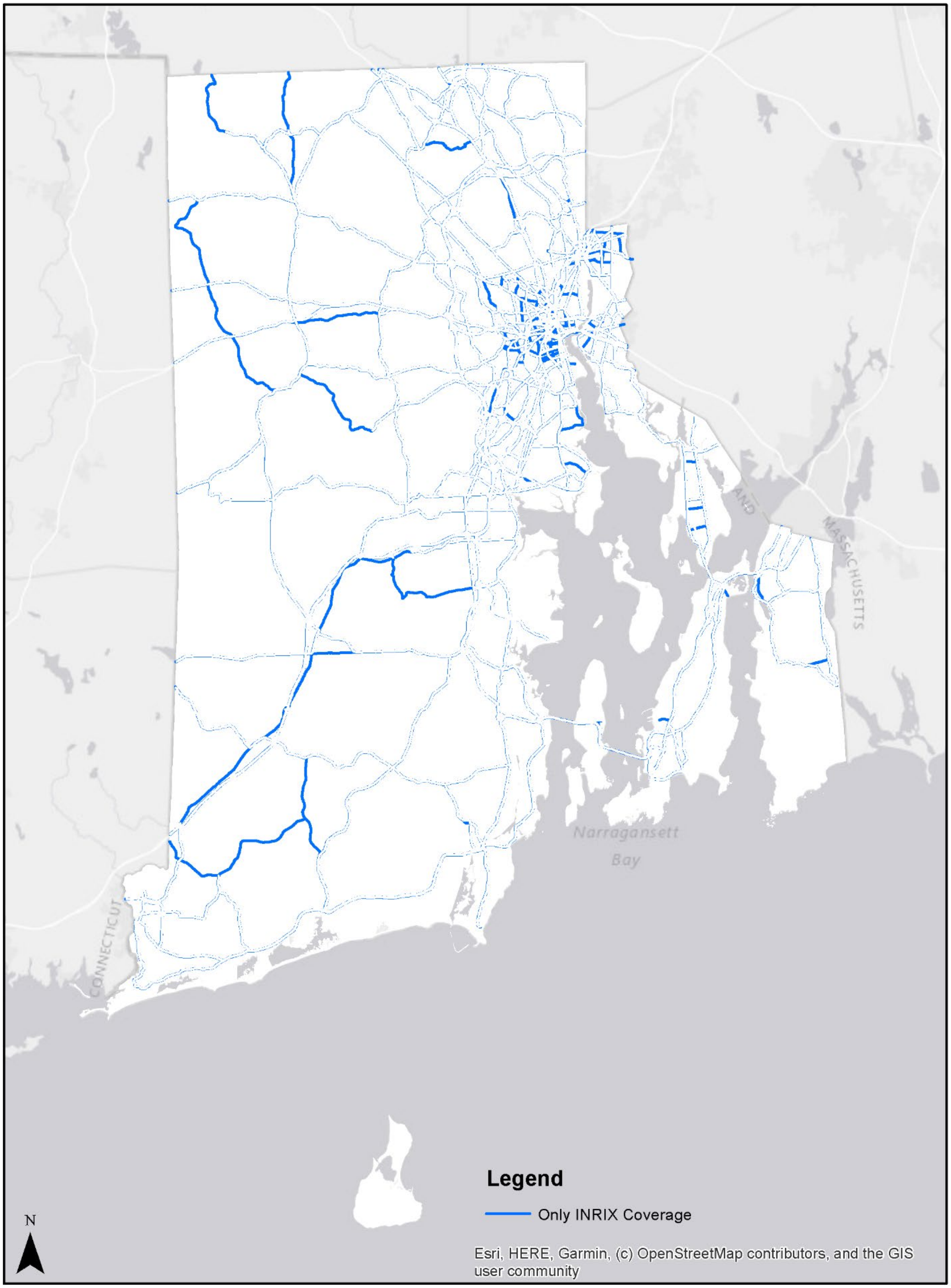


Figure 3.4 CMP Public Transportation Network

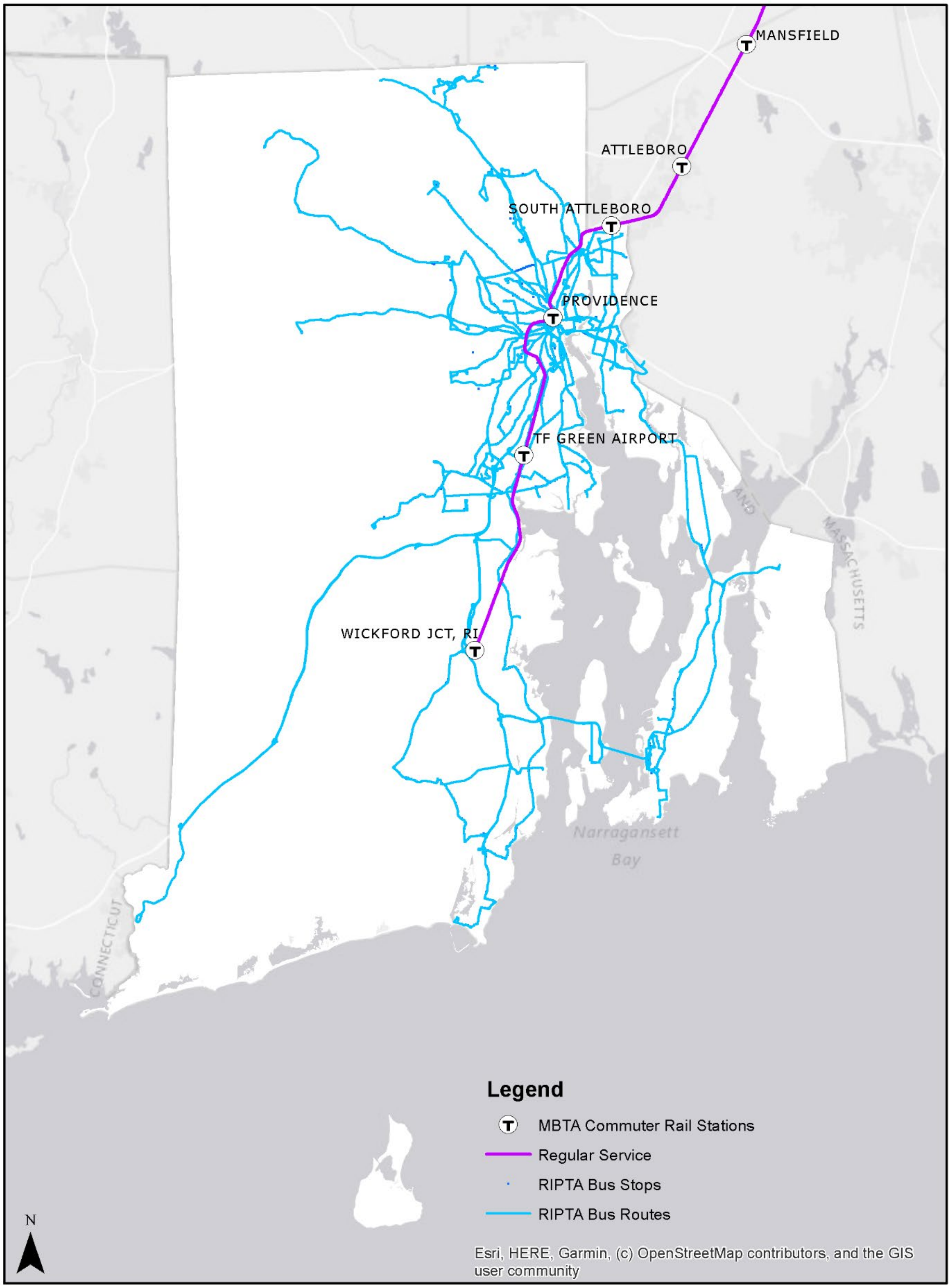
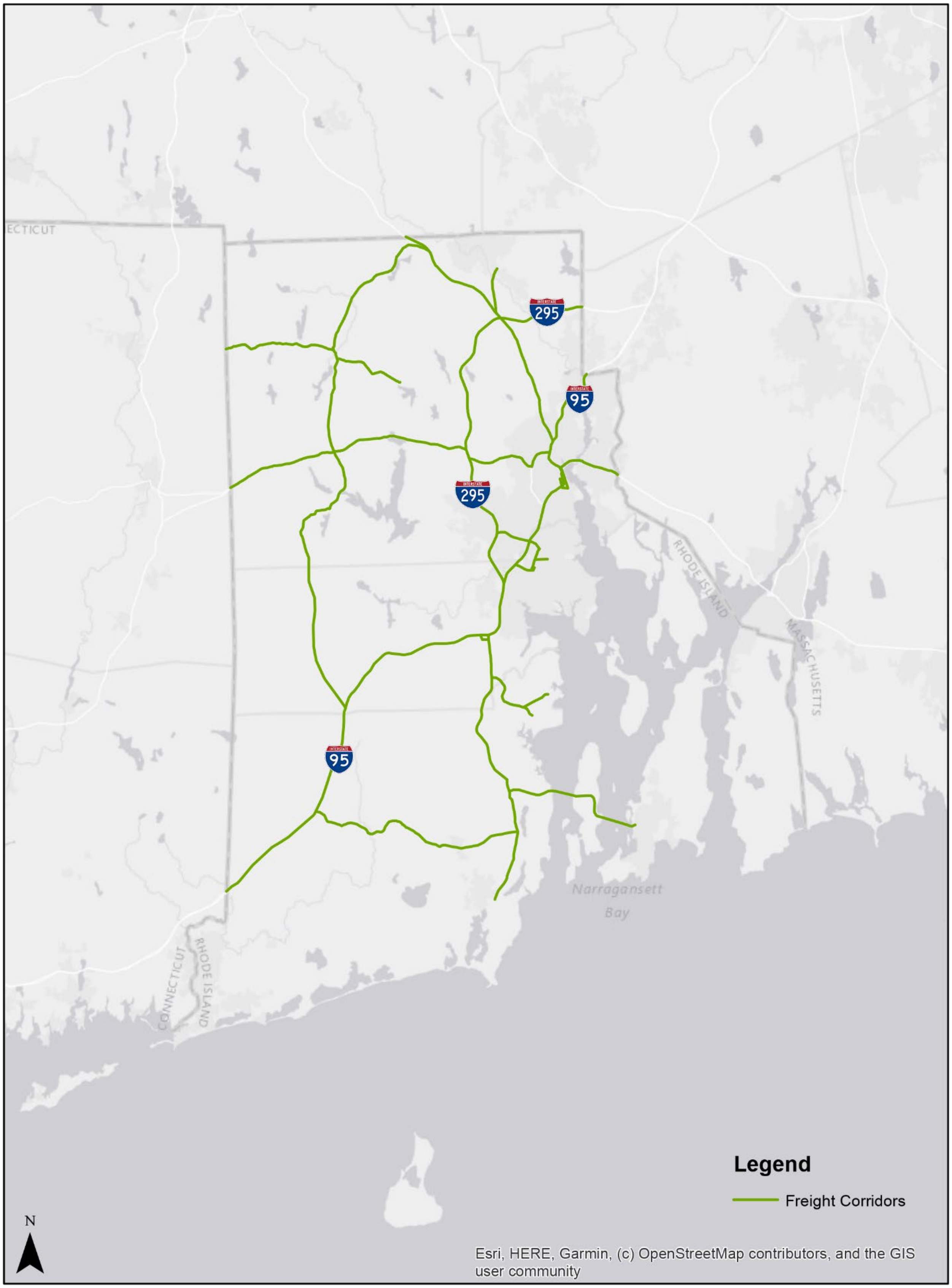


Figure 3.5 CMP Bicycle Facilities Network

Figure 3.6 Freight Network



4.0 Multimodal Performance Measures

Performance measures will allow the Rhode Island Division of Statewide Planning and its partners to evaluate and characterize current and anticipated system performance and communicate this information to decision-makers and stakeholders. The performance measures are intended to provide a statewide assessment of the multimodal transportation system and assist in evaluating congestion management strategies and in tracking progress in meeting the congestion objectives. It is anticipated that strategies focused on alleviating the specific congested corridors and bottlenecks identified in this plan will likely result in a shift in the statewide performance measures in a positive direction. If a congestion management strategy is applied to a specific identified location, it may also be beneficial to then compute a subset of the performance measures for that location only to aid in evaluating the effectiveness of the strategy.

The statewide measures identified herewith account for the four major dimensions of congestion defined in FHWA's Congestion Management Process, including intensity (severity of congestion), duration, extent (number of systems affected), and variability.

The performance measures were developed to help RIDSP and its partners assess how well the congestion management strategies are addressing the CMP objectives. The measures include travel time measures, reliability measures, measures addressing transit system reliability, measures addressing multimodal (transit, bicycle, pedestrian infrastructure) availability, freight performance measures, accessibility measures, and land use measures. The performance measures are categorized by the CMP objective they are intended to support.

The performance measures listed below have been developed in coordination with the CMP Working Group as well as the CMTF and align with performance measures required to comply with Federal and/or State requirements or policies as well as other plans/processes that have been developed by the State, including RIDOT's Transportation Systems Management & Operations (TSMO) performance measures, the LRTP performance measures, the Transit Master Plan (TMP) performance measures, and other measures where applicable. This will avoid duplicative efforts and provide consistency within the State.

Congestion Performance Measurement and COVID-19

This study was completed at a time when the Nation, including Rhode Island, was in the midst of a global pandemic creating unprecedented and unforeseen impacts on travel patterns. In the short term, the drastic reduction in travel during this time will have a significant impact on performance measures reported for the year 2020. Furthermore, the pandemic may have longer-term impacts on how and when people travel even after economic and social activities have returned to pre-pandemic levels. The performance measures identified in this plan will provide valuable information in tracking short and long term impacts. The baseline value of the performance measures were computed using 2018 data. While the baselines observed for the year 2018 will be drastically different than those in 2020, the methodology remains sound and will be vital for the tracking of congestion in the upcoming years. The results of ongoing performance measurement and comparison to the 2018 baseline presented in this report not only allow for assessing the level of economic recovery but also may also suggest the need to prioritize strategies differently if long-term travel patterns and needs change.

4.1 Definition of “Unacceptable” Congestion

For the first time in the U.S., the MAP-21 legislation and subsequently the FAST Act introduced performance-based transportation program requirements. FHWA’s Notice of Proposed Rulemaking (NPRM), finalized on May 20, 2017, formalized the performance measures for System Performance, Freight, and the Congestion Mitigation and Air Quality Improvement Program (CMAQ), referred to as the PM3 measures. These performance measures are now part of FHWA’s National Highway Performance Program, National Highway Freight Program (NHFP), and CMAQ Program. The MAP-21 PM3 measures in conjunction with other MAP-21 measures on infrastructure and safety will now be the de facto standard performance measures utilized by State DOTs to assess their transportation systems. Consequently, the RI CMP performance measures should be consistent with the PM3 measures in terms of defining “unacceptable” congestion.

The MAP-21 NPRM for the PM3 measures included definitions of terms such “reliable travel” and “excessive delay” which provide a solid basis for defining “unacceptable” congestion. These two terms account for both nonrecurring and recurring congestion. The metric used for measuring reliable travel on Interstates and on the non-Interstate National Highway System, as defined by the MAP-21 NPRM and referred to as Level of Travel Time Reliability (LOTTR), is the ratio of 80^{th} percentile travel time to 50^{th} percentile travel time, with values lower than 1.5 considered reliable travel. In other words, a LOTTR greater than 1.5 is considered “unreliable” travel according to the MAP-21 NPRM. The metric for measuring excessive delay is the difference between the average travel time (50th percentile travel time) and a threshold travel time. The threshold travel time, as defined by the MAP-21 NPRM, is 60 percent of the posted speed limit.

Based on discussions with the CMP WG and the CMTF, “unacceptable” congestion for the Rhode Island Congestion Management Process is defined in terms of both reliability and delay as follows:

- Unacceptable Reliability: Level of travel time reliability > 1.5.
- Unacceptable Delay: Speeds < 60 percent of the posted speed limit.

4.2 Sources of Congestion

Historically, performance measures related to congestion have typically been speed, travel time, delay, density of traffic, or traffic volumes; and agencies throughout the country typically made improvements by increasing capacity. Over the past several decades, both FHWA and State DOTs have come to recognize that given budgetary and other constraints, capacity improvements are challenging and that the focus needs to shift to operations on existing infrastructure. A greater emphasis is now being placed on providing reliable transportation operations which requires a comprehensive understanding of all of the sources of congestion.

A detailed travel time analysis was conducted to identify the sources of congestion in Rhode Island. The analysis was based on 2018 travel times included in the National Performance Management Research Dataset (NPMRDS). The NPMRDS provides travel times for each 5-minute interval on the NHS. The NHS is defined in terms of Traffic Messaging Channel (TMC) links. A total of 1,845 TMC links are included in the NPMRDS in 2018 for Rhode Island. Provided below is a description of the analysis steps to identify the sources of congestion.

First, the total peak hour excessive delay was computed for each TMC link for each day of each of the 12 months in 2018. Peak-hour excessive delay (PHED) was computed as the difference between the average travel time and the threshold travel time, defined to be at 60 percent of the posted speed limit. In cases when the average travel time was less than the threshold travel time, the PHED was set to zero. The total PHED was calculated as the sum of the delay during each 5-minute interval during the peak periods as defined in the FHWA NPRM for the PM3 measures—7:00 to 10:00 a.m. and 3:00 to 7:00 p.m.

The next step was to assign the above delay calculation on each TMC for each day into one of several possible "buckets" of delay. Based on a previous analysis of sources of congestion conducted in 2005 by Cambridge Systematics, Inc. (CS) and the Texas Transportation Institute (TTI), further discussions with CS as part of the RI CMP, and more recent efforts by the I-95 Corridor Coalition, the major sources of congestion are known to be the following:

- Recurring.
- Weather.
- Work Zone.
- Incidents.
- Holiday.

Recurring congestion was assumed to include delay that occurs on an ongoing basis from bottlenecks and poor signal timings. The remaining four sources were assumed to reflect the additional delay resulting from weather, work zone, incidents, and holiday travel over and above the normal recurring congestion occurs.

The impacts of weather were analyzed using hourly precipitation data from land-based monitoring stations in Rhode Island. This data was downloaded from the National Centers for Environmental Information of the National Oceanic and Atmospheric Administration (NOAA) website. Based on prior research conducted by TrafInfo for RIDOT's Transportation Systems Management and Operations performance measures, traffic speeds are impacted by hourly precipitation greater than ¼ inches per hour. All days in 2018 with precipitation rates greater than this threshold were identified.

The RIDOT Transportation Management Center maintains the RhodeWays database which includes information on incidents and planned work zones on all major highways in Rhode Island. Both the incidents and planned work zones were processed to identify the dates, highway, direction, and town where each incident or work zone occurred.

While the planned work zone data collected by the RIDOT TMC covers most of the construction and maintenance activities by RIDOT, the incident information is generally restricted to the major highways around the City of Providence. In order to better account for the impact of incidents, the total PHED for each day on each TMC link was analyzed to determine the number of days in a month with a PHED value. If the number of days in a month that a TMC link had a PHED value was less than 12, then it was assumed that any of those days without a weather or work zone event had a PHED value due to an incident.

Each day for each of the 1845 TMC links was then tagged to indicate (a) if that day and link was impacted by weather; (b) if that day and link was impacted by and incident or work zone; and (c) if that day was a holiday. In other words, each day for each TMC link would be tagged as being impacted by weather, a work zone, an incident, and/or a holiday. A TMC link on any given day could have more than one of these impacting factors resulting in a PHED value greater than zero.

The total PHED values for each day for each TMC link were then aggregated into the following "buckets" and the average daily PHED calculated for each TMC link:

- Weather only.
- Work zone only.
- Incident only.
- Weather + Work Zone.
- Weather + Incident.
- Work Zone + Incident.
- Weather + Work Zone + Incident.
- Holiday.
- No Event (indicating a normal day with no additional impacting factors).

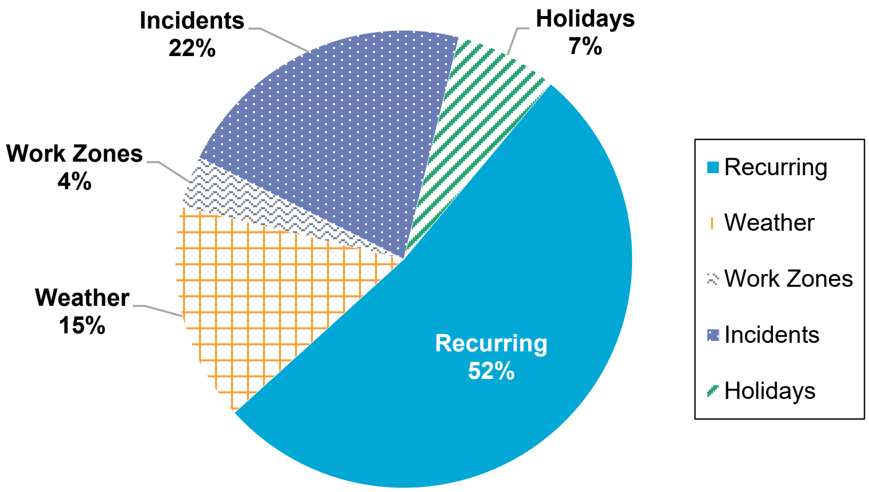
The average daily PHED for each of the above delay "buckets" was then computed by adding the average daily PHED for all TMC links for that "bucket."

The average daily PHED for No Event was assumed to be for a normal day representing the normal recurring congestion without any additional impacts from factors such as weather, work zones, incidents, or holiday. This was used as the base to compute the additional delay resulting from weather, work zones, incidents, and holidays.

Additional delay resulting from a combination of factors was broken down into their component factors in proportion to the delays individually for those factors. For example, the delay for weather and work zones was disaggregated based on delays for weather only and work zones only.

The average daily PHED for each month for each delay "bucket" was aggregated to obtain the overall distribution of the sources of congestion in Rhode Island for 2018. Figure 4.1 presents this in chart form. The performance measures for the RI CMP need to account for the illustrated sources of congestion.

Figure 4.1 Sources of Congestion in Rhode Island
January to December 2018



4.3 Performance Measures by CMP Objective

In consultation with the CMP WG, a set of performance measures were developed to help assess the progress made in achieving each of the CMP objectives. Following is a discussion of the various performance measures under each CMP objective. Details of the data sources and calculation methods for each performance measure are provided in Appendix A.

A. Improve Reliability of the Transportation System

Reliability refers to the consistency or dependability of travel times from day to day or across different times of the day. Following are the performance measures under this objective:

A.1 Interstate Reliability	Percent person-miles traveled on the Interstates that are reliable.
A.2 Non-Interstate NHS Reliability	Percent of person-miles traveled on the non-Interstate NHS that are reliable.
A.3 CMP Network Reliability	Percent of person-miles traveled on the CMP network that are reliable.
A.4 Reliability during Inclement Weather	Percent of person-miles traveled on the CMP network that are reliable during days with inclement weather.
A.5 Reliability through Work Zones	Percent of person-miles traveled on the CMP network that are reliable on days and highways with work zones.
A.6 RIPTA Bus Reliability	Reliability of travel on RIPTA buses.
A.7 Incident Clearance Time	Average incident clearance time on major highways in the Providence region.
A.8 Incident Rate	Number of incidents per million VMT on major highways in the Providence region.

A.1 Interstate Reliability

This performance measure is one of the MAP-21 PM3 measures that the RIDOT Office of Performance Management (OPM) must report to FHWA every year. It is based on the travel times within the NPMRDS for each month provided by the FHWA. The metric used for measuring reliable travel on Interstates, as defined by the MAP-21 NPRM, is referred to as Level of Travel Time Reliability. It is calculated as the ratio of 80th percentile travel time to 50th percentile travel time, with values lower than 1.5 considered reliable travel. The measure is reported as the percent of reliable person-miles traveled on the Interstates and the non-Interstate NHS.

A.2 Non-Interstate NHS Reliability

This performance measure also is one of the MAP-21 PM3 measures that the RIDOT OPM has to report to the FHWA every year. It is based on the travel times within the NPMRDS for each month provided by the FHWA. The metric used for measuring reliable travel on Interstates, as defined by the MAP-21 NPRM, is referred to as LOTTR. It is calculated as the ratio of 80th percentile travel time to 50th percentile travel time, with values lower than 1.5 considered reliable travel. The measure is reported as the percent of reliable person-miles traveled on the Interstates and the non-Interstate NHS.

A.3 CMP Network Reliability

This performance measure is computed exactly the same way as A.1 or A.2 but is computed for the CMP Network. The CMP Network is defined as highways within the State of Rhode Island that are functionally classified as minor arterial and above. This measure is based on the travel times collected by INRIX, a private information provider, and is available through the Probe Data Analytics Suite by the Regional Integrated Transportation Information System and is managed by the University of Maryland CATT laboratory. The travel time data for each month needs to be manually downloaded using the PDA Suite and is stored on one of Rhode Island DoIT's Microsoft SQL servers. The RIDOT TMC has created predefined SQL queries to allow RIDSP to store the data and to compute the measure.

A.4 Reliability during Inclement Weather

This performance measure is computed in the same manner as A.3 described above. The only difference is that while A.3 is computed for all 365 (or 366) days in a year, this measure is computed for only those days in a year with one or more hours during the peak period (7 to 10 a.m. and 3 to 7 p.m.) with a precipitation rate of greater than ¼ inches per hour. Currently, the RIDOT TMC maintains the database which identifies the days in a year with inclement weather for use as part of RIDOT's TSMO program. This information could also be used by RIDSP along with predefined SQL queries to compute this measure.

A.5 Reliability through Work Zones

This performance measure is computed in the same manner as A.3 described above. The only difference is that while A.3 is computed for all TMC links and for all 365 (or 366) days in a year, this measure is computed for only those TMC links and for only those days in a year which had a planned work zone. Currently, the RIDOT TMC maintains a database with information on all planned work zones in the State. This information could also be used by RIDSP along with predefined SQL queries to compute this measure.

A.6 RIPTA Bus Reliability

Consistent with how reliability is measured for highway travel, transit travel time reliability can be defined as the ratio of the 80th percentile travel time on a route or route segment to the 50th percentile travel time, during peak periods. This provides an indication of how the bus travel time on a route under the worst 20 percent of conditions compares with typical or average conditions. A larger ratio means a higher likelihood of unacceptably long delays to transit commuters compared to the expected travel time. The measures help understand the effects of highway congestion on bus operations and that by making bus travel more reliable can lead to a greater use of the transit option. The ratio of 80th to 50th percentile travel time is computed for each route segment and weighted by passenger-hours.

A.7 Incident Clearance Time

As discussed above, incidents are a significant source of nonrecurring congestion. The effects of incidents are measured by the previously discussed reliability measures. However, it is important to also better understand incident characteristics so that steps can be taken to better manage incidents. One of the performance measures widely used by all agencies is the incident clearance time, which is the time between when an incident is detected and confirmed to the time when the incident responders have left the scene. By minimizing incident clearance times, the impact on traffic also is minimized and hence travel time reliability can be improved and congestion reduced.

A.8 Incident Rate

In addition to understanding the time it takes to clear an incident, it also is important to measure the number of incidents occurring on the CMP network. The greater the number of incidents on a highway, the lower the travel time reliability on that highway. The likelihood of an incident occurring is directly proportional to the number of vehicles; highways with higher average daily traffic (ADT) are likely to have a higher number of incidents. This measure accounts for this relationship between number of incidents and ADT. It is the ratio of the number of incidents to the VMT on a highway. VMT is the product of the ADT and the length of the highway. The measure is an average of the incident rates on all major highway links around the Providence region for which the RIDOT TMC currently has incident information.

B. Reduce Recurring Congestion

Following are the performance measures under this objective.

B.1 PHED	Annual hours of peak hour excessive delay per capita.
B.2 PHED on CMP Network	Annual hours of peak hour excessive delay per capita on the CMP network.
B.3 PHED during Inclement Weather	Annual hours of peak hour excessive delay per capita on the CMP network during days with inclement weather.
B.4 PHED through Work Zones	Annual hours of peak hour excessive delay per capita on the CMP network on days and highways with work zones.
B.5 Number of Bottlenecks	Number of bottlenecks on the CMP network with an average queue length of greater than 0.25 miles and average duration of greater than 45 minutes.
B.6 Total Delay at Bottlenecks	Sum of the total delay at bottlenecks (as defined by CATT Lab) on the CMP network with an average queue length of greater than 0.25 miles and average duration of greater than 45 minutes.
B.7 Transit Vehicle Load Factor	Percent of passenger-hours on buses with load exceeding capacity.
B.8 Passenger Hours of Delay on RIPTA Buses	Passenger hours of delay on RIPTA buses.

B.1 Peak Hour Excessive Delay

This performance measure is one of the MAP-21 PM3 measures that the RIDOT Office of Performance Management determines on a monthly and yearly basis. As the metropolitan Providence region is in attainment of national ambient air quality standards, the Providence MPO is not required to submit this measure to FHWA on an annual basis. It is based on the travel times within the NPMRDS for each month provided by the FHWA.

B.2 PHED on the CMP Network

This performance measure is computed exactly the same way as B.1 but is computed for the CMP Network using INRIX travel times downloaded from the PDA Suite. The RIDOT TMC has created predefined SQL queries to allow RIDSP to store the data and to compute the measure.

B.3 PHED during Inclement Weather

This performance measure is computed in the same manner as B.2 described above. The only difference is that while B.2 is computed for all 365 (or 366) days in a year, this measure is computed for only those days in a year with one or more hours during the peak period (7 to 10 a.m. and 3 to 7 p.m.) with a precipitation rate of greater than ¼ inches per hour. The inclement weather information maintained by the RIDOT TMC could also be used by RIDSP along with predefined SQL queries to compute this measure.

B.4 PHED through Work Zones

This performance measure is computed in the same manner as B.2 described above. The only difference is that while B.2 is computed for all TMC links and for all 365 (or 366) days in a year, this measure is computed for only those TMC links and for only those days in a year which had a planned work zone. The work zone information maintained by the RIDOT TMC could also be used by RIDSP along with predefined SQL queries to compute this measure.

B.5 Number of Bottlenecks

The UMD CATT Lab defines a bottleneck as an occurrence when the prevailing travel time goes below a threshold speed of 60 percent of the posted speed limit. Each such individual occurrence is aggregated to determine bottlenecks. Several metrics are computed for each bottleneck, including base impact (sum of queue lengths over a duration) and total delay (base impact weighted by the speed differential between free flow and observed speed and the average daily traffic). Based on discussion with the CMP WG, a threshold was set to identify the number of bottlenecks. All bottlenecks with at least ¼ mile of average queue length and having at least 45 minutes of average daily duration, as computed over an annual period, are selected as part of this measure. RIDSP will be able to obtain this using the PDA Suite.

B.6 Total Delay at Bottlenecks

This measure differs from the above measure B.5 in that it is the sum of the total delay of all the bottlenecks identified in measure B.5. As mentioned above, the PDA Suite provides a metric called total delay for each bottleneck. Total delay of a bottleneck accounts for the average queue length, the speed differential between free flow and operating speed, and the average daily traffic.

B.7 Transit Vehicle Load Factor

This measure estimates the extent to which transit operations and passenger mobility are impeded by operation of buses at crush loads. This measure is defined as the percent of RIPTA system passenger-hours operated at crush loads (segments exceeding seated capacity). Passenger count data from onboard automatic passenger counters (APC) will be used along with information on bus operations. Not all RIPTA buses currently have APC onboard. As APC is installed on more buses, more routes can be included in this measure.

B.8 Passenger Hours of Delay on RIPTA Buses

This measure estimates the amount of delay experienced by passengers on RIPTA buses as a result of congestion on bus routes and roadways. Delay is defined as the difference between "free-flow" and actual travel time, multiplied by the number of passengers affected. Delay can be calculated for various temporal and spatial aggregations. The measure for statewide reporting is the total annual hours of passenger-delay, computed at the segment level.

C. Improve Freight and Goods Movement

The performance measures under this objective include the following.

C.1 Truck Reliability on Interstates	Truck travel time reliability on all Interstates in the State of Rhode Island.
C.2 Travel Time Reliability on Freight Corridors	Travel time reliability on the primary freight corridor highways on the CMP network.
C.3 Number of Freight Bottlenecks	Number of bottlenecks on freight corridors within the CMP network.
C.4 Truck Congestion Cost	Truck congestion cost on the freight corridors within CMP network.

C.1 Truck Reliability on Interstates

This performance measure also is one of the MAP-21 PM3 measures that the RIDOT Office of Performance Management determines on a monthly and yearly basis. It is restricted to Interstate highways and is based on truck travel times within the NPMRDS for each month provided by the FHWA.

C.2 Travel Time Reliability on Freight Corridors

The RIDSP has defined the primary freight corridor network for the State of Rhode Island.[4] It includes the Interstates as well as other major highways, including Route 146, Route 4, Route 102, Route 138, and portions of U.S. Route 6 and U.S. Route 44. This performance measure is the same as A.3 but for the network that includes all the highways and roads included in the Rhode Island's primary freight corridor that also are on the CMP network.

[4] http://www.planning.ri.gov/planning-areas/transportation/freight-planning.php.

C.3 Number of Freight Bottlenecks

Performance measure B.5 is a count of all the bottlenecks on the CMP network that satisfy the threshold of ¼ mile queue lengths and 45 minutes of average daily delay. This measure identifies all those bottlenecks identified in B.5 that are on the Rhode Island primary freight corridor network.

C.4 Truck Congestion Cost

Performance measure B.2 is related to peak-hour excessive delays on the CMP network. This measure will be computed similarly to B.2 but will be restricted on those highways on the Rhode Island primary freight corridor. The peak-hour excessive delay will be multiplied with a commercial value of time to estimate the cost of truck/freight congestion. The commercial value of time will be taken from the Texas A&M Transportation Institute Annual Urban Mobility Report.[5]

D. Increase Mode Choice and Competitiveness

Following are the measures under this objective.

D.1 Bike Path Mileage	Mileage of bike paths in the State.
D.2 Bike Path Usage	Average bike path utilization.
D.3 HOV/Dedicated Bus Lane Route Miles	Mileage of high-occupancy vehicle (HOV) and dedicated bus lanes.
D.4 Percent of SOV Travel	Percent of nonsingle occupancy vehicle (Non-SOV) travel.
D.5 Commuter Rail Ridership	Annual commuter rail ridership.
D.6 RIPTA Bus Ridership	Annual RIPTA bus ridership.
D.7 Providence/Newport Ferry Ridership	Annual Providence/Newport ferry ridership.

D.1 Bike Path Mileage

This performance measure is the total center miles of bike paths in the State. The Rhode Island Geographic Information System has a RIDOT Bike Paths data layer which includes bike lanes, bike routes, and bike paths. This measure is restricted to bike paths only as currently the data on bike lanes and routes is not accurate. In the future, when more accurate data becomes available, this measure may be expanded to cover all bicycle facilities in the State.

D.2 Bike Path Usage [Future Measure]

This measure is proposed as a future measure due to lack of existing data. it is intended to assess the level of utilization of the following eight bike paths in the State of Rhode Island. They include:

- Blackstone River Bikeway.
- East Bay Bike Path.

[5] https://mobility.tamu.edu/umr/.

- William C. O'Neill Bike Path.
- Washington Secondary Bike Path.
- Fred Lippitt Woonasquatucket River Bike Path.
- Ten Mile River Greenway.
- Quonset Bike Path.
- Warren Bike Path.

For each of the above listed bike paths, percent of days in a year each path was utilized will be computed. A path is considered utilized on any day if it had at least one bicyclist on that facility. The measure is an average of the percent of all bike paths. In order to compute this measure, continuous bicycle counting stations will need to be installed on each of the above listed paths. Among these paths, only the William C. O'Neill Bike Path currently has counting stations. Consequently, this measure will be computed in the future after continuous bicycle count stations have been installed on other paths.

D.3 HOV/Dedicated Bus-lane Route Miles

One important method to combat highway congestion would be to encourage a shift to other modes of transportation. This measure describes the extent of efforts to increase vehicle occupancy by constructing HOV facilities or dedicated bus lanes. The measure is the total lane-miles of HOV and bus-on-shoulder on Interstates and limited access highways, and dedicated bus lanes on arterial streets.

D.4 Percent of SOV Travel

This performance measure is one of the MAP-21 PM3 measures that the RIDOT Office of Performance Management must report to the FHWA. The final rule provides three methods to estimate the percent of single-occupant vehicles within the overall traffic in the State. The method selected by the RIDSP is to use the information provided in the American Community Survey (ACS) published by the U.S. Bureau of Census annually using the latest five-year data.

D.5 Commuter Rail Ridership

This measure tracks the weekday ridership of the MBTA commuter rail in Rhode Island by riders boarding and alighting at Providence Station, TF Green Airport, Wickford Junction, and any new stations opened in future. The measure is the annual total of the number of weekday passenger trips on the MBTA Providence commuter rail line originating or ending at each station.

D.6 RIPTA Bus Ridership

This measure provides the level of usage of the RIPTA buses in Rhode Island. It is the annual average weekday daily trips on the entire RIPTA bus route system.

D.7 Providence/Newport Ferry Ridership

This measure tracks the ridership on the Providence-Newport Ferry that runs between 25 India Street in Providence and Perrotti Park in Newport. It is the number of passenger trips in a year (when the ferry is operational) on the State-sponsored Providence-Newport Ferry. Each trip equates to one rider boarding at either 25 India Street in Providence or Perrotti Park in Newport. The counts are conducted by the operator and provided to the RIDOT Office of Transit.

E. Improve Intermodal Connectivity

Following are the measures under this objective.

E.1 Percent Population with Transit Access	Percent of population with access to high-frequency transit.
E.2 Percent Jobs with Transit Access	Percent of jobs with access to high-frequency transit.
E.3 Bike System Connectivity	Ratio of connected bike path miles to total bike path mileage.

E.1 Percent Population with Transit Access

This measure is the estimated percent of the State's population that is within ¼ mile of a transit stop providing high-frequency service or MBTA commuter rail station. "High-frequency" service is defined as having headways of 15 minutes or less during peak periods. The computation of this measure requires the use of geographic information system (GIS) tools and General Transit Feed Specification data to calculate the total population that lives within a ¼ mile radius from each high-frequency RIPTA bus stop or rail station. The measure is the ratio of the population with high-frequency transit access divided by the total State population.

E.2 Percent Jobs with Transit Access

This measure is similar to E.1 but is based on jobs rather than population. The computation of this measure requires the use of GIS tools to calculate the total number of jobs that are located within a ¼ mile radius from each RIPTA bus stop with high-frequency service or MBTA commuter rail station. The measure is the ratio of the jobs with high-frequency transit access divided by the total jobs in the State.

E.3 Bike System Connectivity

This measure is an assessment of whether the bike paths within the State form a coherent network. It is computed as a ratio of system mileage of longest contiguous conglomeration of bicycle paths to the total bike path mileage in the State as computed in D.1 above. When more accurate information becomes available for bike lanes and bike routes, this measure can be modified to include all bicycle facilities in the State.

F. Promote and Invest in Innovative Congestion Management Technologies

Following are the measures under this objective.

F.1 Number of Intersections with Advanced Signal Control	Number of signalized intersections that automatically adjust signal timings in response to fully actuated detection and/or adaptive algorithm.
F.2 Number of Intersections with Remote Monitoring Capability	Number of signalized intersections with remote agency monitoring and control functionality.
F.3 Number of Real-time Travel Time Signs per Route Mile	Number of real-time travel time signs (hybrid guide signs) per mile of routes covered by the real-time travel time system.
F.4 Number of RIPTA Bus Routes with Transit Priority Treatment	Number of RIPTA bus routes with transit priority treatment (transit signal priority, bus lanes, queue jump lanes, etc.).

F.1 Number of Intersections with Advanced Traffic Control

This measure is intended to be a subset of the traffic signals included under F.2. It accounts for those traffic signals in the State with the capability of remote monitoring and control that also have the ability to automatically adjust the signal timings on an ongoing basis using either the local detection system or using an adaptive algorithm that exists either locally running on a computer hardware located within the traffic signal cabinet or running on a central computer. Like F.2, initially, this measure includes only the State signals and those belonging to the City of Providence. Once a method has been established to share such information, this measure could include all the traffic signals within the State.

F.2 Number of Intersections with Remote Monitoring Capability

This measure accounts for number of traffic signals in the State that have the capability for remote monitoring and control by the agency of jurisdiction. Remote monitoring and control would require a communication link to the traffic signal controller, necessary software and computer equipment at the transportation agency, and the ability for the agency to use the software to connect to the remote traffic signal to monitor and control the traffic signal. This measure is intended to cover all traffic signals in the State—both within RIDOT's jurisdiction as well as those belonging to the various cities/towns within Rhode Island. Initially, the measure includes all State signals as well as those within the City of Providence jurisdiction. Once a method has been established to share such information, the measure could cover all traffic signals within the State.

F.3 Number of Real-Time Travel Time Signs per Route Mile

This measure assesses the level of real-time travel time information provided to motorists in the State. The real-time travel time signs also are referred to as hybrid guide signs. These are traditional green guide signs providing a destination and distance that also include an LED portion to display the prevailing travel time to each destination on that sign. The measure is computed as the ratio of the total number of real-time travel time signs to the total length of route miles displayed on the travel time signs.

F.4 Number of RIPTA Bus Routes with Transit Priority Treatment

To improve transit operations, several transit priority treatments are available to RIDOT and RIPTA. They include transit signal priority (TSP), queue jump lanes where a portion of one of the approach lanes at a signalized intersection is dedicated to buses to allow them to bypass the queue of traffic stopped at the intersections, and dedicated bus lanes. This measure is the total number of RIPTA bus routes that have any level of transit priority treatment along the route.

G. Promote Land Development and Infill Development/Redevelopment in Transportation-Efficient Locations

Following are the measures under this objective.

G.1 Percent of Permits in Transit Propensity Areas [Future Measure]	Percent of permits issued in transit propensity areas.[1]
G.2 Transportation Funds Invested in Transit Propensity Areas	Percent of transportation funds invested in transit propensity areas.

[1] "Transit propensity areas" are defined in Rhode Island's Transit Master Plan based on minimum population and job densities needed to support transit.

G.1 Percent of Permits in Transit Propensity Areas [Future Measure]

This measure is proposed as a future measure due to lack of existing data. It attempts to integrate land use into the Congestion Management Process. It provides an assessment of how much of the land development in the State is occurring within areas with greater propensity for transit. The RIDSP has identified areas within the State that have a greater propensity to transit given the existing public transportation system. Any land development project has to obtain a building permit from the local Government as well as, if applicable, a Physical Alternative Permit (PAP) from RIDOT. The State of Rhode Island has initiated an E-permitting portal that consolidates the permitting applications into one web portal. This measure would be a computation of the proportion of permits for land developments within the identified transit propensity areas. While it would be ideal to account for all permits for land development, initially this measure may be restricted to those land developments requiring a PAP from RIDOT. RIDSP should work towards obtaining information for all permits through the State's E-permitting portal.

G.2 Transportation Funds Invested in Transit Propensity Areas

This measure considers the amount of transportation funds invested within transit propensity areas. The information on transportation funds invested can be extracted from the STIP. This measure will help assess to what extent transportation funds are being focused to areas that have a greater propensity for transit usage.

H. Reduce Emissions and Improve Air Quality

Following are the measures under this objective.

H.1 Total Vehicles Miles Traveled per Capita	Total VMT per capita.
H.2 Emissions Reductions by CMAQ Projects [Future Measure]	Emission reductions by CMAQ projects.
H.3 Regional air quality attainment status	Regional air quality attainment status.
H.4 GHG emissions [Future Measure]	GHG emissions from vehicles on the CMP network.

H.1 Total Vehicle Miles Traveled per Capita

The amount of vehicle travel within the State can be measured by VMT which is the total of all vehicle trips multiplied by trip length. VMT is computed by adding the product of the ADT and the length of all highway segments within the State. The VMT statistics for Rhode Island can be obtained from RIDSP or from the FHWA Highway Statistics annual publication, and the latest population estimate can be obtained from the U.S. Bureau of the Census.

H.2 Emission Reduction by CMAQ Projects [Future Measure]

This measure is proposed as a future measure due to lack of existing data. The MAP-21 legislation and the subsequent FAST Act legislation require a performance-based transportation program. Any project funded using Congestion Mitigation and Air Quality Program Federal funds would need to demonstrate the benefits towards emission reduction. RIDOT is required to annually report to FHWA the reductions in emissions for each applicable criteria pollutant and precursor for all projects funded with CMAQ funds. The total emission reductions will be reported as the CMP performance measure.

H.3 Counties in Air Quality Attainment

The Clean Air Act established national ambient air quality standards and any region not meeting these standards is in "nonattainment." Over the past few years, Rhode Island has met the air quality standards and all five counties have been designated as being in attainment. This measure is a count of the number of counties designated as in attainment.

H.4 Greenhouse Gas Emissions [Future Measure]

This measure is proposed as a future measure due to lack of existing data. It is intended to respond to the Resilient Rhode Island Act of 2014 related to climate change and GHG emissions as part of the Congestion Management Process. The measure will be the total GHG emissions from highway vehicles (automobiles, trucks, and transit) on the CMP network, as measured in million metric tons of carbon dioxide equivalent (MMTCO2e). The Rhode Island Department of Environmental Management and RIDSP will work together to compute this measure using VMT and emission factor data.

4.4 2018 Baseline Performance Measure Values

The following table provides a summary of the performance measures discussed above and the data for each performance measure for 2018. This may be used as a baseline to compare the results of future performance measure assessments to determine the effectiveness of the congestion management strategies.

Table 4.1 2018 Baseline Performance Measures

Objective	Performance Measure	Resp.	2018
Improve Reliability of the Transportation System	A.1 Interstate Reliability	RIOPM	78.6%
	A.2 Non-Interstate Reliability	RIOPM	88.7%
	A.3 CMP Network Reliability	RIDSP	92.0%
	A.4 Reliability During Inclement Weather on CMP Network	RIDSP	91.9%
	A.5 Reliability Through Work Zones on CMP Network	RIDSP	91.1%
	A.6 RIPTA Bus Reliability (ratio of 80^{th} to 50^{th} percentile time)	RIPTA	1.16
	A.7 Average Incident Clearance Time (minutes)	RIDOT TMC	29
	A.8 Average Incident Rate (incidents/million VMT)	RIDOT TMC	1.75

Objective	Performance Measure	Resp.	2018
Reduce Recurring Congestion	B.1 Peak-Hour Excessive Delay (PHED) (millions of hours)	RIOPM	14.71
	B.2 PHED on CMP Network on CMP Network (millions of hours)	RIDSP	9.34
	B.3 PHED During Inclement Weather on CMP Network (millions of hours)	RIDSP	3.72
	B.4 PHED Through Work Zones on CMP Network (millions of hours)	RIDSP	0.37
	B.5 Number of Bottlenecks	RIDSP	160
	B.6 Total Delay at Bottlenecks (millions of hours)	RIDSP	2,900
	B.7 Transit Vehicle Load Factor (% of passenger-hours at load factor >1)	RIPTA	2.9%
	B.8 Passenger-Hours of Delay on RIPTA Buses	RIPTA	9,000
Improve Freight and Goods Movement	C.1 Truck Reliability on Interstates	RIOPM	1.79
	C.2 Truck Reliability on Freight Corridors	RIDSP	1.48
	C.3 Number of Freight Bottlenecks	RIDSP	27
	C.4 Truck Congestion Costs	RIDSP	$82M
Increase Modal Choice and Competitiveness	D.1 Bike Path Mileage	RIDSP	241
	D.2 Bike Path Usage [Future Measure]	RIDSP	–
	D.3 HOV/Dedicated Bus-Lane Route Miles	RIDOT	0.8
	D.4 Percent of Non-SOV Travel	RIDSP	18.2%
	D.5 Commuter Rail Ridership (million trips)	RIDOT	1.14
	D.6 RIPTA Bus Ridership (million trips)	RIPTA	16.3
	D.7 Providence/Newport Ferry Ridership	RIDOT	46,400
Improve Intermodal Connectivity	E.1 Percent of Population with Transit Access	RIDSP	18.1%
	E.2 Percent of Jobs with Transit Access	RIDSP	21.8%
	E.3 Bike System Connectivity	RIDSP	0.3
Promote and Invest in Innovative Congestion Management Technologies	F.1 Number of Intersections with Advanced Traffic Control[1]	RIDOT	720/1182
	F.2 Number of Intersections with Remote Monitoring[1]	RIDOT	4/1182
	F.3 Number of Real-time Travel Time Signs Per Route Mile	RIDOT TMC	0
	F.4 Number of RIPTA Bus Routes with Transit Priority Treatment	RIPTA	1
Promote Land Development and Infill Development/ Redevelopment in Transportation-Efficient Locations	G.1 Percent of Permits in Transit Propensity Areas [Future Measure]	RIDSP	–
	G.2 Transportation Funds Invested in Transit Propensity Areas	RIDSP	TBD
Reduce Emissions and Improve Air Quality	H.1 Total Vehicle-Miles of Travel Per Capita	RIDSP	7,577
	H.2 Emission Reductions by CMAQ Projects [Future Measure]	RIDSP	–
	H.3 Counties in Air Quality Attainment	RIDSP	5 of 5
	H.4 GHG Emissions (MMTCO2e) [Future Measure]	RIDSP	–

1 Intersection metrics currently include those under the jurisdiction of the State and of the City of Providence.

5.0 Data Collection, Needs, and Monitoring

5.1 Data Collection

5.1.1 *National Performance Management Research Data Set*

The NPMRDS Analytics website provides free access to monthly travel time data for all the highways within Rhode Island on the National Highway System. The NPMRDS data is provided to public agencies at no cost and is the basis for reporting the system performance measures to FHWA.

The data extraction from the NPMRDS Analytics website is a manual process. Each month the RIDOT TMC Consultant logs into the website and makes a request to download the monthly data. The prior month's data is typically available five business days into the current month. The website typically fulfills the request within an hour when the data is ready to be downloaded. At that time, the RIDOT TMC Consultant downloads the data and stores it on a RIDOT SQL server called the Rhode Island System Performance Measures (RISPM) database.

The RISPM database currently houses all of the NPMRDS data to date since January 2016, with each month in a separate database table. In addition to the monthly travel time data, the RISPM also includes information on each highway link within the NPMRDS, or Traffic Messaging Channel links. Occasionally, the NPMRDS Analytics website posts updates to the TMC link descriptions, consisting of additions or deletions in the TMC links. When this happens, the RIDOT TMC consultant updates this within the RISPM.

5.1.2 *Rhode Island System Performance Measurement*

In addition to storing the NPMRDS travel time data, the RISPM database also stores information on work zones, specifically related to planned lane closures, inclement weather data as well as traffic count data.

The resident engineer and/or the contractor of each RIDOT construction contract is required to submit planned lane closure information related to work zones to the RIDOT Office of Public Information as well as to the RIDOT TMC. RIDOT TMC personnel logs the information contained in the planned lane closure forms into an Excel spreadsheet. This Excel document has macros that automatically store the information in the RISPM. Information collected includes the date, time, and duration of the planned lane closure and the number of lanes closed, among other details related to each construction contract. Data entry of the planned lane closure information for work zones occurs more or less daily, especially during the construction season, when all of the lane closure forms received at the RIDOT TMC are entered into the RISPM.

Monthly precipitation reports are downloaded from the National Climatological Data Center maintained by the NOAA. These reports are manually processed, and information is entered into the RISPM database on the days and hours in a month when precipitation exceed ¼" per hour.

The traffic count data housed within the RISPM is restricted to those radar vehicle detectors managed by the RIDOT TMC. Data from these detectors is collected by the DataCollector server software at the TMC. The RISPM is configured to automatically extract the data from the DataCollector database on a daily basis for the sole purpose of processing the data in a format that can be uploaded to RIDOT's Traffic Database Management System (TDMS) hosted by Midwestern Software Solutions, LLC (MS2). All the traffic data collected by RIDOT is hosted by MS2 in the cloud on RIDOT's TDMS.

5.1.3 RhodeWAYS

The RhodeWAYS database is the central storage of information related to all the traffic incidents processed by the RIDOT TMC. Detailed information is collected for each incident by the operators, including the time when the incident was reported and confirmed, the time when any lanes blocked by the incident were cleared, and finally when the incident responders cleared the incident and left the scene. The manual data entry of incidents occurs on a continual basis as and when an incident occurs. Currently, the incident data collection is primarily on major highways within the Providence Metro Region and includes all Interstates as well as Route 4, Route 6, Route 10, Route 37, and Route 146. In the future other State roads will be added to the RhodeWAYS database for collecting incident data; this is expected to expand the above list of major highways identified for performance monitoring related to incident management.

5.1.4 INRIX

The RIDSP currently procures travel time data collected by INRIX, a private information provider, which is available through the Probe Data Analytics Suite by the Regional Integrated Transportation Information System and is managed by the University of Maryland CATT laboratory. The PDA Suite not only provides access to the raw travel time data, similar to the NPMRDS Analytics portal, but also provides access to tools to conduct a variety of analyses, including identifying bottlenecks, creating heat maps of variations in congestion over time for specific highway segments, and generating a variety of analysis profiles (speed, travel time, reliability) for specific highway segments.

5.1.5 Rhode Island Public Transportation Authority

RIPTA collects data on transit performance and ridership using automated vehicle locator systems and automated passenger counters. Data is collected for individual trips at the level of the route segment (between two timepoints) and the overall route. These data include scheduled and actual run times, boardings and alightings, and passenger load between timepoints. RIPTA computes secondary measures from these primary measures, including average velocity, average load and load factor, overcrowding, schedule deviation, and on-time performance.

5.1.6 Rhode Island Geographic Information System

The RIGIS is an online portal that provides access to a variety of data for the State. It also provides access to several tools to generate maps and process information.

The RIGIS has information related to all modes of transportation organized as follows:

- Roads within the State.
- All transit routes, including ferries.
- Airports.
- Bicycle facilities.
- Traffic data in terms of average daily traffic.

5.1.7 *Others*

American Community Survey

The U.S. Bureau of Census publishes the ACS once every year for five-year periods based on data collected at a sample of households (about 3.5 million). The information is used to provide updated information regarding commuter habits, including mode share.

RIDOT Office of Transit, New Starts and Transportation Alternatives

This office at RIDOT obtains commuter rail ridership data from the MBTA and collects ridership and performance information on the Providence-Newport Ferry.

Rhode Island E-Permitting Portal

This is a statewide initiative to provide a web-based portal to both State and local agencies to review permit applications, manage inspections and review electronic plans. This portal can be used to obtain information to help understand the nature of land development in the State and relate it to transportation and congestion issues in the State.

5.2 Data Needs

Table 5.1 identifies needs for new or enhanced data to support the full range of performance measures that Rhode Island has identified for this CMP.

Table 5.1 Additional Data Needs for Congestion Management Performance Measures

CMP Objectives	CMP Performance Measures	Data Needs
Improve Reliability of the Transportation System	A.1 Interstate Reliability: Percent of person-miles traveled on the Interstate that are reliable.	None.
	A.2 Non-Interstate NHS Reliability: Percent of person-miles traveled on the non-Interstate NHS that are reliable.	None.
	A.3 CMP Network Reliability: Percent of person-miles traveled on the CMP network that are reliable.	None.
	A.4 Reliability during Inclement Weather: Percent of person-miles traveled on the CMP network that are reliable during days with inclement weather.	None.
	A.5 Reliability through Work Zones: Percent of person-miles traveled on the CMP network that are reliable on days and highways with work zones.	Accurate work zone limits using latitude/longitude.
	A.6 RIPTA Bus Reliability: Reliability of travel on RIPTA buses.	Expand APC data collection to achieve more complete route coverage.
	A.7 Incident Clearance Time: Average incident clearance time on major highways in the Providence region.	Continue to expand coverage of incident data collection.
	A.8 Incident Rate: Number of incidents per million VMT on major highways in the Providence region.	Continue to expand coverage of incident data collection.

CMP Objectives	CMP Performance Measures	Data Needs
Reduce Recurring Congestion	B.1 Peak-Hour Excessive Delay: Annual hours of peak hour excessive delay per capita.	None.
	B.2 PHED on CMP Network: Annual hours of peak hour excessive delay per capita on the CMP network.	None.
	B.3 PHED during Inclement Weather: Annual hours of peak hour excessive delay per capita on the CMP network during days with inclement weather.	None.
	B.4 PHED through Work Zones: Annual hours of peak hour excessive delay per capita on the CMP network on days and highways with work zones.	Accurate work zone limits using latitude/longitude.
	B.5 Number of Bottlenecks: Number of bottlenecks on the CMP network with an average queue length of greater than 0.25 miles and average duration of greater than 45 minutes.	None.
	B.6 Total Delay at Bottlenecks: Sum of the total delay at bottlenecks (as defined by CATT Lab) on the CMP network with an average queue length of greater than 0.25 miles and average duration of greater than 45 minutes.	None.
	B.7 Transit Vehicle Load Factor.	Expand APC data collection to achieve more complete route coverage.
	B.8 Passenger-Hours of Delay on RIPTA Buses.	Expand APC data collection to achieve more complete route coverage.
Improve Freight and Goods Movement	C.1 Truck Reliability on Interstates: Truck travel time reliability on interstates in the State of Rhode Island.	None.
	C.2 Travel Time Reliability on Freight Corridors: Travel time reliability on the primary freight corridor highways on the CMP network.	None.
	C.3 Number of Freight Bottlenecks: Number of bottlenecks on freight corridors within the CMP network.	None
	C.4 Truck Congestion Cost: Truck congestion cost on the freight corridors within the CMP network.	None.
Increase Modal Choice and Competitiveness	D.1 Bike Path Mileage: Mileage of bike paths in the State.	None.
	D.2 Bike Path Usage: Average bike path utilization. [Future Measure]	Develop a network of short-term and permanent bike traffic counting stations to systematically track usage over time and space.
	D.3 HOV/Bus Lane Miles: Mileage of HOV and dedicated bus lanes.	None.
	D.4 Percent of non-SOV Travel: Percent of travel in nonsingle occupancy modes.	None.
	D.5 Commuter Rail Ridership: Annual commuter rail ridership.	None.
	D.6 RIPTA Bus Ridership: Annual RIPTA bus ridership.	None.
	D.7 Providence/Newport Ferry Ridership: Annual Providence/Newport ferry ridership.	None.

CMP Objectives	CMP Performance Measures	Data Needs
Improve Intermodal Connectivity	E.1 Percent Population with Transit Access: Percent of population with access to transit.	None.
	E.2 Percent Jobs with Transit Access: Percent of jobs with access to transit.	Update employment estimates at least every 10 years.
	E.3 Bike System Connectivity: Ratio of connected bike path miles to total bike path mileage.	None.
Promote and Invest in Innovative Congestion Management Technologies	F.1 Number of Intersections with Remote Monitoring Capability: Number of signalized intersections with remote agency monitoring and control functionality.	Need data from City of Providence
	F.2 Number of Intersections with Advanced Signal Control: Number of signalized intersections that automatically adjust signal timings in response to fully actuated detection and/or adaptive algorithm.	Need data from local jurisdictions.
	F.3 Number of Real-time Travel Time Signs per Route Mile: Number of real-time travel time signs (hybrid guide signs) per mile of routes covered by the real-time travel time system.	None.
	F.4 Number of RIPTA Bus Routes with Transit Priority Treatment: Number of RIPTA bus routes with transit priority treatment.	None.
Promote Land Development and Infill Development/ Redevelopment in Transportation-Efficient Locations	G.1 Percent of Permits in Transit Propensity Areas: Percent of permits in transit propensity areas. [Future Measure]	Need data on all permit applications.
	G.2 Transportation Funds Invested in Transit Propensity Areas: Percent of transportation funds invested in transit propensity areas.	TBD.
Reduce Emissions and Improve Air Quality	H.1 Total VMT per Capita.	None.
	H.2 Emissions Reductions by CMAQ Projects. [Future Measure]	TBD.
	H.3 Regional Air Quality Attainment Status.	None.
	H.3 GHG Emissions. [Future Measure]	TBD.

5.3 Performance Monitoring

In order for the Congestion Management Process to maintain quality, up to date data for the performance measures, monitoring standards and protocols must be established. This section provides an overview of agencies responsible for monitoring data and performance as well as recommendations.

5.3.1 *Current Monitoring Activities*

Current ongoing or proposed performance monitoring activities include the following:

- **Rhode Island's TSMO Performance Measurement Plan and Work Program** provides formalized recommendations on data collection/use, workflows, and resource needs associated with a RIDOT and RIDSP TSMO Performance Measurement Program.[6] The work program includes a list of 41 measures.

[6] RIDOT and RI Department of Administration, Division of Statewide Planning. Rhode Island's TSMO Performance Measurement Plan and Work Program. prepared by Jacobs and TrafInfo Communications, January 2020.

These are classified as 1) *required* performance measures—those needed to comply with Federal and/or State requirements or policies; 2) *recommended* measures that are essential components of the program and for which data is readily available; and 3) *optional* measures which are currently more challenging or impossible to compute from available data. A reporting frequency ranging of monthly, quarterly, biannually, or annually is specified for each measure. Responsibility also is specified (RIDOT TMC, RIDOT Office of Safety, RIDOT Office of Transit, RIPTA, or RIDSP). A number of these measures also are included in the proposed CMP performance measures list. Tables in the work program provide detailed descriptions of how each measure will be calculated; this CMP report uses the same format to describe CMP measure calculations and data issues. As the work program has just been finalized at the time of this writing, the monitoring program has not yet been implemented.

- **The RIDOT Office of Performance Management** has established over 400 performance measurement indicators that cover all Department Sections to aid in making good business decisions, address safety programs, and Federal requirements. These measures are reported quarterly to the Governor. As part of the TSMO performance measurement plan development, this list was reviewed for overlap with potential TSMO measures and categorized as being process, input, output, or outcome measures.[7] The list was also reviewed for CMP overlap as part of CMP plan development. Overlap mainly includes rail and RIPTA ridership (2.4.7, 2.4.8) and some of the systemwide travel time/reliability measures.

5.3.2 *Recommended Monitoring Plan*

Monitoring and Evaluation

Evaluation of projects after they are implemented is often a neglected step. However, it is an essential step in the CMP process. The Final Rule on Metropolitan Transportation Planning calls for “a coordinated program for data collection and system performance monitoring to assess the extent of congestion, to contribute to determining the causes of congestion, and *evaluate the efficiency and effectiveness of implemented actions*.” (FHWA, 2008) The purpose of this step is to ensure that implemented strategies are having the desired effect on congestion and to inform the selection and prioritization of future strategies. This could include modifying the expected congestion impacts of strategies or eliminating a strategy from future consideration if it is ineffective in addressing congestion.

The first step in performance monitoring is simply to track the status of proposed projects, including whether and when they have been implemented (opened to the public or service initiated), and any changes to the projects as initially recommended in the CMP.

Once the status of proposed projects is known, two general approaches are used for evaluating the *effectiveness* of these projects, in conjunction with other conditions and actions:

- **System-Level Performance Evaluation—**A statewide analysis of historical trends to identify improvement or degradation in system performance in the State as a whole.

- **Project or Strategy Effectiveness Evaluation—**An analysis of before and after conditions for a specific congestion mitigation project or program.

[7] Jacobs. Development of a TSM&O Performance Measurement Plan and Work Program for RIDOT and RISPP: Task 2 Memo: September 2017.

It is recommended that both evaluation types be used in Rhode Island. System level performance should be monitored through data collected as part of the CMP Performance Monitoring Plan, in order to evaluate system operations on a statewide basis and identify changes in congestion levels from the previous reporting period. System level monitoring will provide feedback on the systemwide effectiveness of implemented congestion mitigation strategies and projects.

Project or strategy effectiveness evaluations should be conducted through an analysis of before and after conditions for specific implemented congestion mitigation projects and programs. For major investments, a follow-up evaluation should be conducted three years after project completion, and results should be reported in terms of applicable CMP performance measures (not all applicable measures will be relevant to individual projects). For other investment types, before and after analysis should be conducted on an as-needed basis, or as funding and resources allow.

Examples of project-level performance measures that align with system-level measures are shown in Table 5.2. Not all of these measures may need to be tracked; the nature and objectives of the project may only be relevant to some measures. Also, some measures may be tracked for the corridor in which the project operates, not just the facility or service that is affected—for example, for a rail service improvement or new bike path, highway congestion on the parallel highway corridor might also be tracked.

Table 5.2 Sample Project-level Performance Measures Corresponding to Statewide Measures

Objective	Statewide CMP Performance Measure	Sample Project Evaluation Performance Measure
A. Improve Reliability of the Transportation System	A.1 Interstate Reliability	Travel reliability on affected highway segment/corridor
	A.2 Non-Interstate Reliability	
	A.3 CMP Network Reliability	
	A.4 Reliability During Inclement Weather on CMP Network	
	A.5 Reliability Through Work Zones on CMP Network	
	A.6 RIPTA Bus Reliability (ratio of 80th to 50th percentile times)	Reliability on bus routes using affected segment/corridor
	A.7 Average Incident Clearance Time (minutes)	Average incident rate on affected segment/corridor
	A.8 Average Incident Rate (incidents/million VMT)	
B. Reduce Recurring Congestion	B.1 Peak Hour Excessive Delay (hours)	PHED on affected segment/corridor
	B.2 PHED on CMP Network on CMP Network (hours)	
	B.3 PHED During Inclement Weather on CMP Network (hours)	
	B.4 PHED Through Work Zones on CMP Network (hours)	
	B.5 Number of Bottlenecks	Number of bottlenecks on affected segment/corridor
	B.6 Total Delay at Bottlenecks (millions of hours)	Total delay on affected segment/corridor
	B.7 Transit Vehicle Load Factor (% of passenger-hours at load factor >1)	Transit vehicle load factor on affected segment/corridor
	B.8 Passenger-Hours of Delay on RIPTA Buses	Passenger-hours of delay on routes using affected segment/corridor

Objective	Statewide CMP Performance Measure	Sample Project Evaluation Performance Measure
C. Improve Freight and Goods Movement	C.1 Truck Reliability on Interstates	Truck reliability on affected segment/corridor
	C.2 Truck Reliability on Freight Corridors	
	C.3 Number of Freight Bottlenecks	Number of freight bottlenecks on affected segment/corridor
	C.4 Truck Congestion Costs	Truck congestion costs on affected segment/corridor
D. Increase Modal Choice and Competitiveness	D.1 Bike Path Mileage	Miles of bike path included in project
	D.2 Bike Path Usage [Future Measure]	Bike usage on affected project/ corridor
	D.3 HOV/Dedicated Bus-Lane Route Miles	Miles of HOV/dedicated bus lane added
	D.4 Percent of Non-SOV Travel	Percent of travelers in segment/corridor who are not an automobile driver
	D.5 Commuter Rail Ridership	Commuter rail ridership in affected corridor
	D.6 RIPTA Bus Ridership	Bus ridership on routes using affected segment or in corridor
	D.7 Providence/Newport Ferry ridership	NA
E. Improve Intermodal Connectivity	E.1 Percent of Population with Transit Access	Change in number of people with access to high-frequency transit
	E.2 Percent of Jobs with Transit Access	Change in number of jobs with access to high-frequency transit
	E.2 Bike System Connectivity	Number of new bike network connections created
F. Promote and Invest in Innovative Congestion Management Technologies	F.1 Number of Intersections with Advanced Traffic Control	Number of intersections where advanced traffic control is introduced
	F.2 Number of Intersections with Remote Monitoring	Number of intersections where remote monitoring is introduced
	F.3 Number of Real-time Travel Time Signs Per Route Mile	Number of real-time travel time signs added
	F.4 Number of RIPTA Bus Routes with Transit Priority Treatment	Whether project includes priority treatment for buses
G. Promote Land Development and Infill Development/ Redevelopment in Transportation-Efficient Locations	G.1 Percent of Permits in Transit Propensity Areas [Future Measure]	NA
	G.2 Transportation Funds Invested in Transit Propensity Areas	Whether project is located in a transit propensity area
H. Reduce Emissions and Improve Air Quality	H.1 Total Vehicle-Miles of Travel Per Capita	Change in VMT on affected segment/corridor
	H.2 Emission Reductions by CMAQ Projects [Future Measure]	Change in air pollutant emissions caused by changes in traffic before and after project
	H.3 Counties in Air Quality Attainment	NA
	H.4 GHG Emissions [Future Measure]	Change in GHG emissions caused by changes in traffic before and after project

Congestion Performance Monitoring Report

To support monitoring activities, RIDSP should prepare a report annually that presents data on each of the identified CMP performance measures. The report should include:

- An inventory of the status of congestion mitigation projects proposed in the CMP, as well as any other projects undertaken that might have had significant congestion impacts.
- A cumulative review of performance by year over time for each CMP measure, so that progress can be tracked starting from the year in which monitoring began.
- Observations on any significant trends and a discussion of factors that may have led to those trends, including actions to implement congestion management strategies, as well as external factors such as growth in traffic or population, severe weather conditions, etc. that may have influenced congestion during the latest year.
- Identification of any changes in data sources or computational methods that may have influenced each measure.
- Potential responses to trends—e.g., if congestion is increasing rapidly in a particular corridor, should efforts be made above and beyond existing plans to address the congestion?
- Review of the trends in relation to 5- and 10-year targets. RIDSP is undertaking an effort to establish targets for most of the CMP performance measures. When these targets become available, they should be reviewed to determine if additional responses to manage congestion are needed.

The performance measure descriptions (Appendix A) identify the agency or agencies responsible for tracking each performance measure. It will be RDSP's responsibility to collect data on each measure from the responsible agency.

CMP Updates

In conjunction with LRTP updates, RIDSP should update the Congestion Management Process, including any changes to performance measures, data sources, or monitoring and reporting methods that may be warranted based on lessons learned as experience is gained with the program. CMP updates may also include updates to the congestion management network.

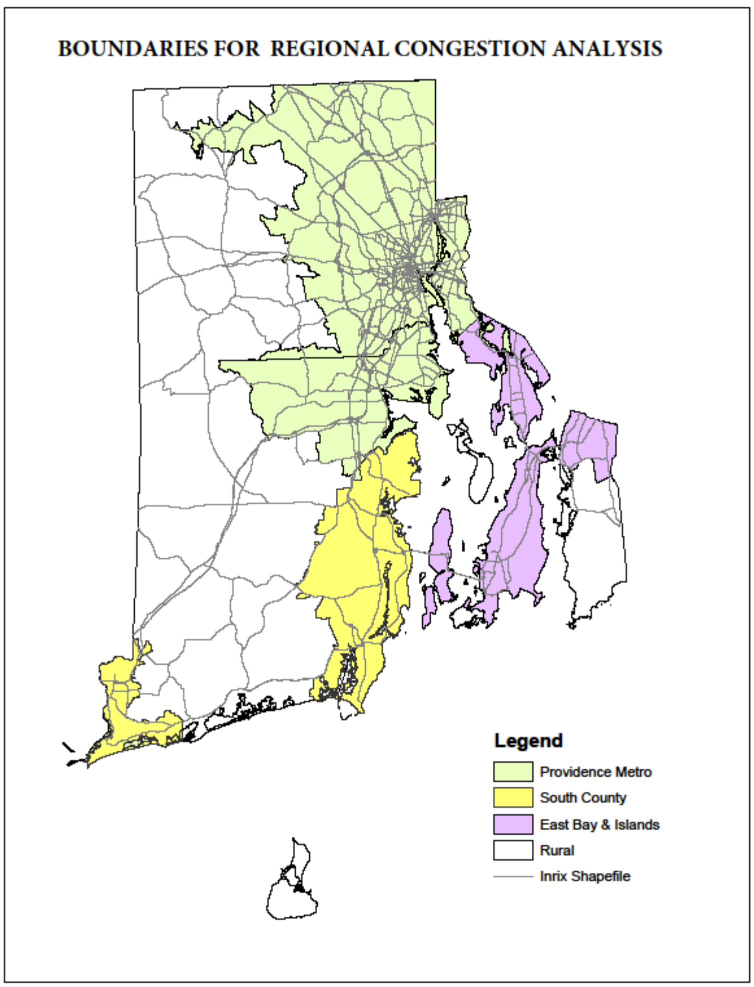
6.0 Congestion in Rhode Island Today

An analysis of regional congestion in Rhode Island was performed by dividing the State into the following four regions:

1. Providence Metro.
2. South County.
3. East Bay and Aquidneck Island.
4. Rural.

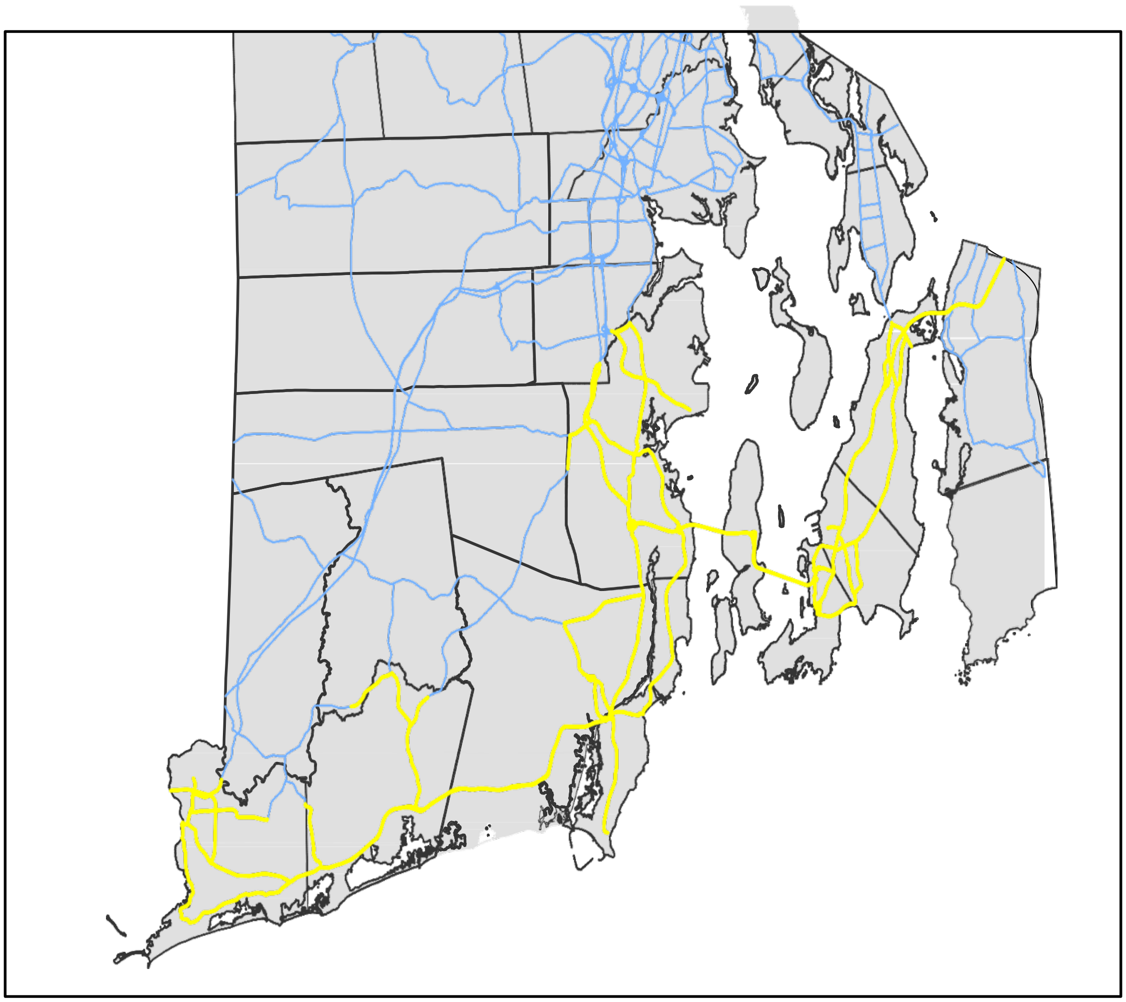
The Providence Metro region comprises of the urban area within Providence and Kent counties. The South County region includes the urban area within Washington County. The East Bay region includes the urban area within Bristol County, and Aquidneck Island includes the urban area within Newport County. The Rural region encompasses the area outside of the urban boundary within the State. The boundaries of the regions are shown in Figure 6.1.

Figure 6.1 Regional Analysis Boundaries



The above regions were identified after several iterations of regional analyses and discussions with the CMP Working Group. An additional fifth region was identified as Recreational/Beach Areas as shown in Figure 6.2. This includes highways on the CMP network within the towns of Westerly, Charlestown, South Kingstown, North Kingstown, Narragansett, Jamestown, Newport, Middletown, Portsmouth and Tiverton.

Figure 6.2 Highways Identified Within Recreational/ Beach Areas



Travel time data from INRIX for 2018 that is available through the Probe Data Analytics portal managed by the CATT Lab of the University of Maryland was utilized for the regional congestion analysis. This data is available for each 5-minute interval of each day for all highway links covering nearly the entire CMP network as discussed previously. Each highway link is represented as a Traffic Message Channel link. Each 5-minute travel time for each TMC link was processed to determine the average travel time for each 5-minute period for each of the 12 months in 2018. The average 5-minute travel time data was converted into average speed based on the length of each TMC link. The reference speed or posted speed limit also is available for each TMC link. Any 5-minute interval on any TMC link with an average speed less than 60 percent of the posted speed limit was considered to be congested. This threshold of congestion as 60 percent of the posted speed limit was established based on discussions with the CMP Working Group and is consistent with FHWA's NPRM to identify excessive delay for the PM3 system performance measures. The percent of congested TMC links, in terms of length, versus the total TMC link length for the entire State was computed for each hour of an average day for each month. The percent congested links for each month was averaged to obtain the percent congestion for each hour of a 24-hour period for the year 2018. Table 6.1 presents the information for an average weekday in 2018 for each of the five regions listed above. Given that the Providence Metro region covers a large area, it was deemed important to extract the analysis results specifically for the City of Providence. Table 6.1 also presents information specific to the City of Providence in addition to the Providence metro region. Table 6.1 also presents the same information for an average weekend in 2018.

The weekday analysis presented in Table 6.1 shows that the Providence Metro region is the most congested with roughly 10 percent of all highways within the CMP network congested during a typical morning peak hour and 17 percent of all highways congested during a typical evening peak hour. If one were to consider the City of Providence alone, then the level of congestion is around 26 percent during the morning peak hour and 46 percent during the evening peak hour. In the East Bay and Aquidneck Island region, 5 percent of the highways are congested during the morning peak hour and 9 percent during the evening peak hour. The peak hour may vary by region; for the East Bay and Aquidneck Island region the evening peak hour is 4 to 5 p.m. while the evening peak hour for the Providence Metro region is 5 to 6 p.m. In general, there is little congestion within the South County and Rural regions.

As expected, the level of congestion in general was much lower on an average weekend than on an average weekday. While there may be certain pockets of congestion during weekends, especially during the summer months, the level of congestion for the region is less than 5 percent. Even Recreational/Beach Areas had higher levels of congestion during an average weekday than during an average weekend.

Table 6.1 INRIX Travel Time Data

Percent Length of Highways Under Congestion[1] by Area Type—2018 (Weekdays)

		Time of Day																							
Region[2]	Length[3]	12 a.m.	1 a.m.	2 a.m.	3 a.m.	4 a.m.	5 a.m.	6 a.m.	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	12 p.m.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.	8 p.m.	9 p.m.	10 p.m.	11 p.m.
Providence Metro	471.2	0%	1%	1%	1%	1%	1%	1%	4%	10%	3%	2%	3%	4%	4%	8%	13%	15%	17%	6%	1%	1%	1%	0%	0%
Providence City[4]	90.3	1%	2%	2%	2%	2%	2%	2%	10%	26%	9%	7%	8%	12%	14%	22%	39%	45%	46%	20%	5%	3%	2%	2%	2%
East Bay and Islands	49.2	1%	1%	2%	1%	1%	1%	1%	2%	5%	3%	3%	4%	5%	4%	4%	8%	9%	7%	2%	1%	1%	1%	1%	1%
South County	94.7	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%	1%	0%	0%
Rural Areas	197.3	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Beach Areas	154.8	1%	1%	1%	1%	1%	0%	1%	1%	3%	2%	2%	2%	3%	3%	3%	5%	5%	4%	2%	1%	1%	1%	1%	1%

Percent Length of Highways Under Congestion[1] by Area Type—2018 (Weekends)

		Time of Day																							
Region[2]	Length[3]	12 a.m.	1 a.m.	2 a.m.	3 a.m.	4 a.m.	5 a.m.	6 a.m.	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	12 p.m.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.	8 p.m.	9 p.m.	10 p.m.	11 p.m.
Providence Metro	471.2	0%	0%	1%	0%	0%	1%	1%	0%	0%	1%	2%	3%	4%	4%	4%	3%	3%	2%	2%	1%	1%	1%	0%	0%
Providence City[4]	90.3	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%	2%	2%	2%	2%	1%	1%	1%	1%	0%	0%	0%	0%	0%
East Bay and Islands	49.2	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%	1%
South County	94.7	0%	1%	1%	1%	0%	0%	0%	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	1%
Rural Areas	197.3	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Beach Areas	154.8	1%	1%	1%	1%	1%	0%	0%	1%	1%	1%	2%	2%	3%	3%	2%	2%	2%	1%	1%	1%	1%	1%	1%	1%

1 "Under congestion" is when the average speed on a highway link is below 60 percent of the reference speed (speed under low volume conditions).

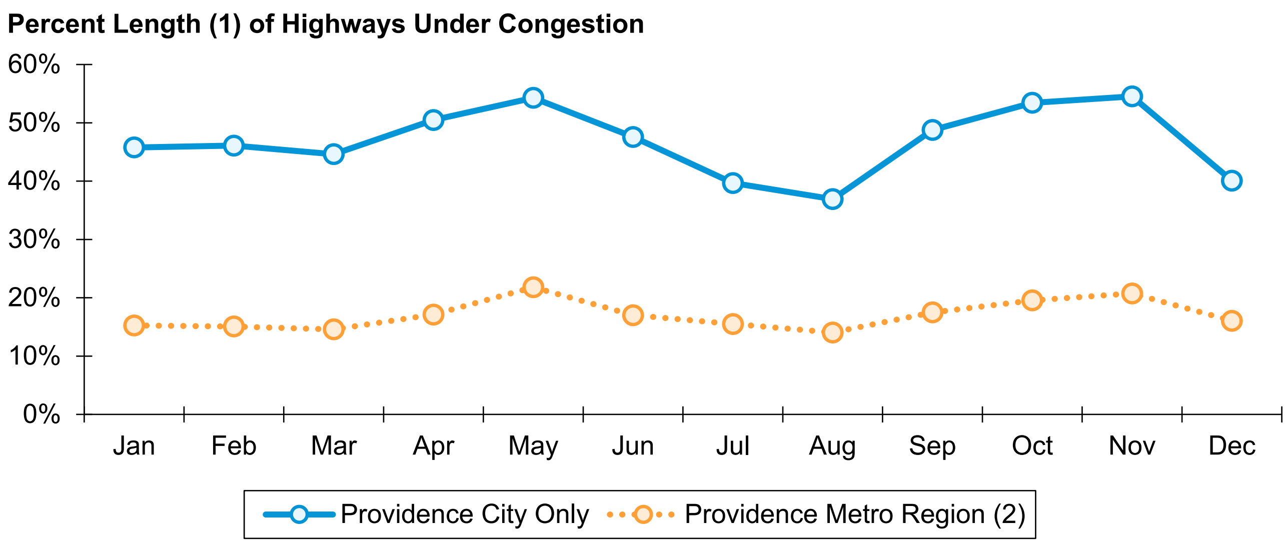
2 See map showing region boundaries:
Providence Metro: Urban areas within Providence and Kent Counties.
East Bay and Islands: Urban areas within Bristol and Newport Counties.
South Bay: Urban areas within Washington County.

3 "Length" is the centerline miles in both directions for major arterials and roads as defined by INRIX (it does not include local roads).

4 Providence City includes the area within Providence Metro that is within the City of Providence.

Figure 6.3 presents the monthly variation in congestion for both the Providence Metro region as well as the City of Providence. The average congestion levels among all highways within the Providence Metro region varies between 15 and 20 percent through the year. The level of congestion within the City of Providence is higher, varying between 35 and 55 percent of highways identified as congested. The higher levels of congestion appear to be in spring and fall while the congestion during the summer months appears to be lower. This may be related to schools and colleges and universities being open during spring and fall.

Figure 6.3 Monthly Variation in Highway Congestion in 2018

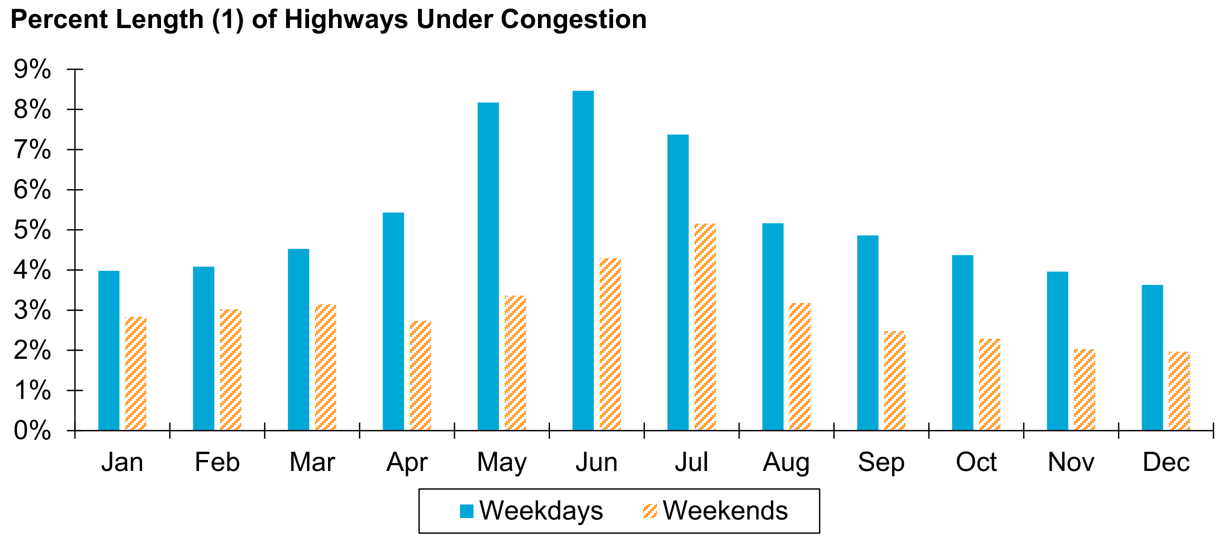


(1) Length is the centerline miles of major arterials and highways in both directions (no local roads).

(2) Providence Metro includes urban areas within Providence and Kent Counties.

Figure 6.4 presents the monthly variation of congestion within the Recreational/Beach Areas. The chart clearly indicates higher levels of congestion during the summer months. It is interesting to note that even during the summer months, the average congestion is higher on weekdays than on weekends.

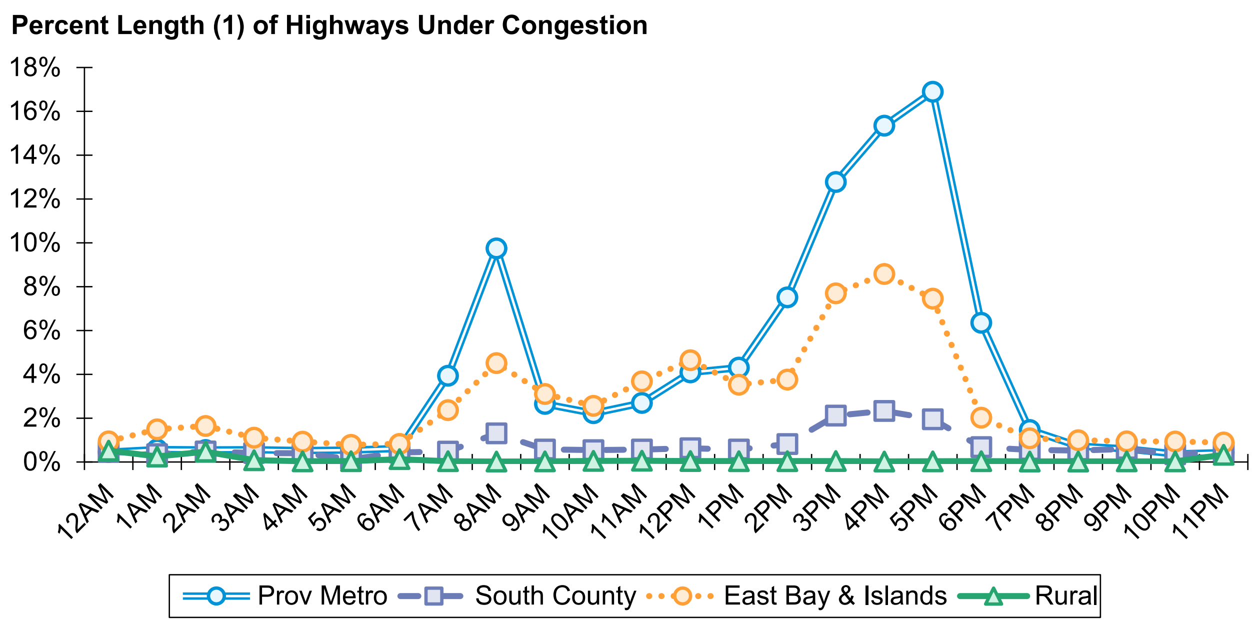
Figure 6.4 Monthly Variation in Congestion in Recreational/Beach Areas in 2018



(1) Length is centerline miles of major arterials and highways in both directions (no local roads).

An analysis was also conducted to better understand the temporal variations of congestion within the various regions. Figure 6.5 shows the variation in congestion during an average 24-hour period in 2018.

Figure 6.5 Hourly Variation in Congestion in 2018



(1) Length is centerline miles of major arterials and highways in both directions (no local roads).

The hourly profile of congestion is typical with peak levels of congestion during the morning and evening periods. Both the Providence Metro region and the East Bay and Aquidneck Island region also show relatively small increases in congestion levels during the midday period.

6.1 Bottlenecks

An analysis was conducted in order to identify the top 30 bottleneck locations in Rhode Island on the CMP network for which detailed congestion management strategies will be developed. The Bottleneck Ranking tool on the UMD CATT Lab RITIS PDA Suite was used to identify and rank bottlenecks and determine which ones have the greatest impact. The PDA Suite defines bottlenecks as locations on the roadway where conditions have fallen below a certain percent of the reference speed for an extended period. The temporal and geospatial extent of bottlenecks can be used to determine which locations are particularly troublesome for the traveling public.

The UMD CATT Lab defines a bottleneck as an occurrence when the prevailing travel speed drops below a threshold speed of 60 percent of the posted speed limit. Each such individual occurrence is aggregated to determine bottlenecks. Several metrics are computed for each bottleneck, including base impact (sum of queue lengths over a duration) and total delay (base impact weighted by the speed differential between free flow and observed speed and the average daily traffic). After discussion with the CMP WG, a threshold was set to identify bottlenecks that indicate recurring congestion for the purposes of identifying bottlenecks to manage congestion. Bottlenecks that only occurred occasionally due to an incident, work zone, or special event needed to be discarded.

The following threshold criteria was adopted by the CMP Working Group to identify bottlenecks:

- All bottlenecks having at least ¼ mile of average queue length.
- All bottlenecks having at least 45 minutes of average daily duration.

Next, the bottlenecks from the PDA Suite that met these criteria were ranked by total delay. Since the total delay by the CATT Lab utilized an estimated ADT, the ADT numbers were checked against information on the RIDOT MS2 portal as some of the ADTs in the PDA Suite did not match with RIDOT estimated ADTs. A factor was applied to the total delay for each bottleneck based on the relative change in the ADT, and the bottlenecks were ranked again. This resulted in a list of top 30 bottlenecks that are on roadways of different functional classifications, including Interstates and arterials and some arterials with traffic signals.

The Performance Charts tool on the PDA suite was used to obtain the AM and PM peak-hour travel times in minutes through each bottleneck. In addition, each bottleneck was assessed to determine if it was on a RIPTA bus route and if so, the route number(s) were noted. The bottlenecks were also characterized if they were on the State’s primary freight corridor network. The top 30 bottlenecks that resulted from this analysis are presented in Table 6.2. The maps of each bottleneck are included in Appendix B.

Table 6.2 Top 30 Bottlenecks in 2018

Rank	Map	Bottleneck Location[1]	Freight Corridor	RIPTA Bus Routes	Average Max Length[2]	Average Daily Duration[3]	Base Impact[4]	Speed Differential[5]	Congestion[6]	Total Delay[7]	Peak Hour Travel Speed Through Bottleneck (mph)		Peak Hour Travel Times Through Bottleneck (min)	
											AM	PM	AM	PM
1	1	I-95 S @ RI-7/RI-146/ Charles St/Exit 23	Yes	1	2.29	3 h 43 m	175,690	5,670,083	274,885	344,087,155	24.3	20.4	5.7	6.7
2	2	I-95 N @ U.S. 1 ALT/Thurbers Ave/ Exit 18	Yes	8, 12, 14, 65, 66, 95	2.24	2 h 4 m	98,866	3,316,662	155,672	203,780,340	31.0	26.4	4.3	5.1
3	3	I-95 N @ U.S. 6/RI-10/Exit 22	Yes	54, 59	1.69	2 h 20 m	79,293	2,466,408	127,527	200,107,335	44.8	22.9	2.3	4.4
4	4	I-195 W @ I-95	Yes	NA	2.52	46 m	45,086	1,666,027	112,662	149,979,906	23.2	20.3	6.5	7.4
5	3	RI-146 S @ I-95	Yes	54, 59	1.02	3 h 37 m	92,202	3,400,576	193,639	141,815,790	20.2	19.2	3.0	3.2
6	3	I-95 N @ RI-7/RI-146/ Charles St/Exit 23	Yes	54, 59	1.89	1 h 5 m	46,901	1,538,399	81,108	133,239,245	44.6	23.7	2.5	4.8
7	3	U.S. 6 E @ I-95	Yes	21, 30	0.67	4 h 41 m	62,666	1,984,146	127,994	124,485,384	21.5	14.7	1.9	2.7
8	2	I-95 N @ RI-10/ Exit 16	Yes	8, 12, 14, 62, 65, 66, 95	2.34	1 h 1 m	48,383	1,662,464	77,759	110,460,918	28.3	31.1	5.0	4.5
9	4	I-195 W @ Broadway/Exit 6	Yes	60	1.24	1 h 5 m	26,561	975,421	53,313	61,549,539	13.2	15.4	5.6	4.8
10	5	U.S. 1 S @ Airport Rd	Yes	1, 20	0.64	5 h 55 m	80,799	1,591,739	108,456	44,926,206	22.2	20.7	1.7	1.9
11	6	RT-103/RI-103 E @ RI-103/Main St	No	60, 61	1.12	3 h	67,055	868,574	89,131	33,167,171	16.6	12.3	4.0	5.5

Rank	Map	Bottleneck Location[1]	Freight Corridor	RIPTA Bus Routes	Average Max Length[2]	Average Daily Duration[3]	Base Impact[4]	Speed Differential[5]	Congestion[6]	Total Delay[7]	Peak Hour Travel Speed Through Bottleneck (mph)		Peak Hour Travel Times Through Bottleneck (min)	
											AM	PM	AM	PM
12	7	RI-146 N @ Sayles Hill Rd	Yes	54, 59	0.38	6 h	52,347	1,526,886	93,950	32,964,019	30.4	15.4	0.8	1.5
13	4	I-195 W @ U.S. 44/ 4th St/Taunton Ave/ Exit 4	Yes	60	0.92	1 h 22 m	11,373	416,399	26,129	31,643,898	23.6	19.1	2.3	2.9
14	6	RI-114 N @ RI-103/Baker St/Child St	No	60, 61	0.63	5 h 13 m	62,980	807,962	86,751	30,068,830	15.4	10.7	2.5	3.5
15	8	RI-4 S @ W Allenton Rd	Yes	14, 65	1.7	1 h 14 m	46,755	1,542,316	72,818	29,950,655	36.5	40.9	2.8	2.5
16	5	RI-2 S @ RI-117/ Centerville Rd	No	NA	0.92	2 h 43 m	44,581	664,777	56,784	29,612,639	NA	19.7	NA	2.8
17	5	U.S. 1 N @ RI-117/Greenwich Ave/Centerville Rd	No	14	1.09	1 h 35 m	35,114	621,045	52,735	28,804,810	26.1	14.6	2.5	4.5
18	9	RI-15 W @ RI-7/ Douglas Ave	No	58	1.42	2 h 2 m	50,543	614,084	63,033	28,459,798	21.7	14.3	3.9	6.0
19	5	RI-4 N @ I-95	Yes	14, 62, 65, 66	0.58	48 m	11,095	423,104	22,723	25,335,445	43.6	38.4	0.8	0.9
20	9	RI-15 E @ RI-126/ Smithfield Ave	No	72, 73	1.53	1 h 8 m	35,157	395,661	46,701	24,142,860	17.1	13.2	5.4	7.0
21	10	U.S. 6 W @ Hartford Pike	Yes	NA	0.79	4 h 28 m	60,977	1,179,687	84,394	24,003,125	39.6	39.4	1.2	1.2
22	9	RI-15 E @ RI-7/ Douglas Ave	No	58	0.6	3 h 17 m	39,799	513,106	51,844	21,323,677	14.8	11.8	2.4	3.1
23	8	U.S. 1 S @ RI-4	No	14, 65	0.27	5 h 21 m	19,664	301,038	29,007	19,535,578	14.0	11.9	1.2	1.4
24	2	Eddy St S @ I-95/ Thurbers Ave	Yes	1, 3, 62	1.01	1 h 49 m	38,543	423,089	50,557	19,003,539	14.0	10.6	4.3	5.7

Rank	Map	Bottleneck Location[1]	Freight Corridor	RIPTA Bus Routes	Average Max Length[2]	Average Daily Duration[3]	Base Impact[4]	Speed Differential[5]	Congestion[6]	Total Delay[7]	Peak Hour Travel Speed Through Bottleneck (mph)		Peak Hour Travel Times Through Bottleneck (min)	
											AM	PM	AM	PM
25	9	RI-15 E @ RI-146/ Louisquisset Pike	No	NA	0.63	2 h 35 m	26,895	365,025	38,411	18,566,006	19.0	13.9	2.0	2.7
26	5	Ri-2 N @ Ri-115/Toll Gate Rd	No	NA	0.41	3 h 30 m	23,145	363,429	32,082	18,476,282	NA	18.1	NA	1.4
27	9	U.S. 44 W @ RI-5/ Sanderson Rd/ Cedar Swamp Rd	No	9	0.71	2 h 18 m	34,503	544,078	43,546	17,692,564	18.7	17.1	2.3	2.5
28	4	U.S. 44 W @ I-195	No	35, 78	0.76	1 h 27 m	23,686	375,498	43,757	17,363,185	11.6	13.8	3.9	3.3
29	7	RI-146 S @ Sayles Hill Rd	Yes	54, 49	0.98	1 h 4 m	21,567	601,923	34,621	17,074,328	28.1	34.0	2.1	1.7
30	11	I-295 N @ RI-37/ EXIT 3	Yes	NA	1.18	48 m	18,007	703,219	31,931	16,707,706	49.1	37.8	1.4	1.9

[1] Approximate location of the origin of the bottleneck (when observed speed goes below 60 percent of a reference or free flow speed).

[2] Average of the maximum queues formed during each occurrence of the bottleneck.

[3] Average of the duration of each occurrence of the bottleneck.

[4] Base Impact is the sum of the queue lengths over the duration of the bottleneck.

[5] Speed differential is base impact weighted by the difference between free-flow speed and observed speed.

[6] Congestion is base impact weighted by the measured speed as a percentage of free-flow speed.

[7] Total Delay is Base impact weighted by the difference between free-flow travel time and observed travel time multiplied by the average daily volume (ADT).

6.2 Freight Bottlenecks

As a starting point, the top 20 freight bottleneck locations were identified using the bottlenecks identified above and considering only those that were identified to be on the State's primary freight corridor network.

An analysis was then conducted to determine if any additional bottlenecks should be identified as freight bottlenecks even if they are not on the state's primary freight corridor network based on truck percentages in the State. Truck percentages from RIDOT continuous and short duration count stations were used for this analysis. This resulted in including the bottlenecks at the intersection of RI-114 at RI-103.

This analysis resulted in 18 of the bottlenecks identified above also being freight bottlenecks. In the freight bottleneck analysis, bottlenecks that occurred at the same intersection were combined to form one bottleneck. In order to complete the list of 20, two additional bottlenecks were added to the list. These bottlenecks were the next two in the ranking that were bottlenecks on the state's primary freight corridor network. The top 20 freight bottlenecks that resulted from this analysis are shown in Table 6.3. Per 23 CRF490.109 (f)(2), Table 6.3 includes the route and milepost of each bottleneck as well as the Highway Performance Monitoring System (HPMS) roadway section inventory data (annual average daily traffic (AADT), average annual daily truck traffic (AADTT), travel time data and measure of delay, and the capacity feature causing the bottleneck (geometric, weight grade, or other constraints affecting trucks).

Table 6.3 Top 20 Freight Bottlenecks in 2018

Rank	Map	Bottleneck Location[1]	HPMS Route ID[2]	Mile Point[3]	2018 AADT[4]	2018 AADTT[5]	HPMS F_System[6]	Route on STRATNET[7]	Truck Network	Total Delay[8]	Total Truck Delay[9]	Peak Hour Travel Times Through Bottleneck (min) AM	Peak Hour Travel Times Through Bottleneck (min) PM	Capacity Feature Causing the Bottleneck
1	1	I-95 S @ RI-7/ RI-146/ Charles St/ Exit 23	6500	5.195	146,356	5,825	Interstate	Yes	National Network	344,087,155	13,694,742	5.7	6.7	Lane striping is for Type B weave favoring Route 146 over I-95 SB. Traffic on I-95 SB has to do 1 lane change for Exit 22 and 2 for Route 6/10 which slows traffic on I-95 SB
2	2	I-95 N @ U.S. 1 ALT/Thurbers Ave/Exit 18	6400	35.094	161,154	9,825	Interstate	Yes	National Network	203,780,340	12,423,780	4.3	5.1	Probably a result of the horizontal curve just upstream of the ramp merge combined with downstream lane drop to I-195 EB
3	3	I-95 N @ U.S. 6/ RI-10/Exit 22	6400	37.73	178,936	7,539	Interstate	Yes	National Network	200,107,335	8,430,999	2.3	4.4	Heavy ramp traffic impacting the mainline with downstream lane drop to Route 146 NB
4	4	I-195 W @ I-95	6700	3.508	151,616	8,186	Interstate	Yes	National Network	149,979,906	8,097,665	6.5	7.4	Major system interchange consisting of on-ramps followed by on-ramp and downstream lane drop on I-95 NB; major ramp merge from I-195 following by lane drop to Thurbers Ave on I-95 SB
5	3	RI-146 S @ I-95	5110	15.847	67,658	3,260	Principal Arterial—Other Freeways and Expressways	No	National Network	141,815,790	6,833,183	3.0	3.2	Heavy ramp traffic merging onto mainline
6	3	I-95 N @ RI-7/RI-146/ Charles St/ Exit 23	6400	37.939	191,123	7,945	Interstate	Yes	National Network	133,239,245	5,538,767	2.5	4.8	Four-lane I-95 NB mainline drops to 3 lanes with exit only lane to Route 146 NB with upstream on-ramp from Exit 22

Rank	Map	Bottleneck Location[1]	HPMS Route ID[2]	Mile Point[3]	2018 AADT[4]	2018 AADTT[5]	HPMS F_System[6]	Route on STRATNET[7]	Truck Network	Total Delay[8]	Total Truck Delay[9]	Peak Hour Travel Times Through Bottleneck (min) AM	PM	Capacity Feature Causing the Bottleneck
7	3	U.S. 6 E @ I-95	600	21.316	84,999	3,360	Principal Arterial—Other Freeways and Expressways	No	State Truck Route	124,485,384	4,920,892	1.9	2.7	Major interchange; Ramp merges on the ramps resulting in upstream bottlenecks
8	2	I-95 N @ RI-10/ Exit 16	6400	33.32	174,916	7,345	Interstate	Yes	National Network	110,460,918	4,638,429	5.0	4.5	Heavy ramp traffic from Route 37 and from Jefferson Ave combined impacting the mainline
9	4	I-195 W @ Broadway/ Exit 6	6700	1.916	122,289	8,200	Interstate	Yes	National Network	61,549,539	4,127,160	5.6	4.8	Lane drop within Interchange
10	5	U.S. 1 S @ Airport Rd	100	44.274	28,281	718	Principal Arterial—Other	No	Not Applicable	44,926,206	1,140,590	1.7	1.9	Major signalized intersection
11	6	RI-114/Main St @ RI-103/ Child St	3700	16.58	17,339	428	Principal Arterial—Other	No	State Truck Route	33,167,171	818,706	2.5	3.5	Two closely spaced intersections along Rte. 114—one at Market St and the other at Route 103
12	7	RI-146 @ Sayles Hill Rd	5100	9.822	53,000	1,340	Principal Arterial—Other Freeways and Expressways	No	State Truck Route	32,964,019	833,430	0.8	1.5	Only signalized intersection on a limited access highway
13	4	I-195 W @ U.S. 44/4th St/ Taunton Ave/ Exit 4	6700	2.505	142,107	5,297	Interstate	Yes	National Network	31,643,898	1,179,518	2.3	2.9	Type C weave but favoring the ramp and not I-195 WB mainline. 3 lanes on I-195 WB opens up to 5 lanes on the bridge. Heavy ramp traffic merging onto I-195 WB that has an upstream horizontal curve
14	8	RI-4 S @ W Allenton Rd	410	9.318	53,539	2,400	Principal Arterial—Other Freeways and Expressways	No	State Truck Route	29,950,655	1,342,602	2.8	2.5	Signalized intersection

Rank	Map	Bottleneck Location[1]	HPMS Route ID[2]	Mile Point[3]	2018 AADT[4]	2018 AADTT[5]	HPMS F_System[6]	Route on STRATNET[7]	Truck Network	Total Delay[8]	Total Truck Delay[9]	Peak Hour Travel Times Through Bottleneck (min) AM	PM	Capacity Feature Causing the Bottleneck
15	5	RI-4 N @ I-95	400	9.77	76,167	5,600	Principal Arterial—Other Freeways and Expressways	No	State Truck Route	25,335,445	1,862,729	0.8	0.9	Two lanes on I-95 mainline merging with a 3 lane Rte. 4 ramp
16	10	U.S. 6 W @ Hartford Pike	600	10.087	10,566	737	Principal Arterial—Other	No	State Truck Route	24,003,125	1,674,267	1.2	1.2	Signals on U.S. 6 WB at Rte. 110 EB
17	2	Eddy St S @ I-95/ Thurbers Ave	141600	0.932	17,804	376	Principal Arterial—Other	No	Not Applicable	19,003,539	401,333	4.3	5.7	Major signalized intersection
18	11	I-295 N @ RI-37/Exit 3	6800	4.137	53,981	2,677	Interstate	Yes	National Network	16,707,706	828,561	1.4	1.9	Steep grade
19	12	U.S. 1 N @ RI-4	100	29.511	58718	2,200	Principal Arterial—Other Freeways and Expressways	No	State Truck Route	12,678,204	475,017	1.2	1.4	Major signalized intersection
20	13	I-295 S @ I-95	6900	23.483	22182	Not Available	Interstate	Yes	National Network	9,660,563	479,082	1.2	1.7	Two-lane I-295 SB ramp merges with I-95 mainline followed by 2 consecutive lane drops on I-95 S

1 Approximate location of the origin of the bottleneck (when observed speed goes below 60 percent of a reference or free flow speed).

2 Unique identifier assigned by RIDOT to the highway.

3 Location of the bottleneck in terms of linear distance along the route.

4 Annual average daily traffic (vehicles per day).

5 Annual average daily truck traffic (trucks per day).

6 Functional classification.

7 STRATNET—Strategic Highway Network.

8 Total Delay is Base impact weighted by the difference between free-flow travel time and observed travel time multiplied by the average daily volume (AADT).

9 Total Delay adjusted by the truck percentage.

6.3 Congested Highway Corridors

In addition to identifying the top 30 bottlenecks and the top 20 freight bottlenecks, the congestion analysis also is included the identification of the top 20 congested corridors in the State. The above discussion on bottlenecks identified isolated points (intersections or merge points) that are at the root of some of the recurring congestion experienced in the State. However, there are several highway segments throughout the State where traffic operating levels meet the congestion threshold that are not included as part of the top 30 bottlenecks. Furthermore, in some cases, there are highway segments that are comprised of several bottleneck locations. The congested corridors analysis is the identification of all highway segments throughout the State that meet the congestion threshold which are then grouped together to form corridors to allow development of congestion management strategies that would address the issues identified within the corridor as a whole. This avoids the need for a cumbersome process of identifying congestion management strategies of each individual bottleneck location.

The first step was to compute the average (50th percentile) travel time for each TMC segment for each hour of a typical day in 2018. There are about 4,900 TMC segments within the INRIX travel time coverage within Rhode Island. An average travel time was determined for each of 24 hours for each of the TMC links. This involved combining travel time data for each of the 12 months in 2018.

The PDA Suite provides a reference speed for each TMC link. This is typically a free-flow speed. Based on an initial review of the reference speed provided, it was determined that many of the reference speeds had to be adjusted as the free flow travel time was often greater than the average travel time. The reference speed for each TMC link was iteratively adjusted by modifying the speed so as to have a reference speed such that the free-flow travel time is always less than the average travel time.

Using the updated reference speed as discussed above, a threshold speed was established for each TMC link at 60 percent of the reference speed. As discussed previously, the CMP Working Group established 60 percent of the reference speed to be the threshold for congestion. Any TMC link with an average travel time during any hour resulting in an average speed lower than the threshold speed was identified to be congested. The delay during each hour was computed as the difference between the average travel time and the threshold travel time. If the delay computed was less than zero, the delay was set at zero.

Directional AADT was associated with each TMC link and hourly factors were used to determine the traffic volume for each hour on each TMC link. Based on the hourly volume and the delay, the vehicle hours of delay (VHD) was computed for each TMC link for each hour during a 24-hour period. Finally, the VHD for each TMC link was computed for the AM peak period (6 to 9 a.m.) and the PM peak period (3 to 6 p.m.). The VHD from the AM and PM peak periods were combined to obtain the total VHD for each TMC link. It is important to note that not all TMC links had a number for total VHD. Only those TMC links that were identified as being congested either during the AM peak or the PM peak period would have a number for the total VHD.

The next step was grouping TMC links into logical corridors. This was performed through iterations of two phases. The first phase was through automated processing of only the congested TMC links resulting in groupings of TMC links into corridors. This was subsequently reviewed manually to further group both congested and uncongested TMC links and identify congested corridors with a logical start and end point. Further details of each of these two phases are provided below.

In the first phase, the TMC links were automatically processed to identify if a congested TMC link had an adjacent TMC link in the same direction that was also congested. If so, the two TMC links were tagged to be in the same corridor. The total length and total VHD was then computed for each such congested corridor identified through this automated process, and the product of VHD and length computed for each corridor. This was used to rank the congested corridors. A total of approximately 1,200 congested corridors were initially identified.

The initial list of congested corridors was then manually reviewed within ArcGIS to determine if any two or more congested corridors located on the same highway (i.e., same route number) should be further combined into one. If two or more of the congested corridors were deemed appropriate to be combined, then all the TMC links within these congested corridors were assigned the same corridor identification. When corridors were combined, it resulted in changes in length and VHD. For this reason, the total length and total VHD were then recomputed for the updated corridor definitions and ranked. The newly ranked corridors were again reviewed manually to determine if additional congested corridors should be combined and the process was repeated iteratively. At the end of six such iterations, the final list of top 20 congested corridors was identified.

The last step was to identify a logical start and end point for each corridor so as to allow for a future project to be defined by RIDOA/RIDOT to address the congestion on the corridor. Table 6.4 shows the list of top 20 congested corridors as well as the end points. Congested corridors on limited access highways are in one direction only, while the others are in both directions. Like the bottlenecks, each congested corridor is identified with the RIPTA bus routes on those corridors and if the corridor is on the State's primary freight network. Using the PDA suite, the travel times during the AM and PM peak hours are shown for each corridor along with functional classification and ADT. "Delay" is defined as the time spent traveling below 60 percent of reference (free flow) speed. Peak hours are defined as 6 to 10 a.m. and 3 to 7 p.m. Person-hours of delay is computed by multiplying delay by the number of vehicles by the average 1.7 occupancy factor for Rhode Island.

Maps of the congested corridors are included in Appendix C.

Table 6.4 Top 20 Congested Corridors

Rank	Corridor From—To	Functional Classification	Freight Corridor	RIPTA Bus Routes	Length (mi)	Average Daily Traffic	Peak Hour Person-Hours of Delay[1]	AM Peak Hour Travel Time (min)		PM Peak Hour Travel Time (min)	
								EB/NB	WB/SB	EB/NB	WB/SB
1	Interstate 95—Northbound from Route 37, Cranston to Branch Ave, Providence	Interstate	Yes	8, 12, 14, 62, 65, 66, 95, 54[1], 59[1]	7.7	166,800	1687	15.7	NA	18.4	NA
2	Interstate 95—Southbound from Seekonk River Bridge, Pawtucket to Branch Ave, Providence	Interstate	Yes	1, 54, 59	2.9	95,400	946	NA	7.3	NA	7.6
3	Interstate 195—Westbound from Massachusetts State Line to I-95 Interchange, Providence	Interstate	Yes	60, 61, 35, 78	3.5	81,500	671	NA	11.1	NA	10.9
4	U.S. Route 6—Eastbound from Pocasset Ave, Providence to Dean St, Providence	Other Freeway and Expressway	Yes	9, 10, 21, 30	1.5	84,200	510	4.4	NA	4.3	NA
5	State Route 146—Southbound from Mineral Spring Ave, North Providence to I-95 Interchange, Providence	Other Freeway and Expressway	Yes	54, 59	2.7	64,800	500	NA	7.5	NA	6.3
6	U.S. Route 44 between State Route 116, Smithfield and Canal St, Providence	Principal Arterial	No	9, 50, 56, 57, 58	8.3	23,500	463	24.4	20.4	26.5	24.9
7	I-95/U.S. Route 6 Interchange Exit 22 Ramp, Providence from U.S. Route 6 Eastbound to I-95 Northbound	Interstate	No	none	0.6	50,000	449	2.0	NA	4.2	NA
8	State Route 15/Mineral Spring Ave between U.S. Route 44, North Providence and Main St, Pawtucket	Principal Arterial	No	27, 58, 73	5.1	19,900	321	16.9	17.1	20.4	21.6
9	Branch Ave, Providence between Douglas Ave (RI-7) and North Main St	Minor Arterial	No	58	2.0	20,000	218	8.9	6.8	9.4	9.5
10	Dean St, Providence between Westminster St and Kinsley Ave	Minor Arterial	No	9[1]	0.8	40,000	209	3.7	4.0	5.6	4.7

Rank	Corridor From—To	Functional Classification	Freight Corridor	RIPTA Bus Routes	Length (mi)	Average Daily Traffic	Peak Hour Person-Hours of Delay[1]	AM Peak Hour Travel Time (min)		PM Peak Hour Travel Time (min)	
								EB/NB	WB/SB	EB/NB	WB/SB
11	State Route 146—Northbound from I-295 Lincoln to Sayles Hill Rd, North Smithfield	Other Freeway and Expressway	Yes	54, 59	1.2	30,000	176	2.2	NA	4.3	NA
12	Cranston St, Providence between Huntington Ave and Westminster St	Minor Arterial	No	18, 31	1.3	22,000	175	8.6	2.4	9.7	3.6
13	U.S. Route 1/Dave Gavitt Way Frontage Rd—Northbound, Providence from Broad St to I-95 Interchange Exit 22	Principal Arterial	No	17[1], 18[1], 19[1], 31[1]	0.7	35,200	167	2.1	NA	4.3	NA
14	State Route 113/East St between Providence St, West Warwick and Post Rd Extension, Warwick	Principal Arterial	No	14, 21, 62, 66, 29[1], 8[1]	2.2	25,100	164	5.7	6.7	6.8	7.8
15	Hartford Ave, Providence between Killingley St and Olneyville Square	Minor Arterial	No	28	1.7	53,000	161	5.1	5.5	5.4	6.0
16	North Main St, Providence between Randall St and Branch Ave	Principal Arterial	No	11 (R Line)	0.3	20,100	153	1.2	1.4	1.2	1.5
17	Westminster St, Providence between Olneyville Square and Franklin St	Minor Arterial	No	17, 19, 27[1], 28[1], 18[1], 31[1], 1[1], 92[1]	1.4	10,600	148	6.9	7.0	7.2	9.2
18	Eddy St, Providence between Broad St and Dyer St	Principal Arterial	No	1, 3, 58, 62, 92[1]	2.0	17,100	147	9.3	8.4	10.1	10.1
19	Warwick Ave, Cranston/Broad St, Providence between Park Ave, Cranston and Elmwood Ave, Providence	Principal Arterial	No	11 (R), 1[1], 3[1], 6[1]	4.0	18,500	145	11.4	10.7	13.5	13.5
20	State Route 114 (Pawtucket Ave/Prospect St/Broad St) between I-195 Exit 7, East Providence and Hunt St, Central Falls	Principal Arterial	No	71, 78, 1[1], 11 (R)[1], 71[1], 72[1], 73[1], 75[1], 76[1], 80[1], 35[1], 33[1], 34[1]	7.1	16,000	143	21.7	20.7	25.0	23.6

[1] Small section of bus route runs along corridor.

7.0 Congestion Management Strategies

This section identifies congestion management strategies that could be applied to mitigate congestion in Rhode Island, including at the top 30 bottlenecks, top 20 most congested corridors, and top 20 freight bottlenecks.

7.1 Developing Congestion Management Strategies

A wide variety of potential strategies are available to mitigate congestion in Rhode Island, many of which have been implemented or evaluated. These strategies are presented in a "toolbox" that is based on congestion management best practice documents and the experience of the project team in developing congestion management plans for other agencies throughout the United States. This section discusses general priorities for congestion management strategies, introduces the toolbox as a resource, and discusses general considerations when selecting strategies for further consideration or implementation.

7.1.1 *Congestion Management Priorities*

A guiding principle for Rhode Island's CMP, which is developed to be consistent with the Rhode Island Moving Forward LRTP 2040, is that preference be given to demand management strategies that reduce travel, while leaving high-cost capacity increases that primarily serve single occupant vehicle travel as a last resort. The FHWA CMP Guidebook also states that "given the expense and possible adverse environmental impacts of adding new SOV capacity, due consideration should be given to travel demand management and operational measures before electing to add capacity."

The following is a list of congestion management strategy types in general order of priority.

1. TDM strategies that eliminate or reduce the need to make trips by motor vehicle.
2. Land use strategies that promote mixed-use and transit-oriented development and allow for reduced use of motor vehicles for some discretionary trips.
3. Strategies that expand public transportation and promote the use of higher occupancy modes.
4. Bicycle and pedestrian strategies that shift trips to bicycling and walking modes.
5. Operational improvements and ITS that make the best use of existing capacity.
6. Pricing strategies that reduce vehicle demand.
7. Roadway/mobility (non-ITS) strategies that are designed to help improve operations and relieve bottlenecks on existing facilities through improvements that do not add capacity.
8. Roadway capacity expansion strategies such as adding additional capacity to existing roadway facilities or constructing new roadway facilities that serve newer developed or rapidly developing areas, or where gaps exist in the existing freeway or arterial network.

Some strategies (such as TDM and operation improvements) can be implemented relatively quickly, while others (such as land use and major investments) are longer-term strategies. The balance of authority between the State and municipalities also varies by strategy; for example, the State has only indirect ability to influence land use patterns. It is likely that in any situation, multiple types of strategies will be needed to fully address the causes and mitigate the effects of congestion.

7.1.2 *Congestion Management Toolbox*

The complete congestion management toolbox is included in Appendix D. This toolbox lists strategies within each type of strategy and includes:

- A brief definition/description of the strategy.
- Congestion impacts (a qualitative description of how the project affects congestion).
- Application scale (statewide, corridor, and/or project).
- Implementation costs (qualitative assessment).
- Implementation timeframe (e.g., short—1 to 5 years; medium—5 to 10 years; long—greater than 10 years).

The toolbox should be considered as the “universe” from which congestion management strategies are selected. Section 7.3 provides more discussion of which strategies are most applicable to Rhode Island and identifies which specific strategies should be implemented or studied further. The strategic action plan included as Section 8.0 of this report identifies specific responsibilities for moving these strategies forward.

7.1.3 *Identifying Strategies*

Federal guidance recommends that congestion management strategies be identified based on their ability to support regional congestion management objectives, meet local context and relevance, 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.

CMP goals and performance measures have been identified by the CMP Working Group and the CMTF. These goals and performance measures provide context for identifying appropriate strategies to resolve specific congestion issues. Strategies should be evaluated based on their ability to meet CMP goals and improve CMP performance measures, as well as any other considerations related to general goals and objectives set forth in the LRTP.

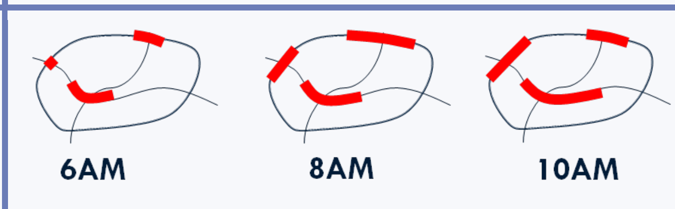
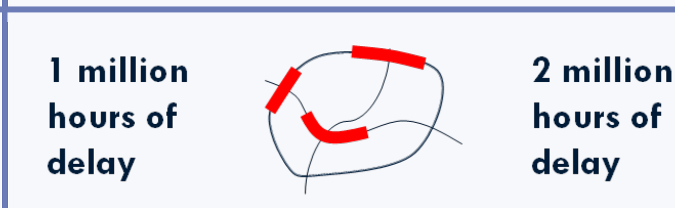
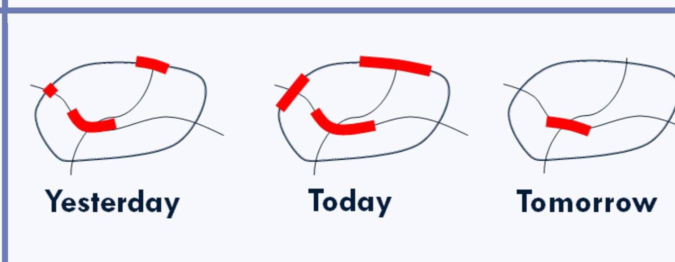
To select the most appropriate strategies, an agency must also understand the nature of the need and current operating characteristics of the system, corridor, and project location. The most appropriate congestion management strategies may vary depending on:

- The specific issue or dimension of congestion that needs to be addressed.
- The objectives to be accomplished at the location, which may include other things besides congestion (e.g., safety improvements, economic development, equitable mobility, reduced community or environmental impacts).
- Current operational characteristics of the system, corridor, and project location.

- The availability of right-of-way (ROW), for strategies involving geometric changes.
- The availability of funding, which may vary by the type of strategies implemented.
- Environmental and societal concerns.

Figure 7.1 illustrates the various dimensions of congestion. As an example of how this can inform the selection of congestion management strategies, if congestion is broadly distributed spatially, regionwide strategies may be needed; while if congestion is primarily concentrated at a few locations, location-specific strategies may be more appropriate. Highly variable congestion may suggest a focus on strategies to improve reliability, such as incident management and road weather management, whereas consistent day-to-day congestion points to a need for eliminating bottlenecks and reducing daily traffic volumes.

Figure 7.1 Dimensions of Congestion

Spatial How much of the system is congested? The image presents an example of a metropolitan highway network with 20 percent of all miles congested.	
Temporal How long does congestion last? The image presents an example of a metropolitan highway network with congestion from 6:00 a.m. through 10:00 a.m.	
Severity How much delay is there or how low are travel speeds? The image shows that for the same percentage of miles congested, the number of vehicles and total hours of vehicular delay can be different.	
Variability How does congestion change from day to day? The image shows how the severity and location of congestion can change from day to day. More variation in travel time indicates less reliable travel. A reliable system would have consistent levels of congestion from hour to hour and day to day.	

7.2 Inventory of Current and Planned Congestion Management Projects and Programs

This section describes recent and underway plans and studies that include potential congestion mitigation impacts. An overview of congestion-relevant plans and studies is followed by analysis of specific projects and strategies detailed in the LRTP, STIP, Rhode Island's Freight and Goods Movement Plan, draft Transit Master Plan, and draft Bicycle Mobility Plan as well as existing TDM programs in Rhode Island.

7.2.1 Recent and Ongoing Plans and Studies

Below are recent and underway plans and studies in Rhode Island that include congestion management elements. Descriptions highlight the plan or study's relevance to congestion management.

- **2040 LRTP:** The 2040 LRTP encompasses automobiles, public transit and buses, ferries, and active transportation. The plan also includes the freight sector, which contributes to and is affected by several bottlenecks in Rhode Island. The 2040 plan is under development by RIDSP and will likely be complete in 2020.[8]

- **Statewide Transportation Improvement Program FFY2018 to 2027:** The STIP, developed by RIDSP, lists transportation projects that the State of Rhode Island intends to implement using Federal funds in conjunction with State funds. The Federal fiscal year (FFY) 2018 to 2027 STIP includes the development of several large transit projects, including the Downtown Transit Connector and a new commuter rail station at the Pawtucket/Central Falls city line. The STIP invests funding in transportation alternatives statewide and encompasses the RI*STARS Bottleneck Reduction Program. Many of the Federal funding sources cited, including the Surface Transportation Block Grant Program, the NHFP, and the CMAQ Program, are directed at projects that reduce congestion, along with accomplishing other objectives.[9]

- **Bicycle Mobility Plan (January 2019 Draft, RIDSP):** The Bicycle Mobility Plan is a statewide initiative to expand the bicycle network strategically such that bicycling in Rhode Island is safe and enjoyable. The plan aims to help establish bicycle connections to destinations, especially those that currently—or have the potential to—draw bicyclists throughout a given city or region. Among other outcomes, the planned network of facilities is anticipated to help mitigate traffic congestion and air pollution.[10]

- **Transit Master Plan:** Rhode Island began its first TMP in mid-2018, aiming to better understand the condition, needs, and future solutions to the transit network. The plan includes transit modes (bus, rail, and ferry) and has identified three scenarios of transit improvements at the time of writing: Address Most Pressing Needs, Improve and Expand Transit, and Comprehensive Statewide Transit Network. Section 2.4 includes specific Transit Strategy Reports, which describe a range of recommended interventions, many of which are oriented towards shifting ridership away from single-occupancy vehicles and towards public transportation. The plan is being developed by RIPTA, RIDOT, and RIDSP.[11]

- **Rhode Island Strategically Targeted Affordable Roadway Solutions Program (March 2018 Update):** The RI*STARS program involves partnerships between local communities and RIDOT staff to identify critical safety and congestion locations in the State. Starting in 2013, RIDOT incorporated the Localized Bottleneck Reduction program into the RI*STARS program. As part of this program, RIDOT investigates highway segments and signalized intersections experiencing fatal and serious injury crashes as well as high delay/congestion. Mitigation measures range from restriping auxiliary lanes to longer-term solutions such as roadway widening.

8 http://www.planri.com/.

9 http://www.planning.ri.gov/planning-areas/transportation/tip.php.

10 http://www.planri.com/.

11 https://transitforwardri.com/.

- **RIPTA Bus-on-Shoulder Feasibility Study (2017):** RIPTA produced a feasibility study in 2017 for bus-on-shoulder operations and feasibility in Rhode Island. The study examined geometric attributes, levels of congestion, and the types of roadway improvements that would be required to implement such a system.

- **State of RI Freight and Goods Movement Plan (2016, amended 2017):** This comprehensive multimodal plan developed by RIDSP describes the immediate and long-range planning activities and investments associated with Rhode Island's freight system. The plan inventories facilities with mobility issues, including bottlenecks, and identifies strategies to address them. It also identifies significant congestion or delay caused by freight movements and strategies to mitigate that congestion or delay.

- **RIPTA Transit Signal Priority Expansion Plan (2017):** The TSP Expansion Plan is designed to guide RIPTA in implementing an expanded TSP network across the State and to document the benefits of TSP more broadly. RIDOT's LRTP includes five projects from this plan in its pool of projects; these projects describe opportunities to incorporate transit signal priority on five key RIPTA corridors. Facilitating faster transit service is one way to shift ridership towards high-capacity modes and reduce congestion.

- **Aquidneck Island Transportation Study (2011):** This study integrates regional transportation and land-use planning and incorporates transit, ferry, and active modes in addition to automobiles. Aquidneck Island is the location of one of the top 30 bottlenecks in Rhode Island and home to several congestion-related projects identified in the STIP.

- **Transportation 2037 (2017, State Guide Plan Element 611, Report #116):** This plan, developed by RIDSP, addresses Rhode Island's transportation needs over 20 years. The plan incorporates surface transportation for both passengers and freight as well as connections to other modes. Among several revisions from the 2008 plan is an updated CMP. (That process will be replaced by the process being developed in this study.)

- **Strategic Highway Safety Plan (2017):** The Rhode Island Strategic Highway Safety Plan (SHSP) is RIDOT's five-year transportation safety plan. The SHSP seeks to identify the State's safety needs, set goals for reducing fatalities and injuries, and allocate investments in safety projects and programs. The plan highlights congestion as one significant outcome of traffic incidents.

- **RI Greenhouse Gas Reduction Plan (2016):** This plan, developed for the Executive Climate Change Coordinating Council, includes strategies, programs, and actions to meet the targets for GHG emission reductions as established in the Resilient Rhode Island Act. The plan demonstrates that widespread adoption of clean energy technologies and practices would be necessary to meet these long-term targets, including significant electrification of heating and transportation energy use. The plan identifies two routes for VMT reduction: (1) decreasing the absolute number of single-occupancy vehicle trips by promoting and investing in alternative modes of transportation (e.g., rail, bus, ridesharing, biking, walking); and (2) reducing the absolute length of single-occupancy vehicle trips by encouraging higher-density patterns of development or changes in behavior.

- **Energy 2035 (2015):** This plan, developed by the Office of Energy Resources, updates the State Guide Plan Element 781 adopted in 2002. It describes Rhode Island's energy system and sets goals and policies to improve energy security, cost-effectiveness, and sustainability in energy production and consumption in the electricity, thermal, and transportation sectors. The plan calls for efforts to reduce

VMT by investing in alternative modes of transportation, promoting sustainable development and land use practices, and piloting programs to incentivize reduced discretionary driving.

- **City of Providence Great Streets Plan (January 2020):** The Great Streets Master Plan establishes a vision and framework for citywide improvements to connect all Providence neighborhoods to a high-quality network within the public realm. The plan recommends strategies for creating a safe, comfortable street network for multimodal users. Among recommendations offered in the plan is that the City should work with stakeholders to identify streets with the most traffic congestion and implement dedicated zones to create safer conditions for rider drop-offs, pick-ups, and deliveries to reduce congestion in key areas.

- **RhodeWorks 10-Year Transportation Improvement Program:** Passed and signed into law in 2016, RhodeWorks is a 10-year, $4.7 billion investment program designed to bring Rhode Island's transportation system, especially its bridges, into a state of good repair. The Rhode Island Bridge Replacement, Reconstruction, and Maintenance Fund Act of 2016 funds the program by enabling:

  - RIDOT to establish and collect tolls on large commercial trucks traveling on Rhode Island bridges.
  - The refinancing and restructuring of existing grant anticipation revenue vehicle (GARVEE) bonds.
  - The issuance of new GARVEE bonds, not to exceed $300 million.

  The 10-Year Transportation Improvement Program, developed by RIDOT, identifies the projects and programs to be funded with the resources provided by the RhodeWorks initiative. The plan provides more funding for bridges, pavement, transit, and transportation alternatives (e.g., bicycle paths, pedestrian facilities, and Americans with Disabilities Act (ADA)-compliant facilities) when compared to the existing funding, offering increased opportunities to shift mode choice towards transit and active modes.

- **U.S. DOT's Better Utilizing Investment to Leverage Development (BUILD):** Previously known as Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grants, Congress has dedicated nearly $7.9 billion for 11 rounds of national infrastructure investments to fund projects that have a significant local or regional impact. RIDOT has already secured BUILD grants for two projects—the Simple, Smarter Roads for the Newport Innovation Corridor ($20 million in 2018), and Washington Bridge Rehabilitation and Redevelopment Project ($25 million in 2019). In June 2020, RIDOT submitted two more applications, one for $4 million to plan the "Missing Move" and Quonset Connector Ramps at the I-95/Route 4/Route 403 interchange, and the other for $25 million to support the "Opening the Cranston Canyon" project with a series of safety and congestion improvements to Route 37 and I-295 North.

7.2.2 2018–2027 STIP

Projects in Rhode Island's 2018 to 2027 STIP were reviewed to identify programmed projects relevant to congestion management. Projects highlighted in this inventory had one or more of the following characteristics:

- Identified congestion alleviation as a major goal of the project.
- Identified a project site that aligned with one of the top 30 bottlenecks or the top 20 congested corridors in Rhode Island as determined by the project team.

- Expanded bus or commuter rail service on a scale or in a location such that congestion mitigation could reasonably result.
- Expanded pedestrian or bicycle access at a network level or along a key corridor or intersection such that congestion mitigation could reasonably result.
- Sought to manage travelers' demand such that use of SOVs, and thus congestion, could reasonably decline.

Appendix D provides a table with the location of the project, value, year funded, description, type of congestion intervention, and which (if any) of the top corridors or bottlenecks are addressed. Some projects are not corridor-specific (for example, a transit center serving multiple commuting corridors into downtown Providence or a funding pot for traffic signal improvements), in which case they are identified as "statewide."

7.2.3 *2040 LRTP*

The draft LRTP also was reviewed to identify planned projects or programs relevant to congestion management. The methodology for, including projects in this inventory was similar to that described above for the STIP. One difference between the two plans, though, is that while the STIP includes a list of programmed projects, the LRTP is more abstract in nature, identifying only "congestion mitigation strategies and technologies." Those strategies or technologies that referenced a specific location or that appeared to be regionally significant were included in this inventory, which is presented in Appendix E.

7.2.4 *Rhode Island Transit Master Plan*

Rhode Island's Transit Master Plan, Transit Forward, will establish a vision for the State's passenger transportation network. In May 2019, RIPTA, RIDOT, and the Division of Statewide Planning released a State of the System Report, which established a starting point for Transit Forward. The report provides an overview of current transit services and operating characteristics; major transit facilities; current ridership levels and recent ridership trends; market analysis examining demand for transit service through 2040; a "gap analysis" of transit services; and a description of issues, opportunities, and next steps.

Based on this information, RIPTA, RIDOT, and RI Statewide Planning have developed several "transit strategy reports." The reports include services, programs, and policies. Several of the strategies have potential congestion mitigation or avoidance implications:

Develop High-Capacity Transit Services

- **Light Rail:** This document explores the possibility of new light rail service from Downtown Pawtucket to the Cranston City Line via Main Street, Downtown Providence, and Broad Street as well as between Olneyville Square and College Hill via Downtown Providence. These projects could affect bottlenecks between Pawtucket and Providence and in the Downtown Providence area.
- **BRT/Rapid Bus/Express Bus:** Separate documents explore the possibility of bus rapid transit (BRT) in downtown Providence; Rapid Bus service in the Providence Metro or along regional routes; and the development of new express bus services from communities currently outside RIPTA's express/regional network, including Burrillville, Coventry, North Kingstown, East Greenwich, and Bristol.

Improve Existing Services

- **Frequent Transit/Extended Hours:** These strategies explore the establishment of a transit "backbone" with high-frequency service as well as extended service hours on both weekdays and weekends. A Frequent Transit Network would likely build off of RIPTA's Downtown Transit Corridor and Key Corridor Network, with additional potential radial routes to Central Falls, East Providence, Cranston, Warwick, Woonsocket, and Newport. These improvements are intended to increase the convenience and attractiveness of transit service, thereby boosting ridership.

- **Transit Priority/Transit Emphasis Corridors:** Strategies such as dedicated transit lanes, part-time and shared lanes, and intersection transit priority help make transit more attractive by making service competitive with driving. Transit Emphasis Corridors are entire corridors featuring bus-priority lanes, signal priority, and high-quality bus stops. The potential Transit Emphasis Corridors identified are located in downtown Providence along the routes of several of the top 30 bottlenecks.

- **Faster and More Frequent Passenger Rail:** This strategy examines the possibility of expanded passenger rail service connecting Rhode Island and Boston.

- **Bus-On-Shoulder Operations:** Buses that operate on highways can gain valuable travel time advantage when allowed to use highway shoulders in congested conditions. In 2017, RIPTA began investigating bus-on-shoulder operations for 15 routes that operate on highways and other limited access roads. The potential sites for bus-on-shoulder operations aligns with several identified bottleneck sites.

Expand Service to New Areas

- **Service to Smaller Markets:** This strategy explores relatively new approaches to serving smaller markets, such as rideshare partnerships and microtransit point-to-point services, as well as more traditional approaches involving specialized shuttles and reservation-based point-to-point services. The RIPTA-managed TDM program Commuter Resource RI (CRRI) is identified as particularly well-suited to helping build and manage such partnerships.

- **Crosstown Service:** This strategy explores opportunities for crosstown transit service in Providence through use of the crosstown arterials. This approach would target increased ridership in the Providence metro area.

- **Special Events and Tourism Services:** Several large annual events in Rhode Island generate traffic and parking congestion and expanded special event and tourism service options could help mitigate these impacts. Additional options could mitigate congestion related to the WaterFire festival, PVDFest, and the Newport Jazz Festival.

- **First Mile/Last Mile Connections:** This strategy considers how pedestrian/bicycle improvements, TMA/employer shuttles, ridesharing, and microtransit could help increase access to transit services. These connections would likely support several of the Mobility Hubs described below.

- **Service Buy-Ups:** This strategy explores how transit agencies develop programs to enable local governments, businesses, and other stakeholders to directly fund specific transit improvements. RIPTA is considering how this approach could facilitate better access to corporate campuses and office parks, education and medical campuses, and developments along major transit corridors.

Improve Facilities and Amenities

- **Better Bus Stops and Facilities/Mobility Hubs:** RIPTA has approximately 3,500 bus stops located throughout the State to which some or all improvements could be applied. Enhanced bus stops improve the transit experience, decrease perceived wait times for transit services, and can contribute to increased ridership. Likewise, Mobility Hubs enhance the transit experience by offering a density of transportation options at specific locations, often combined with public, commercial, or residential amenities. The document identifies potential sites for small, medium, and large hubs, most of which are focused around Providence.

- **More Park and Ride Lots:** RIPTA has proposed several new park and ride lots as part of their Transit Master Plan. These lots will assist in mitigating traffic in congested corridors while providing residents with ready locations to board public transit.

Make Service Easier to Use

- **Fare Integration and/or Mobility as a Service:** Fare integration enables riders to use a single pass to ride services provided by multiple transit agencies. In particular, fare integration could simplify travel between passenger rail and local bus services, encouraging more people to use transit. Similarly, Mobility as a Service increases the ease of transit use by providing the ability to plan, book, and pay for different transportation options using a single smartphone application.

7.2.5 *Travel Demand Management Programs*

CRRI is a RIPTA-coordinated and FHWA-funded TDM program that serves as an information clearinghouse for mobility options in Rhode Island. Through its website and in-person trainings, CRRI provides customized information to commuters on commuting options, including carpooling, vanpooling, public transit, rail transportation, and route planning for bicyclists and walkers. The program aims to reduce SOV trips, increase HOV commuting, reduce traffic congestion, improve air quality, and maximize public transit usage. Several of its offerings are described in more detail below:

- **Agile Mile:** In 2014, CRRI announced its partnership with the commuter rewards program NuRide (now called Agile Mile). The company's application encourages people to choose healthier and more sustainable transportation options by providing rewards through local sponsors. Participants accumulate points by walking, taking the train, carpooling, telecommuting, or biking, and points are redeemable for retail discounts, restaurant coupons, and event tickets. In Rhode Island, local sponsors have ranged from restaurants and concerts to rock climbing gyms. Agile Mile's website allows commuters to search for carpools or vanpools by origin and destination.

- **Vanpool Subsidy:** RIPTA has partnered with Commute with Enterprise, an enhanced service of Enterprise Rent-A-Car, to offer a $300 monthly subsidy to vanpools in Rhode Island. Participants coordinate a group to sign up together to lease a late-model van or sport utility vehicle provided by Enterprise.

- **Employer TDM Programs:**

  - Eco-Pass: Eco-Pass is an annual pass that provides unlimited bus, trolley, and flex route transportation service. The pass is a smart card that enables employers subsidize transit use per ride. Employers pay a reduced rate for the unlimited pass, distribute as many cards as desired, and pay only for the rides employees take. There are no implementation costs and administrative assistance and technical support are free. CRRI's materials emphasize both the environmental impact and cost savings for employers.

- State employee Eco-Pass pilot: This program was created in 2020 to encourage state employees to consider public transit as their primary commuting option. It is a joint program of RIDOA and RIPTA that provides state employees with a free transit pass to access to all RIPTA routes on weekdays. The pilot program will end in November 2020 at which time the State will assess the benefits of the pilot and consider making it a continued program.
- Onsite Trip Planning: Companies of any size can participate in CRRI's onsite events and one-on-one trip planning services for employees.
- U-Pass: Funded by participating colleges and universities, the University Pass Program (U-Pass), allows students at participating schools to obtain free or reduced fare transit. Some students can use their student ID to ride.
- Parking Cash-Out: State law requires that employers who provide subsidized parking for their employees offer a free RIPTA transit pass in lieu of a parking space. The intent of this provision is to reduce vehicle commute trips and emissions by offering employees the option of "cashing out" their subsidized parking spaces and taking transit to work for free. The law applies to employers who are located within $^{1}/_{4}$ mile of a RIPTA bus line; have 50 or more employees; have leased parking; and subsidize employee parking by paying the cost and allowing the employee free or reduced-rate parking.

- **Passenger Experience Enhancement Program (PEEP):** PEEP is RIPTA's Passenger Experience Enhancement Program. It is a complete streets approach, communicated through a design guide, to improving bus stop infrastructure to be safe, accessible, welcoming, and consistent across Rhode Island.

7.2.6 *Freight and Goods Movement Plan*

Rhode Island's Freight and Goods Movement Plan aims to inform agency representatives on the current condition and ongoing trends related to Rhode Island's freight network; to identify needs, gaps and inefficiencies; to offer preliminary recommendations, and to present an implementation plan that reflects fiscal constraints and stakeholder priorities. In doing so, the plan identifies six priority projects, five of which are relevant to congestion issues in the State:

- **Interstate 95 Northbound Viaduct:** This bridge replacement will allow for better capability to handle increased traffic volumes in a safer, more time efficient manner. Average daily traffic counts for 2016 were estimated at 332,000. An annual growth rate of 0.5 percent would bring average daily traffic counts to 365,000 by 2035. This project is funded and will be proceeding.
- **6/10, Interstate 95 Southbound Connection:** The repairs and upgrades proposed for the interchange bridges and ramps will increase capacity and improve safety and reliability. Increasing capacity will decrease existing congestion within the interchange. Average daily traffic counts for 2016 were estimated at 111,000. An annual growth rate of 0.5 percent would bring average daily traffic counts to 122,000 by 2035.

- **Allens Ave, Interstate 95 Southbound Connection:** Allens Avenue is a main thoroughfare for traffic coming to and from the Port of Providence. It currently services over 13,300 vehicles per day. There currently is no direct connection between the two corridors, but current trends suggest traffic growth of 6.4 percent annually. As such, direct access to I-95 South could help reduce the potential for congestion increases on local roads.

- **Route 4, Interstate 95 Connection:** Route 4 is the main route for freight vehicles to and from Quonset Business Park and the Port of Davisville. There currently is no direct access between Route 4 and I-95 South, forcing this traffic onto local streets as they transition between the two corridors. This proposed project would establish a direct connection between Route 4 and I-95 South in order to stabilize traffic flow and remove 41,000 vehicles from local roads daily. With an annual growth rate of 2.8 percent, average daily traffic counts are expected to increase to 140,000 by 2035. RIDOT has requested $4 million from the U.S. DOT's BUILD grant towards planning, preliminary engineering and environmental review.

- **T.F. Green Airport Ramp Expansion:** This proposed project would enhance capacity of T.F. Green Airport's ramp. The project is expected to increase demand for freight and mail movements to and from the airport. At the same time, increased opportunities for air freight flows are anticipated to decrease the number of trucks needed to deliver freight from the Boston Logan Airport to the region, decreasing truck miles traveled overall.

7.2.7 *Bicycle and Pedestrian Improvement Plans*

Rhode Island's draft Bicycle Mobility Plan examines conditions, needs, and gaps surrounding bicycle infrastructure and operations in the State and identifies approaches for achieving the 20-year vision set out by the LRTP. Several components of the plan are relevant to congestion management activities:

- **Promote Bicycle Transportation for State of Rhode Island Employees and Visitors (LRTP Goal 8):** The objectives identified under this LRTP goal contain several TDM elements that would shift commuters away from single-occupancy automobiles. The plan calls for the creation of bicycle parking at all State-owned buildings; locker rooms and showers for bicycle commuters in State-owned buildings with over 50 employees; and new TDM programs offering financial incentives for State employees to bicycle to work (e.g., bicycle maintenance rebates, regular bicycle commuter stipends, free/reduced bike share memberships).

- **Statewide Bicycle Network Gaps:** The plan categorizes all identified gaps as either "Network" or "Destination" gaps. Destination gaps exist along corridors that provide connections to destinations of citywide or regional significance; eliminating these gaps will encourage more people to bike to destinations such as transit stations, State parks and beaches, schools, and retail centers. Network gaps lie between segments of the State's existing bicycle network. Eliminating of these gaps will provide continuous infrastructure using shared-use paths and/or bicycle lanes throughout the State. Many of the Destination and Network Gaps correspond with identified bottleneck locations (for example, bottlenecks 1, 2, 3, 5, 9, 16, 18).

- **Greenway Network:** At the core of Rhode Island's set of candidate bicycle treatments lies a network of greenway paths. Combined with the State's existing bikeways, paths, and trails, this future network of greenways aspires to become the densest collection of off-road paths in the Northeast. Comprising approximately 320 miles, this candidate network would connect each of the State's 39 cities and towns.

With the implementation of candidate routes, Rhode Island's bicycle network is anticipated to help mitigate traffic congestion and air pollution.

7.3 Additional Strategies for Consideration

This section discusses additional strategies that Rhode Island should consider undertaking to mitigate congestion, beyond those identified in the plans reviewed in the previous section.

Section 7.3.1 takes the universe of congestion management strategies identified in the congestion management toolbox and identifies which of those already are being applied in Rhode Island, and which ones should be considered for expanded or new application. This section also identifies potential lead and supporting roles and responsibilities for each strategy.

Section 7.3.2 identifies projects within the LRTP, STIP, Transit Master Plan, and Bicycle Master Plan that align with the top 20 congested corridors and top 30 bottlenecks, and hence which congested corridors and bottlenecks are yet not covered, or are sparsely covered, by programmed or planned projects. All top 20 congested corridor and top 30 bottlenecks should be considered priorities for congestion management. Those corridors or bottleneck locations not currently covered or sparsely covered by a planned project should be considered for additional study to evaluate specific congestion management strategies and project development to address them.

Section 7.3.3 discusses strategies that are not corridor-specific, but that might be expanded on a statewide or substate basis.

7.3.1 *Universe of Strategies*

This section identifies which of the universe of congestion management strategies already are being applied in Rhode Island and which ones should be considered for expanded or new application, either at a statewide level or for specific corridors or projects. This table was developed with direction from the Rhode Island CMTF and Working Group. The table indicates the following options for each strategy:

- **Already doing—**RIDOT, RIDOA, RIPTA, and/or other stakeholders already are implementing this strategy, at least to some degree.
- **Do more: Statewide—**This is an accepted and proven strategy, and RIDOT, RIDOA, and/or RIPTA should expand the general application of this strategy, which may cover the entire State, a region of the State, or multiple corridors. Potential strategies for statewide expansion are discussed in Section 7.3.2.
- **Do more: Corridor—**This is an accepted and proven strategy, and RIDOT, RIDOA, and/or RIPTA should apply this strategy in specific corridors or project locations where it is applicable. The selection of specific strategies should be made on a corridor-by-corridor basis considering the local context and needs.
- **Needs further assessment—**This strategy holds promise for congestion management, but needs further study to determine feasibility, costs, effectiveness, acceptance issues, and/or other benefits and impacts.

Table 7.1 Congestion Management Strategies: Current Status and Recommendations for Further Consideration

Project/Mode Type	Already Doing	Do More: Statewide	Do More: Corridor	Needs Further Assessment
1. Transportation Demand Management Strategies				
Transportation Management Associations		●		
Commuter Rewards/Incentive Programs	●	●		
Programs to Promote Alternative Work Hours and Telecommuting	●	●		
Ridesharing and Vanpool Matching and Incentives	●	●		
Guaranteed Ride Home Program	●			
Trip Reduction Requirements				●
Alternative Travel Mode Events and Assistance	●			
Conversion of Lanes to Managed or high-occupancy toll (HOT) Lanes	●		●	
Car Sharing	●	●		
Shared Mobility Management		●		
2. Land Use Strategies				
Tools and Incentives for Mixed-Use Development, Infill, and TOD	●	●		
Policies to Limit Sprawl	●	●		
3. Public Transportation Strategies				
Reducing Transit Fares/Cross-Honor	●	●		
Increasing Bus Route Coverage or Frequencies		●		
Park-and-Ride Lots	●	●		
Rail Transit			●	
BRT/New Fixed Guideway Busways	●		●	
Dedicated Rights-of-Way for Transit/ Shoulder Running	●		●	
Employer Transit Incentive Programs	●	●		
Electronic Payment Systems and Universal Fare Cards	●			
Realigned Transit Service Schedules and Stop Locations		●		
Intelligent Transit Stops		●		
Transit Intersection Queue Jump Lanes and Signal Priority	●		●	
Enhanced Transit Amenities		●		
Improved Bicycle and Pedestrian Facilities at Transit Stations		●		
Express Bus Service	●	●	●	
Local Circulator		●		

Project/Mode Type	Already Doing	Do More: Statewide	Do More: Corridor	Needs Further Assessment
4. Bicycle and Pedestrian Strategies				
New Sidewalks and Designated Bicycle Lanes	●		●	
Improved Bicycle Facilities at Transit Stations and Other Trip Destinations		●		
Design Guidelines for Pedestrian-Oriented Development		●		
Improved Safety of Existing Bicycle and Pedestrian Facilities	●		●	
Exclusive Nonmotorized Rights-of-Way	●		●	
Bike Sharing Programs	●	●		
Promote Bicycle and Pedestrian Use Through Education and Information Dissemination	●	●		
Micromobility Services	●	●		
5. ITS and Operations Strategies				
Traffic Signal Coordination and Modernization	●	●	●	
Transit Signal Priority	●		●	
Reversible Traffic Lanes				●
Targeted and Sustained Enforcement of Traffic Regulations		●	●	
Freeway Incident Detection and Management Systems	●	●		
Service Patrols			●	
Ramp Metering				●
Advanced Traveler Information Systems	●	●		
Special Events and Work Zone Management	●	●	●	
Road Weather Management	●	●	●	
Traffic Surveillance and Control Systems	●	●	●	
Communications Networks and Roadway Surveillance Coverage	●	●	●	
Transit Vehicle Travel Information	●	●	●	
Speed Harmonization				●
6. Pricing Strategies				
Road Pricing				●
Cordon Area Congestion Fees				●
Congestion Pricing				●
Carbon Pricing /Motor Fuel Tax		●		
VMT fee				●
Traffic Impact Fees				●
Pay-As-You-Drive Insurance		●		
Preferential or Free Parking for HOVs and Parking Pricing	●	●		
Local and Regional Parking Excise Taxes				●

Project/Mode Type	Already Doing	Do More: Statewide	Do More: Corridor	Needs Further Assessment
7. Roadway/Mobility (Non-ITS) Strategies				
Access Management	●		●	
Restricting Turns at Key Intersections	●		●	
Converting Streets to One-Way Operations	●			●
Roadway Signage Improvements	●	●	●	
Geometric Design Improvements	●		●	
Grade Separations (Not Added Capacity)	●		●	
Acceleration/Deceleration Lanes	●		●	
Encourage Local Complete Streets Policies	●	●		
Curb Management	●	●	●	
8. Roadway Capacity Expansion Strategies				
Increasing Number of Lanes without Highway Widening	●			
Highway Widening by Adding Lanes	●			●
New Arterial Streets	●			●
Grade Separations (Added Capacity)				●
Grade Separated Railroad Crossings				●
Major Intersection/Interchange Improvements	●		●	
Hard Shoulder Running			●	

The most appropriate responsibilities for implementing each type of strategy vary and often span multiple agencies. However, some general roles and responsibilities are identified in Table 7.2. In some cases, more than one type of agency may take lead or supporting responsibility for a strategy (colead). In many cases, both RIDOT and municipalities will take lead responsibility, with the RIDOT responsible for State roads and the municipality for local roads. However, even so, RIDOT, RIPTA, or the Division of Statewide Planning can encourage and support municipal efforts through design standards, best practices guidance, and funding incentives. Other strategies—such as bus-on-shoulder running—require partnerships between at least two lead agencies, in this example the road owner and the transit agency. Some strategies must be enabled through legislation or executive action. Section 8.0 of this report identifies specific responsibilities for next steps.

Table 7.2 Roles and Responsibilities for Implementing Congestion Management Strategies

Project/Mode Type	RIDOT	MPO—RIDSP	RIPTA	Municipality	Other
1. Transportation Demand Management Strategies					
Transportation Management Associations			Lead		
Commuter Rewards/Incentive Programs			Lead		
Programs to Promote Alternative Work Hours and Telecommuting		Lead			Colead
Ridesharing and Vanpool Matching and Incentives			Lead		

Project/Mode Type	RIDOT	MPO—RIDSP	RIPTA	Municipality	Other
Guaranteed Ride Home Program			Lead		
Trip Reduction Requirements		Lead			
Alternative Travel Mode Events and Assistance			Lead	Colead	
Conversion of Lanes to Managed or HOT Lanes	Lead				
Car Sharing				Lead	
Shared Mobility Management	Colead			Colead	
2. Land Use Strategies					
Tools and Incentives for Mixed-Use Development, Infill, and TOD	Support	Colead	Support	Colead	
Policies to Limit Sprawl		Colead		Colead	
3. Public Transportation Strategies					
Reducing Transit Fares/Cross-Honor	Colead		Colead		
Increasing Bus Route Coverage or Frequencies			Lead		
Park-and-Ride Lots	Lead	Support	Support		
Rail Transit	Lead				
BRT/New Fixed Guideway Busways	Colead		Colead		
Dedicated Rights-of-Way for Transit / Shoulder Running	Colead		Colead		
Employer Transit Incentive Programs			Lead		
Electronic Payment Systems and Universal Fare Cards			Lead		
Realigned Transit Service Schedules and Stop Locations	Support		Lead	Support	
Intelligent Transit Stops	Support		Lead	Support	
Transit Intersection Queue Jump Lanes and Signal Priority	Colead		Colead	Colead	
Enhanced Transit Amenities	Colead		Colead	Colead	
Improved Bicycle and Pedestrian Facilities at Transit Stations	Colead		Colead	Support	
Express Bus Service			Lead		
Local Circulator			Colead	Colead	
4. Bicycle and Pedestrian Strategies					
New Sidewalks and Designated Bicycle Lanes	Colead	Support		Colead	
Improved Bicycle Facilities at Transit Stations and Other Trip Destinations	Colead		Colead	Colead	
Design Guidelines for Pedestrian-Oriented Development	Support	Colead		Colead	
Improved Safety of Existing Bicycle and Pedestrian Facilities	Colead			Colead	
Exclusive Nonmotorized Rights-of-Way	Colead			Colead	
Bike Sharing Programs				Lead	

Project/Mode Type	RIDOT	MPO—RIDSP	RIPTA	Municipality	Other
Promote Bicycle and Pedestrian Use Through Education and Information Dissemination	Colead	Support		Colead	
Micromobility Services	Colead			Colead	
5. ITS and Operations Strategies					
Traffic Signal Coordination and Modernization	Colead	Support		Colead	
Transit Signal Priority	Colead		Colead	Colead	
Reversible Traffic Lanes	Colead			Colead	
Targeted and Sustained Enforcement of Traffic Regulations	Colead			Colead	Colead
Freeway Incident Detection and Management Systems	Lead				
Service Patrols	Lead				
Ramp Metering	Lead	Support			
Advanced Traveler Information Systems	Lead	Support			
Special Events and Work Zone Management	Lead				
Road Weather Management	Lead				
Traffic Surveillance and Control Systems	Lead				
Communications Networks and Roadway Surveillance Coverage	Lead				
Transit Vehicle Travel Information	Support		Lead		
Speed Harmonization	Lead				
6. Pricing Strategies					
Road Pricing	Lead	Support			
Cordon Area Congestion Fees	Support	Support		Lead	
Congestion Pricing	Lead	Support			
Carbon Pricing /Motor Fuel Tax		Lead			
VMT fee	Colead	Colead			
Traffic Impact Fees	Colead			Colead	
Pay-As-You-Drive Insurance		Lead			
Preferential or Free Parking for HOVs and Parking Pricing	Support	Support		Lead	
Local and Regional Parking Excise Taxes		Support		Lead	
7. Roadway/Mobility (Non-ITS) Strategies					
Access Management	Colead	Support		Colead	
Restricting Turns at Key Intersections	Colead			Colead	
Converting Streets to One-Way Operations	Colead			Colead	
Roadway Signage Improvements	Colead			Colead	
Geometric Design Improvements	Colead			Colead	
Grade Separations (Not Added Capacity)	Colead			Colead	
Acceleration/Deceleration Lanes	Colead			Colead	

Project/Mode Type	RIDOT	MPO—RIDSP	RIPTA	Municipality	Other
Encourage Local Complete Streets Policies	Colead	Support		Colead	
Curb Management	Colead	Support		Colead	
8. Roadway Capacity Expansion Strategies					
Increasing Number of Lanes without Highway Widening	Colead			Colead	
Highway Widening by Adding Lanes	Colead			Colead	
New Arterial Streets	Colead			Colead	
Grade Separations (Added Capacity)	Colead			Colead	
Grade Separated Railroad Crossings	Colead			Colead	
Major Intersection/Interchange Improvements	Colead			Colead	
Hard Shoulder Running	Colead			Colead	

7.3.2 *Statewide Strategies*

Statewide congestion management strategies may have a limited effect at any particular bottleneck location but will have a broader effectiveness at many locations by reducing statewide VMT or supporting corridor-wide improvements in traffic flow. Potential statewide strategies for consideration or expansion in Rhode Island are described below.

Transportation Demand Management Strategies

As described in Section 7.2.5, Rhode Island already operates some commuter-focused TDM programs operated under the umbrella of Commuter Resource RI. For further implementation the State should consider:

- Developing a **TDM strategic plan** for Rhode Island. Such a plan would engage TDM partners, including RIDOT, RIPTA, and major employers and business associations in researching and proposing opportunities to expand TDM and reduce SOV commuting. For example, one step in this process might be to conduct outreach to employers to understand their workforce needs and potential opportunities and barriers to reducing commuting and work-related travel, so that policies and incentives can be better tailored to the needs of Rhode Island's industries. TDM strategic plans have recently been developed for regions such as Columbus (OH), Austin, Denver, and Atlanta. TDM strategic plans can identify areas for improved partnerships, such as linkages between staff involved in TDM programs and those involved in managing and operating the highway system.

- Forming one or more **Transportation Management Associations** to more directly engage employers in promoting and offering travel reduction strategies to their employers. Downtown Providence would be the most obvious candidate for a TMA; if successful here, the concept might be tested in other major employment centers, such as northern Rhode Island and the East Bay. Interest will be greatest where congestion and parking costs are substantial enough to serve as impediments to employees' commuting and potentially to recruiting of new employees.

- Hiring additional staff to engage in **outreach to employers** throughout the State to offer resources or incentives to encourage ridesharing, alternative mode use, and telecommuting.

- Develop a **shared mobility strategic plan** for Rhode Island. This plan would consider the potential growth and implications of shared mobility services in the State, such as transportation network companies (TNC), microtransit, car-sharing, and micromobility services such as scooters. Increased use of TNCs in particular is being tied to higher congestion in many large cities, and congestion will continue to increase if these services serve mainly solo travelers. The plan would identify State policies and incentives to encourage the development of these services in a way that supports equitable mobility and improves safety and the environment. For example, fees on such services might be structured to encourage multi-occupant or nonmotorized travel and discourage SOV rides. Cities such as Austin, the Twin Cities of Minnesota, and Seattle have developed similar plans.

The lessons learned during the COVID-19 pandemic suggest that strategies such as working from home and otherwise substituting travel with electronically mediated activity could play an important role in helping to manage congestion in the future. Actions under the direct control of the State of Rhode Island could include expansion of work-from-home/telework policies for State employees as well as use of tele/videoconferencing for State meetings. The State's TDM outreach programs could provide a mechanism for encouraging private employers to continue or expand their policies. In addition, it is likely that private companies' remote work policies, as well as increase use of telecommunications for shopping, education, medical appointments, and other business, could also lead to changes to future baseline levels of travel and congestion.

Land Use Strategies

The 2006 report, *Land Use 2025: State Guide Plan Element 121* (RIDOA) identifies State policies, objectives, and strategies for land use, conservation, and development, including an Urban Services Boundary and Future Land Use map to define areas appropriate for urban growth versus conservation and maintaining rural character.

While this document provides a foundation for reducing travel through land use, the State could do more to encourage transportation-efficient growth patterns. Such patterns are characterized by areas of compact, infill and/or transit-oriented development that are well-served by transit and nonmotorized modes and reduce trip lengths.

Land use planning is largely in the hands of municipal authorities. However, other States and metropolitan agencies have taken voluntary steps to encourage transportation-efficient growth through actions such as:

- Providing **technical assistance and guidance** for municipalities to revise land use plans and zoning.
- Making Federal or State transportation or **funding** available for municipal planning directed at smart growth objectives, or for infrastructure projects that support smart growth (e.g., pedestrian improvements in a TOD area).
- Revising STIP **project selection criteria** to favor projects that support transportation-efficient growth and development and to discourage projects that encourage sprawl and highway travel. This may include setting criteria for minimum planned densities in station areas planned for TOD when evaluating fixed-guideway project proposals.
- Develop **access management guidelines** and work with municipalities to implement these guidelines in the context of corridor studies and municipal comprehensive and small area land use plans.

Bicycle and Pedestrian Strategies

The Bicycle Mobility Plan under development in 2019 and 2020 is providing a comprehensive look at the State's policies and projects to improve bicycling. Some of the priority corridors in this plan overlap with congested corridors and bottlenecks. Implementing the recommendations of this plan is the major step that the State can take to reduce congestion through bicycle improvements.

The State does not have a corresponding pedestrian plan, although municipalities may develop their own plans for pedestrian improvements. Many states and regional agencies, including the Massachusetts DOT, have developed both pedestrian and bicycle plans. It is recommended that the State **develop a statewide pedestrian plan** that addresses how pedestrians will be accommodated on State roads and provides resources to municipalities for improving year-round pedestrian conditions on local streets.

Public Transportation Strategies

Similar to bicycling, recommendations for public transportation improvements are being developed in the TMP being completed in 2019 and 2020. Implementing the recommendations of this plan is the major step that the State can take to reduce congestion through public transportation improvements.

ITS and Operations Strategies

This category includes strategies that can be applied on a location-specific basis as well as strategies that require regionwide infrastructure or programs. RIDOT already has advanced some ITS technologies such as a Transportation Management Center and communications systems. RIDOT also develops traffic management plans for construction and maintenance projects/activities and scheduled work to avoid congested peak periods as much as possible. RIDOT works with municipalities through the RI*STARS program, as described in Section 7.2.1, to manage and mitigate critical bottlenecks. The 2018 TSMO Performance Measurement Plan and Work Program for RIDOT and RIDSP provides additional information on recommended TSMO strategies and performance measures.

Some strategies generally recommended for consideration or expansion in Rhode Island include:

- Expanding efforts to **modernize traffic signals,** including coordinated and adaptive signal control and transit signal priority on key bus routes; as well as regularly **updating timing** to improve traffic flow through automated traffic signal performance measurement. This might include providing assistance to local jurisdictions managing congested arterial streets, as well as maintaining and updating State owned signals.
- Expanding **incident management,** including service patrols to rapidly respond to and help clear incidents.
- Considering strategies such as **ramp metering, speed harmonization, reversible travel lanes,** and potentially other strategies to improve traffic flow in the most heavily trafficked corridors.

Pricing Strategies

A variety of transportation pricing mechanisms are available; some have congestion management as a main objective while others are more generally directed at raising revenue. Pricing mechanisms currently active in Rhode Island include the motor fuel tax, municipal and private parking costs in certain high-demand locations, and recently instated truck tolls.

General pricing strategies (such as tolls, VMT fees, or a carbon price) can influence congestion by reducing overall travel; however, the most effective strategies will be directed to manage demand at times and locations where congestion is greatest. Pricing-based congestion management strategies that could be considered in Rhode Island include:

- **Congestion pricing,** or tolls that vary by location and time of day, with the highest tolls at times and locations of high congestion.
- Encouragement of **demand-based parking pricing** for municipal off-street and on-street parking facilities.
- **Excise taxes** on off-street parking spaces to encourage provision of less parking where feasible.
- Establishment of a mechanism to implement **traffic impact fees** for new development in congested corridors, to help fund congestion relief measures. Vermont has adopted a process to assess impact fees on a corridor-wide basis.

Some of these options might be considered in conjunction with larger transportation revenue reform, to make up for revenues lost as vehicles become more efficient (or electric) and fuel tax revenue declines. For example, a move towards VMT-based fees or road tolls might support the application of congestion pricing.

Roadway/Mobility (Non-ITS) Strategies

This strategy category includes a variety of geometric and operational strategies that might be implemented on a location-specific basis. All of these are potentially appropriate in Rhode Island but need to be studied in the context of a given bottleneck’s needs and constraints.

Two strategies are called out for more general (statewide) application:

- **Encourage local Complete Streets policies—**Complete Streets are designed for all modes and all users. RIDOT developed a Complete Streets Action Plan in 2015. The State should continue to implement this plan, including supporting and providing incentives for municipalities to adopt Complete Streets policies for their own facilities. As a specific facet of Complete Streets, RIDOT and RIPTA should continue to encourage and support municipalities in implementing the RIPTA 2017 Rhode Island Bus Stop Design Guide, as well as directly following this guide on State roads.
- Address **curb management** issues—Localized congestion has been a byproduct of the rise of transportation network services such as Lyft and Uber, as well as Internet commerce and web-enabled delivery services. Many cities and States are beginning to address this growing problem through curb management, including inventorying curb space, expanding designated areas for pick-ups and drop-offs, and considering additional regulatory or pricing mechanisms.

Roadway Capacity Expansion Strategies

Due to costs, the potential for environmental and community impacts, and the possible long-term effect of encouraging more vehicle travel, roadway capacity expansion is generally considered as the strategy of last resort, to employed when other strategies are insufficient to mitigate congestion. However, such strategies may be warranted on a case-by-case basis, such as to serve areas of high growth or to bridge gaps in the highway network. In some cases, these strategies also are implemented to mitigate safety problems. Added lanes, grade separation, interchange improvements, and new arterial streets are all strategies potentially applicable in Rhode Island. Hard shoulder running during peak periods may also be considered as a capacity expansion strategy that may not require additional right-of-way.

7.3.3 Aligning Planned Projects with Congested Corridors and Bottlenecks

This section compares the project and strategy inventory from the latest STIP, LRTP, Transit Master Plan, Bicycle Mobility Plan, Freight and Goods Movement Plan, and RI*STARS program with the top bottlenecks and congested corridors in the State in order to determine the extent to which currently programmed or planned projects address existing congestion issues. Table 7.3 maps entries from the project and strategy inventory to sites of the “Top 30 Bottlenecks” and “Top 20 Freight Bottlenecks” in Rhode Island.

The “proximate cause” column in this table is an assessment of the immediate geometric and operational characteristics that are contributing to the bottleneck, combined with a level of demand that exceeds the capacity of the segment or interchange. The proximate causes identified in this table include:

- Freeway merge.
- Freeway lane drop.
- Overcapacity traffic signal.
- Steep grade.
- Other.

Bottlenecks were determined to align with projects or strategies when the proposed activity identified the bottleneck location specifically. In addition to those corridors or intersections mentioned by name, some proposed projects or strategies could address congestion issues near a bottleneck and thus indirectly reduce congestion at the bottleneck. For example, several transit projects serving downtown Providence could foreseeably reduce congestion on corridors approaching downtown. Note that implementing the projects or strategies aligned with the bottleneck may not entirely eliminate congestion at the bottleneck. The project may only partially address the problem. Strategies such as bus on shoulder running, for example, will allow bus riders to bypass the congestion but will not improve conditions for other drivers, aside from any reduction in traffic that comes from mode shift to the more attractive bus service. Even if a project were to completely eliminate the immediate bottleneck, it is possible that bottleneck conditions will shift to a downstream location that also is over capacity.

The table indicates that planned projects or strategies address several congestion issues in Rhode Island, and many interventions address sites of both freight and regular bottlenecks. In addition to the bottlenecks aligning directly with interventions, several of the State’s major bottlenecks and congested corridors are in or directly adjacent to downtown Providence. These sites are likely to be affected by several major active transportation and public transportation efforts in the Providence area identified in the LRTP, STIP, Transit Master Plan, and Bicycle Master Plan.

Table 7.3 Combined Top 30 Bottlenecks and Top 20 Freight Bottlenecks and STIP/LRTP Project/Strategy Alignment

Rank[1]	Name	Proximate Cause	Project or Strategy Alignment (if applicable)
R1/F1	I-95 S @ RI-7/ RI-146/ Charles St/ Exit 23	Freeway Merge: Lane striping is for Type B weave favoring Route 146 over I-95 SB. Traffic on I-95 SB must do one lane change for Exit 22 and two lane changes for Route 6/10 which slows traffic on I-95 SB.	• RI*STARS study will look at speed harmonization on Route 146 South or other ITS mitigation (mid term). • Installation of collector-distributor road and ramp braiding—concept done as part of Viaduct South Design Study Report (long term). • Roadway Capacity Expansion (LRTP 2040): Route 6 East at I-95. Resolving merge/weave bottleneck with Route 146 North by using a collector-distributor road.
R2/F2	I-95 N @ U.S. 1 ALT/ Thurbers Ave/ Exit 18	Freeway Merge/Freeway Lane Drop: Horizontal curve just upstream of the ramp merge combined with downstream lane drop to I-195 EB.	• RI*STARS study looking at ramp metering or other ITS solution; possibly restriping to add auxiliary lane between on-ramp and 195 off-ramps. R3 and R4 must be solved to avoid diverting traffic to upstream bottlenecks.
R3/F3	I-95 N @ U.S. 6/ RI-10/Exit 22	Freeway Merge/ Freeway Lane Drop: Heavy ramp traffic impacting the mainline with downstream lane drop to Route 146 NB.	• Roadway Capacity Expansion (STIP): The Providence Viaduct project will transform the I-95 Northbound viaduct for motorists through bridge construction, reconstruction, and rehabilitation, along with the reconfiguration of a series of ramps to separate conflicting lanes of traffic. The construction of a new collector distributor road will also eliminate merging conflicts. The new configuration is expected to significantly improve traffic safety and also reduce backup from the Route 6/10 approach by up to 96 percent. • Roadway Capacity Expansion (LRTP 2040): Route 6 East at I-95. Resolving merge/weave bottleneck with Route 146 North by using a Collector Distributor Road. • Transit Operations (TMP). TMP bus on shoulder Rt. 6 and I-95.
R4/F4	I-195 W @ I-95	Freeway Merge/Freeway Lane Drop: Major system interchange consisting of on-ramps followed by on-ramp and downstream lane drop on I-95 NB; major ramp merge from I-195 following by lane drop to Thurbers Ave on I-95 SB.	• Roadway Capacity Expansion (STIP): The Providence Viaduct project will transform the I-95 Northbound viaduct for motorists, as described under R3. • RI*STARS—looking to restripe and add a lane on I-95 SB between 195 and Rt. 10 or Rt. 37
R5/F5	RI-146 S @ I-95	Freeway Merge: Heavy ramp traffic merging onto mainline.	• Transit Operations (TMP). Rt 146. TMP bus on shoulder at Mineral Spring and I-95. • Roadway Capacity Expansion (LRTP 2040): Route 6 East at I-95. Resolving merge/weave bottleneck with Route 146 North by using a collector-distributor road.

Rank[1]	Name	Proximate Cause	Project or Strategy Alignment (if applicable)
R6/F6	I-95 N @ RI-7/ RI-146/ Charles St/ Exit 23	Freeway Merge/Freeway Lane Drop: 4-lane I-95 NB mainline drops to 3 lanes with exit only lane to Route 146 NB with upstream on-ramp from Exit 22.	• This location will be addressed by components project in R3/F3 above (I-95N Viaduct), including: – New "duck under ramp" for on-ramp from 6/10 Connector to I-95 NB. – New collector-distributor road and merge from I-95 NB to 146 NB. – New deviation for on-ramp from 6/10 Connector/downtown to Route 146 NB and Orms St. • See November 2017 RIDOT Infrastructure for Rebuilding America (INFRA) Grant Application for Full Explanation and Project Description.
R7/F7	U.S. 6 E @ I-95	Freeway Merge: Major interchange; ramp merges on the ramps resulting in upstream bottlenecks.	• Roadway Capacity Expansion (LRTP 2040): Route 6 East at I-95. Resolving merge/weave bottleneck with Route 146 North by using a collector-distributor road. • Roadway Capacity Expansion (STIP): The Providence Viaduct project will transform the I-95 Northbound viaduct for motorists, as described under R3. • Roadway Capacity Expansion (LRTP 2040): I-95 South at Route 146 South. Resolving merge/weave bottleneck with Route 6/10 by installing a collector-distributor road. • Transit Operations (TMP). TMP bus on shoulder Rt. 6 and I-95.
R8/F8	I-95 N @ RI-10/ Exit 16	Freeway Merge: Heavy ramp traffic from Route 37 and from Jefferson Blvd combined impacting the mainline.	• RI*STARS—Restripe and add/extend auxiliary lanes between Rt. 10 and Rt. 37. • Transit Operations (TMP). Bus on shoulder I-95.
R9/F9	I-195 W @ Broadway/Exit 6	Freeway Lane Drop: Lane drop within Interchange.	• Roadway Capacity Expansion (LRTP 2040): Alleviate bottleneck on I-195 WB @ Broadway. I-195 WB has a lane drop between Broadway and the Washington bridge, creating a bottleneck and high congestion. Solution would add a lane to increase capacity. Note: current ROW is constrained and would require significant rebuild of retaining wall. • Washington Bridge project won BUILD grant and will be in construction in 2021. • Project extending fifth lane across bridge to Exit 2. • Transit Operations (TMP): I-195. TMP bus on shoulder Broadway and S. Main.
R10/F10	U.S. 1 S (Post Road) @ Airport Rd	Overcapacity Traffic Signal: Major signalized intersection.	• Roadway Capacity Expansion (LRTP 2040): Add capacity to Airport Road @ Post Road. Many traffic signals in close proximity cause congestion on Airport Road. Signal timing and coordination would help add capacity on Airport Road, better connecting T.F. Green Air freight terminal to main roads. • RI*STARS—signal optimization—Route 1 between Route 37 and Airport Connector.
R11	RT-103/ RI-103 E @ RI-103/Main St	Overcapacity Traffic Signal: Two closely spaced intersections along Rte. 114—one at Market St and the other at Route 103.	• Signal timing improvement. • Capacity expansions and potential new turn lanes especially at Market St. bottleneck. Eliminate on street parking and shoulder and create left turn only lane to allow for geometry Improvements.

Rank[1]	Name	Proximate Cause	Project or Strategy Alignment (if applicable)
R12/F12	RI-146 N @ Sayles Hill Rd	Overcapacity Traffic Signal: Only signalized intersection on a limited access highway.	• ITS and Operations (LRTP 2040): Route 146 at Sayles Hill Road. Eliminate the traffic signal using grade separation. RIDOT submitted INFRA grant to fund this which would start in 2021 if awarded. • Transit Operations (TMP). TMP Bus on shoulder at Rt. 146A and Sayles Hill.
R13/F13	I-195 W @ U.S. 44/4TH ST/ Taunton Ave/ Exit 4	Freeway Merge: Type C weave but favoring the ramp and not I-195 WB mainline. 3 lanes on I-195 WB opens up to 5 lanes on the bridge. Heavy ramp traffic merging onto I-195 WB that has an upstream horizontal curve.	• Roadway Capacity Expansion (LRTP 2040): Taunton and Warren I-195 Interchange. Connectivity to/from Interstate in East Providence. • R9/F9 mitigation would help solve this bottleneck.
R14/F11	RI-114 N @ RI-103/Baker St./ Child St	Overcapacity Traffic Signal: Only signalized intersection on a limited access highway.	• Signal timing improvements. • Capacity expansions and potential new turn lanes especially at Market St. Bottleneck. Eliminate on street parking and shoulder and create left turn only lane to allow for geometry Improvements.
R15/F14	RI-4 S @ W Allenton Rd	Overcapacity Traffic Signal: Signalized intersection.	• Transit Operations (TMP). Rt 4. TMP Bus on shoulder Lafayette and W. Allenton. • Route 4 traffic light removal (LRTP 2040). Grade separation to remove traffic signals from Route 4.
R16	RI-2 S @ RI-117/ Centerville Rd	Overcapacity Traffic Signal: Signalized intersections just past Route 117 (as Rte. 2/ Rte. 117 is grade separated).	• RI*STARS—Widen Rt. 117 between I-95 and Rt. 2 in 2025. • RI*STARS—Consider adaptive signal system along Rt. 2 between I-295 and Rt. 3
R17	U.S. 1 N @ RI-117/ Greenwich Ave/ Centerville Rd	Other: Overcapacity roundabout.	
R18	RI-15 W @ RI-7/ Douglas Ave	Overcapacity Traffic Signal: Major signalized intersection.	• RI*STARS corridor optimization—RIDOT maintenance and restripe to add turn pockets.
R19/F15	RI-4 N @ I-95	Freeway Merge: 2 lanes on I-95 mainline merging with a 3 lane Rte. 4 ramp.	• Roadway Capacity Expansion (LRTP 2037): Construct a new interchange at Route 4/I-95/ Route 403 subject to successful outcome of environmental and TIP processes (BUILD grant application submitted to FHWA in June 2020). • Transit Operations (TMP): TMP Bus on shoulder at I-295 and Rt. 4. • Transit Operations (TMP): I-95_Rt. 4. TMP bus on shoulder at 401 and merge. • RI*STARS—extend Rt. 4 third lane to Cowesset Road (to be added to I-95/Rt. 4 interchange project).
R20	RI-15 E @ RI-126/ Smithfield Ave	Overcapacity Traffic Signal: Signalized intersection.	• RI*STARS corridor optimization—RIDOT maintenance and restripe to add turn pockets.
R21/F16	U.S. 6 W @ Hartford Pike	Overcapacity Traffic Signal: Signals on U.S. 6 WB at Rte. 110 EB.	• Signals have been coordinated as part of 6/10 project.

Rank[1]	Name	Proximate Cause	Project or Strategy Alignment (if applicable)
R22	RI-15 E @ RI-7/ Douglas Ave	Overcapacity Traffic Signal: Major signalized intersection.	• RI*STARS corridor optimization—RIDOT maintenance and restripe to add turn pockets.
R23	U.S. 1 S @ RI-4	Overcapacity Traffic Signal: Major signalized intersection.	• Transit Operations (TMP). Rt 4. TMP bus on shoulder Lafayette and W. Allenton. • Route 4 traffic light removal (LRTP 2040). Grade separation to remove traffic signals from Route 4.
R24/F17	Eddy St S @ I-95/Thurbers Ave	Overcapacity Traffic Signal: Major signalized intersection.	
R25	RI-15 E @ RI-146/ Louisquisset Pike	Overcapacity Traffic Signal: Two closely spaced intersections at the Route 146 interchange.	• Transit Operations (LRTP 2040). Implement bus on shoulder on Hwy 146 Southbound. Implement bus on shoulder on 146 SB from Mineral Spring to downtown (2.3 mi). Concerns about the southern limit/terminus at I-95. System coordinated in 2020.
R26	RI-2 N @ RI-115/ Toll Gate Rd	Overcapacity Traffic Signal: Major signalized intersection.	• RI*STARS—Widen Rt. 117 between I-95 and Rt. 2 in 2025. • RI*STARS—Consider adaptive signal system along Rt. 2 between I-295 and Rt. 3.
R27	U.S. 44 W @ RI-5/ Sanderson Rd/ Cedar Swamp Rd	Overcapacity Traffic Signal: Major signalized intersection with Route 5.	• RI*STARS to consider adaptive signal system.
R28	U.S. 44 W @ I-195	Freeway Merge: Heavy ramp traffic merging onto mainline.	• Addressing R9 (adding lane on Washington St. bridge) will help with R28 mitigation. • Additional strategies through RI*STARS include: – Continue to assess blocking of local road access. – Continue to assess rerouting local traffic patterns and implementing new one-way roads along local road system. – Continue to assess geometry and access from Summit St. to on-ramp.
R29/F12	RI-146 S @ Sayles Hill Rd	Overcapacity Traffic Signal: Two closely spaced intersections along Rte. 114—one at Market St and the other at Route 103.	• ITS and Operations (LRTP 2040): Route 146 at Sayles Hill Road. Eliminate the traffic signal using grade separation. RIDOT submitted INFRA grant to fund this which would start in 2021 if awarded. • Transit Operations (TMP). TMP bus on shoulder at Rt. 146A and Sayles Hill. RIDOT currently has an INFRA grant application to resolve this bottleneck with several changes such as: – Full-depth pavement reconstruction along RI-146 from the I-295 interchange to the Massachusetts state line. – Extending the weave length for RI99 ramp and RI-146 S. – Improving geometry of I-295 SB offramp to RI-146. – Constructing four lanes on RI-146 over Sayles Hill Road with frontage road for access to local businesses and removing outdated signalization. – Placing safety barrier to prevent access to RI-146A and dangerous U-turns. – Replacing two bridges along corridor and doing preservation work on another. – Bus on shoulder and other various traffic safety improvements along RI-146 South into Providence. – ITS/traffic monitoring for full corridor length. – Fiber/broadband installation throughout corridor.

Rank[1]	Name	Proximate Cause	Project or Strategy Alignment (if applicable)
R30/F18	I-295 N @RI-37/ Exit 3	Steep Grade	• Roadway Capacity Expansion (STIP): This line item includes installation of an additional lane on between Exit 3 (Route 37) and Exit 4 (Route 14). • Roadway Capacity Expansion (LRTP 2040): Widen I-295 as bypass. I-295 has been discussed as freight bypass around Providence. This project would add capacity by increasing lane capacity from 2 to 3 lanes in each direction along the southern segment of this Interstate (BUILD grant application submitted to FHWA in June 2020).
F19	U.S. 1 N @ RI-4	Overcapacity Traffic Signal Major signalized intersection.	• Transit Operations (TMP). Rt 4. TMP bus on shoulder Lafayette and W. Allenton. • Route 4 traffic light removal (LRTP 2040). Grade separation to remove traffic signals from Route 4.
F20	I-295 S @ I-95	Freeway Merge/ Freeway Lane Drop: 2 lane I-295 SB ramp merges with I-95 mainline followed by 2 consecutive lane drops on I-95 S.	• Roadway Capacity Expansion (LRTP 2040): Widen I-295 as bypass. I-295 has been discussed as freight bypass around Providence. This project would add capacity by increasing lane capacity from 2 to 3 lanes in each direction along the southern segment of this Interstate. • RI*STARS—added capacity between I-295 and Rt. 4 • Transit Operations (TMP): TMP bus on shoulder at I-295 and Rt. 4.

1 ”R” prior to a rank number denotes a “regular” bottleneck, while “F” prior to a rank number indicates a freight bottleneck.

Table 7.4 identifies potential geometric and operational improvements that could be suited to addressing each proximate cause. A more detailed engineering analysis would be needed for each location to determine the specific solution(s) most appropriate to that location. Such an analysis should evaluate multiple alternatives with consideration of ROW constraints, costs, community and environmental impacts, and other factors. Furthermore, in the context of a congestion management study, the potential impacts of local or statewide demand reduction strategies should be considered before capacity expansion is selected as a preferred solution. Demand reduction strategies are not specifically listed in this table because any time of demand reduction strategy would help to reduce overall traffic demand, which would in turn help to reduce congestion at any type of bottleneck.

Table 7.4 Bottleneck Proximate Causes and Potential Strategies

Proximate Cause	Potential Operations and Capacity Strategies
Freeway Merge	Ramp Metering. Geometric Design Improvements. Acceleration/Deceleration Lanes. Highway Widening by Adding Lanes. Hard Shoulder Running.
Freeway Lane Drop	Freeway Incident Detection and Management Systems. Service Patrols. Speed Harmonization. Highway Widening by Adding Lanes. Hard Shoulder Running.

Proximate Cause	Potential Operations and Capacity Strategies
Overcapacity Traffic Signal	Traffic Signal Coordination and Modernization. Reversible Traffic Lanes. Access Management. Restricting Turns at Key Intersections. Converting Streets to One-Way Operations. Geometric Design Improvements. Grade Separations (Not Added Capacity). New Arterial Streets. Grade Separations (Added Capacity). Major Intersection/Interchange Improvements.
Steep Grade	Geometric Design Improvements. Highway Widening by Adding Lanes.

Several gaps were identified in the coverage of the existing planned projects or strategies. Of the 32 unique bottlenecks, 14 were determined to lack a clear link to congestion-related projects or strategies sufficient to mitigate the problem. Of these sites, six were located in the top congested corridors, potentially indicating congestion issues of greater network-level significance. These locations are therefore recommended as priority sites for further study (listed in order of bottleneck rank):

- Bottleneck R4/F4: I-195 W @ I-95.[12]
  - Congested corridor(s): #3. Interstate 195—Westbound from Massachusetts State Line to I-95 Interchange, Providence.
- Bottleneck R6/F6: I-95 N @ RI-7/RI-146/Charles St/Exit 23.
- Bottleneck R18: RI-15 W @ RI-7/Douglas Avenue, Bottleneck R20: RI-15 E @ RI-126/Smithfield Avenue, and Bottleneck R22: RI-15 E @ RI-7/Douglas Avenue.
  - Congested corridor(s): #8. State Route 15/Mineral Spring Avenue between U.S. Route 44, North Providence and Main St, Pawtucket.
- Bottleneck R24/F17: Eddy St S @ I-95/Thurbers Avenue.

7.4 Evaluating Strategies

A variety of analysis tools are available to help evaluate the effectiveness (or potential effectiveness) of congestion management strategies. These tools can be applied at the following stages of decision-making:

- Deciding on a preferred project alternative to address an identified problem.
- Prioritizing among different candidate projects.
- Estimating the expected benefits of an overall program of projects.
- Developing postimplementation estimates of project benefits (by using observed rather than projected data for as many inputs as possible).

[12] Note: Project in Table 7.1 addresses I-95 but not I-195.

Table 7.5 provides a summary of analysis tools cross-referenced by the types of strategies for which they are most well suited. Table 7.6 identifies the general types of performance measures that can be evaluated by each tool. Only *outcome* performance measures are considered *output* measures (for example, bike path mileage or number of intersections with advanced signal controls) are assumed to be measured through agency tracking rather than through an evaluation tool. Since the CMP measures are expressed as systemwide measures, in most cases the tool will not be able to produce the actual change in the systemwide measure just from a single project-level analysis. For example, an evaluation of change in delay or reliability for an intersection improvement project using Highway Capacity Manual (HCM) methods will not identify the change in total percent of travel that is reliable. However, the project level measures should relate to the overall system level measures. A description of each analysis tool is presented following the tables.

Table 7.5 Congestion Strategy Evaluation Tools/Models by Strategy

Tool/Model	TDM	Land Use	Bike/ Ped	Public Transportation	ITS/ Operations	Pricing	Roadway/ Mobility	Capacity Expansion
Statewide Travel Demand Model		●	[1]	●		[1]	[1]	●
Traffic Simulation Models					●		●	●
Tool for Operations Benefit/Cost (TOPS B-C)					●		●	
Highway Capacity Manual methods					●		●	●
CMAQ Emissions Calculator Toolkit					●			
Transit Corridor Screening Tool				●				
Trip Reduction Impacts of Mobility Management Strategies (TRIMMS)	●	●		●				
Land Use Scenario Planning Tools		●						
Elasticities and Comparison Data	●	●	●	●		●		

[1] The model could potentially be used to support some of the project types in this category, but some modification and enhancement might be required. For example, the user might translate roadway mobility improvements (such as turn restrictions or access management) into equivalent link-level capacity changes and update and rerun the model with the new link capacities.

Table 7.6 Congestion Strategy Evaluation Tools/Models by Performance Measure

Tool/Model	Improve Reliability (Roadway)	Improve Reliability (Transit)	Reduce Recurring Congestion (Roadway)	Reduce Recurring Congestion (Transit)	Improve Freight and Goods Movement (Truck Reliability)	Increase Modal Choice and Competitiveness (% Non SOV; Bike Path Usage; Transit Ridership)	Reduce Emissions and Improve Air Quality (VMT, GHG Emissions)
Statewide Travel Demand Model			●	●		●	●
Traffic Simulation Models			●				
TOPS B-C	●		●				
Highway Capacity Manual Methods	●		●		●		
CMAQ Emissions Calculator Toolkit							●
Transit Corridor Screening Tool				●		●	●
TRIMMS						●	●
Land Use Scenario Planning Tools						●	●
Elasticities and Comparison Data						●	●

7.4.1 *Statewide Travel Demand Model*

The Rhode Island Statewide Travel Demand Model is used to support a variety of analytical needs such as preparation of various system and subarea analyses, including the LRTP, transit projects, toll projects, and other technical analysis. Model outputs, including vehicle-miles of travel, vehicle-hours of travel, and travel speeds by link can be used to illustrate the location, duration, and extent of congestion under baseline and forecast conditions. While measures of baseline traffic congestion are now developed from observed data, the model is still needed to develop forecasts of congestion metrics at a systemwide level. The model can be used to forecast changes in congestion assuming currently programmed TIP projects or for projects included in the LRTP.

The Statewide Travel Demand Model is best suited for providing baseline data such as traffic volumes and capacity on specific links, as well as to assess the impact of major investments in roadway capacity and transit. It is not well suited to evaluate the impacts of other types of congestion management strategies such as intersection improvements, bicycle and pedestrian improvements, or demand management.

7.4.2 *Traffic Simulation Models*

Traffic simulation models are designed to assess the travel impacts of multimodal and roadway specific projects affecting traffic operations. The use of simulation models requires that the analysis area be relatively constrained to a small subarea of the regional network, usually a corridor or specific project area. These 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 models can be somewhat resource-intensive to apply and will generally be developed only for major projects. Information on calculation of various measures of effectiveness using simulation outputs is available in FHWA's Traffic Analysis Toolbox.[13] Emerging methods for using simulation model outputs to calculate travel time reliability impacts are detailed in Strategic Highway Research Program 2 projects L04, L05 (Technical Reference), and L08.

7.4.3 *Tool for Operations Benefit/Cost*

TOPS-BC is one of several benefit/cost tools that can be used to evaluate operational and ITS improvements. It is a spreadsheet tool that provides relatively quick assessments of ITS and operational projects with limited data.[14] The tool is supported by the U.S. Department of Transportation's benefit and cost databases, allowing users to access and incorporate national experience in impact measurement. TOPS-BC provides the following features:[15, 16]

- The ability to investigate the expected range of impacts associated with previous deployments and analyze many transportation system management and operational strategies.
- A screening mechanism to help identify appropriate tools and methodologies for conducting a benefit/cost analysis based on analysis needs.
- A framework and default cost data to estimate the life-cycle costs (including capital, replacement, and continuing operating and maintenance costs) of various transportation system management and operational strategies.
- A framework and suggested impact values for conducting simple sketch planning level benefit/cost analysis for selected transportation system management and operational strategies.
- The latest version of the tool computes travel time reliability performance measures with and without operational strategies deployed.

7.4.4 *Highway Capacity Manual Methods*

The HCM provides methods and tools for estimating the congestion benefits of roadway capacity and traffic operations strategies applied for intersections and roadway segments (urban streets, freeways, and rural roads). Measures include traditional metrics such as travel time/speed, delay, level of service, as well as other quality of service metrics and accessibility.[17]

The HCM methods for freeway facilities and urban streets have recently been enhanced to estimate the reliability benefits of strategies. The reliability methodology is sensitive to the main sources of variability that lead to travel time unreliability, including temporal variability in demand, incidents, weather events, work zones, and special events.

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13 http://ops.fhwa.dot.gov/trafficanalysistools/.

14 https://ops.fhwa.dot.gov/plan4ops/topsbctool/index.htm.

15 http://www.itsbenefits.its.dot.gov/.

16 http://www.itscosts.its.dot.gov/.

17 Highway Capacity Manual, Sixth Edition: A Guide for Multimodal Mobility Analysis.

7.4.5 CMAQ Emissions Calculator Toolkit[18]

FHWA developed a set of spreadsheet tools to assist in calculating emissions reductions from CMAQ projects. The CMAQ tools are noteworthy for requiring relatively low effort and also being tailored to a variety of project types. As of the spring of 2020, tools are available for the following strategies that could reduce congestion:

- Congestion reduction and traffic flow improvements.
- Managed lane facilities and conversions.
- Bicycle and pedestrian improvements.
- Transit bus service and fleet expansion.
- Carpooling and vanpooling.

Two of the tools—managed lanes, and congestion reduction and traffic flow—provide outputs directly relevant to congestion metrics, as well as changes in pollutant emissions. For example, the traffic flow improvement tool provides outputs of before-and-after average traffic speed and travel time savings (for traffic signal synchronization), or delay reduction (for roundabouts and intersection improvements), using HCM methods. The demand focused tools (bike/ped, transit, carpooling/vanpooling) require the user to estimate and input travel demand changes and only provide outputs of emissions changes, and therefore do not provide additional information useful to congestion strategy analysis, aside from supporting the GHG reduction metric.

7.4.6 Transit Corridor Screening Tool

To meet the needs of Rhode Island for evaluating and prioritizing transit improvements, a Transit Corridor Screening Tool was developed as part of the CMP project. This spreadsheet-based tool accepts inputs of changes in transit travel time, frequency/headways, or fares, and provides estimates of the increase in ridership as well as the corresponding decrease in traffic congestion along the corridor served.

The tool is intended for screening and prioritizing investments, based on elasticities of ridership response from the literature. It should not be used as a substitute for more detailed modeling of ridership for major transit improvements. A memorandum documenting the tool's functionality and sample results is provided as Appendix F.

7.4.7 Trip Reduction Impacts of Mobility Management Strategies

The TRIMMS tool, developed by the Center for Urban Transportation Research at the University of South Florida, can be used to estimate the trip reduction, VMT reduction, emissions changes, and cost-effectiveness of travel demand management strategies, including employer/worksite focused strategies as well as land use. TRIMMS is a nonspatial model implemented in a spreadsheet environment.[19] As such it is

[18] A National Cooperative Highway Research Program project is underway as of this writing to develop somewhat similar tools with additional functionality.

[19] http://trimms.com/.

not well-suited to estimate actual changes in congestion. However, changes in VMT generated within a subarea can be compared with total VMT generated in that subarea to estimate the relative impact on traffic volumes and therefore congestion.

Projects and services that can be evaluated by TRIMMS include: transit and other incentives; carpool ride matching; vanpooling; parking policy and pricing; bicycling and walking programs; telework and compressed work schedules; employer services; marketing and promotion; carsharing and bikesharing; park-and-ride lots; shuttle buses; land use/site design; and more.

7.4.8 *Land Use Scenario Planning Tools*

Land use scenario planning tools, including Envision Tomorrow/ET+, CommunityViz, and Urban Footprint can be used to estimate the vehicle travel impacts of alternative land use scenarios, either at a local/subarea level or for an entire region or State. These tools include modules that translate changes in land use patterns into changes in auto-trips, VMT, and emissions. They do not calculate changes in congestion directly, but the changes in trips or VMT could be applied to regional travel demand model or simulation model inputs to estimate changes in congestion or used on their own to look at the potential magnitude of impacts.

These models take some effort to set up and would normally be applied only as part of a land use scenario planning process. However, if Rhode Island were to use such a tool for other purposes, it could be used to inform the selection of land use-based congestion management strategies.

7.4.9 *Elasticities and Comparison Data*

In cases in which a suitable tool does not exist, or the data and resources to apply the tool are insufficient, agencies often use “off-model” approaches to develop rough estimates of impacts. Two common approaches include the use of elasticities and the use of comparison data from similar projects. For example, pricing policies may be evaluated by applying price elasticity estimates (e.g., percent change in vehicle travel with respect to percent change in price) to baseline demand estimates. Elasticities can also be applied to land use (e.g., change in vehicle or walk trips with respect to a change in pedestrian environment or accessibility). Bicycle and pedestrian improvements and transit improvements (such as new shuttle services) also are sometimes evaluated using observed data from similar, implemented projects.

8.0 Strategic Action Plan for Implementing the Congestion Management Process

This section documents the implementation process for the CMP. It describes how CMP projects are integrated into existing plans and programmed and implemented through inclusion of CMP strategies in various components of the Rhode Island transportation planning process. This section also presents a process for conducting a CMP analysis for various transportation investment types and presents an Action Plan to implement data collection, evaluation, and monitoring recommendations.

8.1 Integration with Existing Statewide Plans

This section describes how the CMP coordinates with other major statewide plans, including the Rhode Island LRTP, STIP, modal plans, and major corridor plans. The CMP both informs and receives information from these plans as part of the transportation planning process and requires coordination and communication between agencies and project teams to ensure congestion related goals and strategies are being considered.

Congestion management strategies can be consistent with and support other State objectives. Strategies undertaken to reduce crashes and/or incidents will in turn reduce nonrecurring congestion. Strategies undertaken as part of the CMP to reduce VMT and reduce the number of bottlenecks should result in air quality benefits and reductions in GHG emissions as required by the Resilient Rhode Island Act.

8.1.1 *Long-Range Transportation Plan*

The Rhode Island Moving Forward 2040 LRTP is a critical element of the State Guide Plan, setting direction for State transportation policy and action. It complements elements dealing with land use, economic development, greenspace and greenways, and other related topics. It provides a framework with which local comprehensive plans must be consistent, provides direction to the STIP's list of funded projects, and provides a basis for measuring adherence to air quality standards. It emphasizes people, places and goods movement in a safe and resilient manner, increasing transportation choices through a multimodal transportation network, and support healthy and sustainable communities, environment and the economy.

The CMP is an integral part of the State's long-range planning process and relates to the LRTP in the following ways:

- The LRTP provides a framework for the State's transportation system by identifying goals, objectives, and strategies for the State's transportation needs through the year 2040. For example, one of the goals, Connect People and Places, has Reduce Travel Congestion as one of its objectives using strategies such as emerging technologies, greater mode choice, and through prioritizing networks within each mode to ensure the connection between people and places. The CMP objectives and performance measures are built around this framework.

- The CMP objectives were cross-walked, as shown in Table 2.1, with the Moving RI Forward 2040 Goal Areas to ensure that the new CMP objectives are consistent with the overall congestion management-related goal areas and objectives in RI Moving Forward 2040.

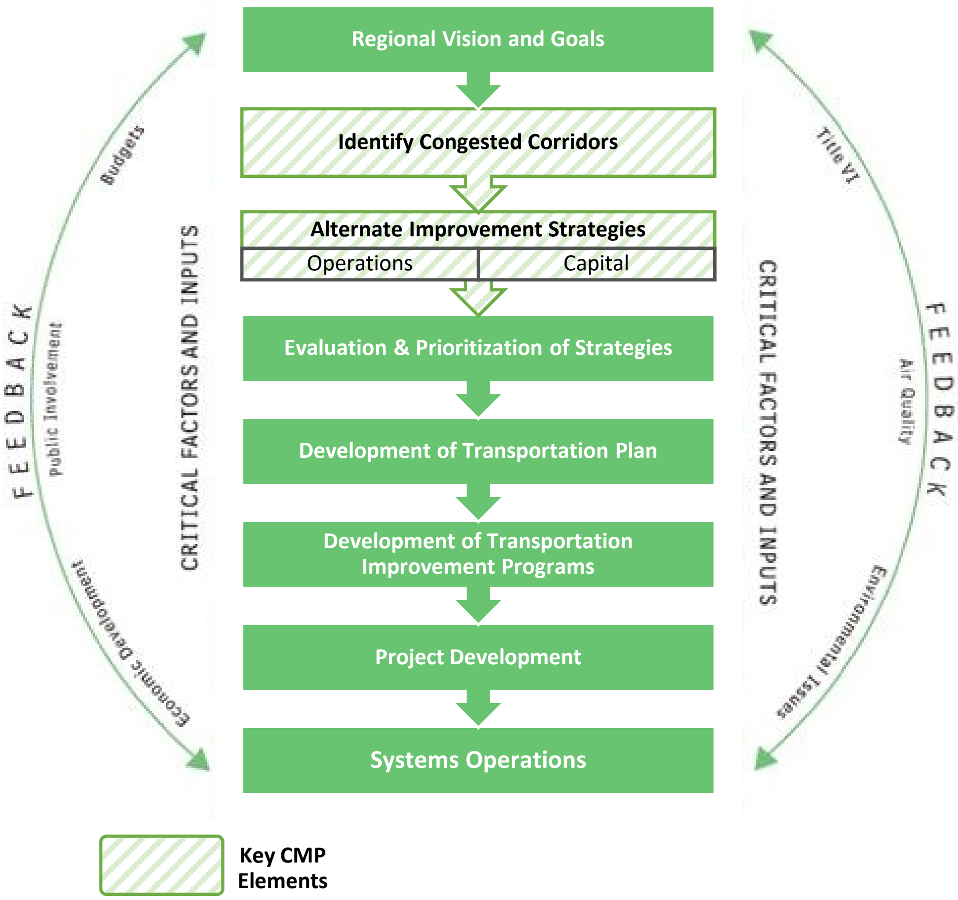
- The LRTP provides performance measures organized by goal area. The CMP uses these performance measures as a framework for developing the CMP performance measures and for understanding current data availability.
- The CMP helps monitor progress on LRTP strategies by establishing performance measures, such as GHG emissions, emission reductions by CMAQ projects, and VMT per capita, that relate to LRTP goals and objectives.
- The CMP provides an important avenue to include land use decision-making within the transportation planning process. It supports promoting land development and redevelopment in transportation-efficient locations.
- The CMP provides information on the location, duration, and extent of congestion, which can be used by Rhode Island's Division of Statewide Planning and its partners to identify congested corridors or segments in need of detailed analysis.
- The CMP Toolbox provides a framework for developing and evaluating transportation projects and strategies that maintain or reduce recurring and nonrecurring congestion. The suggested analysis tools are intended to be used in concert with existing tools such as travel demand modeling, corridor analysis, and traffic simulation to assess how congestion mitigation strategies contribute to achieving statewide goals and objectives related to congestion management. These tools can also be used to inform the LRTP.
- Once projects are implemented, the CMP provides a recommendation for ongoing data monitoring, both to assess the performance of the transportation system and to evaluate the effectiveness of the congestion management strategies that have been implemented. The information from this monitoring will provide important information to inform the success of LRTP strategies and help guide the next LRTP update.

Figure 8.1 shows how the CMP is integrated with the transportation planning process. This diagram is adapted from the FHWA Transportation Planning Process Briefing Book which provides an overview of transportation planning for Government officials, transportation decision-makers, planning board members, transportation service providers, interested stakeholders, and the public.[20] While not specifically called out in this diagram it is important to note that:

- Performance goals and objectives influence the identification of congested locations.
- The monitoring of system performance influences the identification of congestion locations.
- Performance measures influence the development of alternate improvement strategies.
- The regional or statewide travel demand model and other analysis tools are used in the evaluation and prioritization of strategies.

[20] https://www.fhwa.dot.gov/planning/publications/briefing_book/.

Figure 8.1 Integration of the Congestion Management Process with the Transportation Planning Process



Source: FHWA.

8.1.2 *State Transportation Improvement Plan*

The STIP lists transportation projects that the State of Rhode Island intends to implement using Federal funds in conjunction with State funds. For example, the FFY2018 to 2027 STIP includes the development of several large transit projects, including the Downtown Transit Connector and a new commuter rail station at the Pawtucket/Central Falls city line. The STIP is the primary means of implementing most of the congestion management strategies and projects identified through the CMP.

Relating to the CMP, the STIP invests funding in transportation alternatives statewide and encompasses the RI*STARS Bottleneck Reduction Program. Many of the Federal funding sources cited, including the Surface Transportation Block Grant Program, the National Highway Freight Program, and the CMAQ, are directed at projects that reduce congestion, along with accomplishing other objectives.

The Rhode Island Statewide Planning Council has established project application, programming schedule, project evaluation, and project selection processes for the STIP. The Council, Advisory Committee, and staff evaluate and prioritize investments based on criteria approved by the Council. The CMP relates to the STIP in the following ways:

- The CMP defines a process for programming and implementing effective strategies by introducing them into the LRTP process and subsequently for programming into the STIP. The CMP does not directly obligate funds, but rather it presents a toolbox of congestion strategies that can be implemented independently or as part of larger projects and programmed in future LRTPs and STIPs.

- The CMP provides system performance information for use by RIDOT, the Statewide Planning Council, Transportation Advisory Committee, and CMTF in evaluating projects for inclusion in the STIP.

- The CMP provides system performance information for project sponsors, which may influence their project applications for incorporation in the STIP.

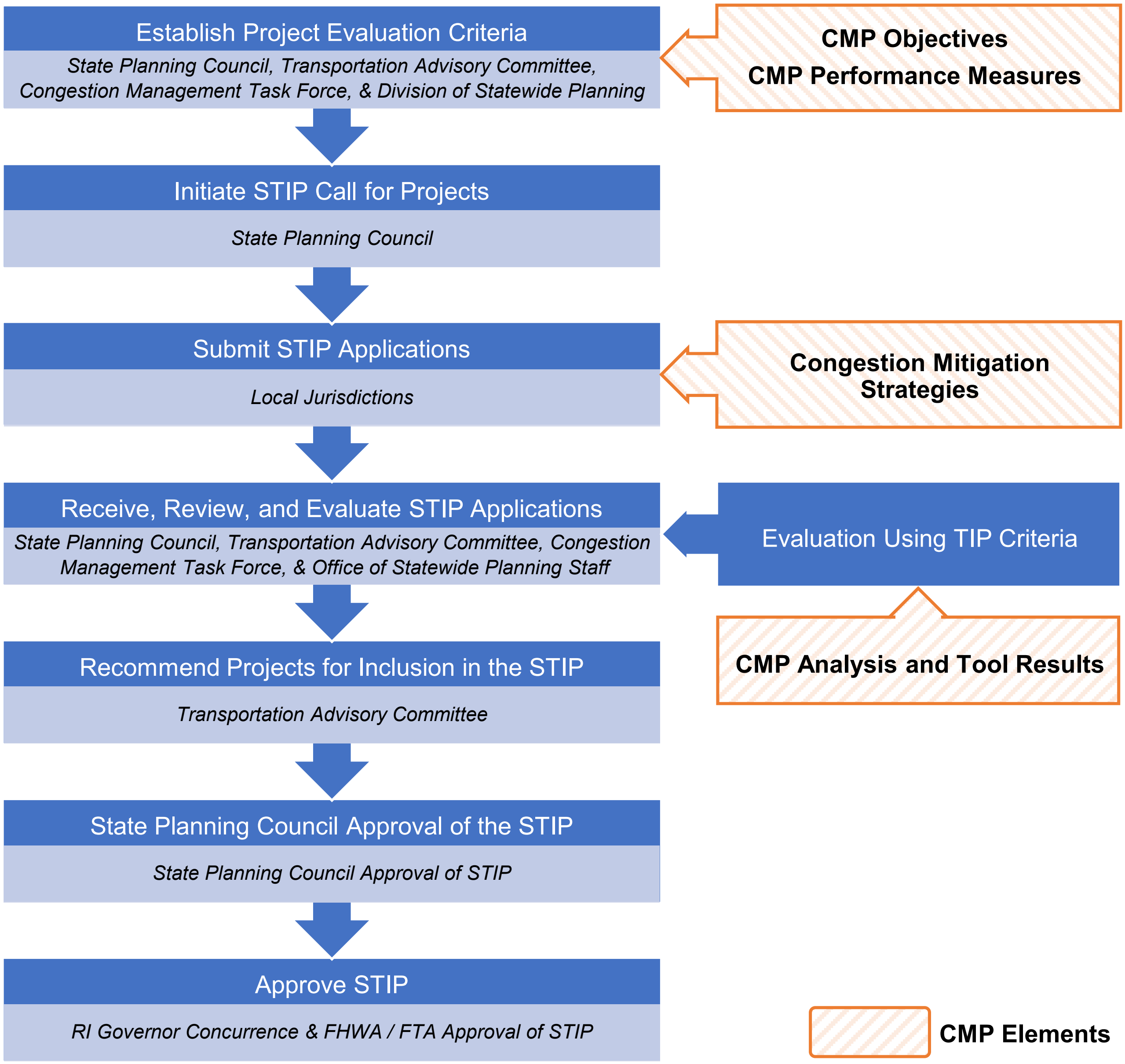
- The CMP Toolbox (Section 7.0) identifies alternative congestion management strategies, such as TDM, bicycle and pedestrian, and public transportation, for evaluation when considering SOV capacity-adding projects for inclusion in the STIP.

- The CMP Toolbox identifies potential congestion impacts, implementation costs, and implementation timelines for evaluating project effectiveness in terms of their contribution to a reduction in vehicle-miles traveled, traveler hours of delay, or number of trips shifted to transit or other alternative modes.

- The next STIP should incorporate the CMP objectives and performance measures into the application scoring process used to select and prioritize projects in the STIP. The CMP is intended to enhance, not replace, the existing STIP project selection process used by the Statewide Planning Council. It serves as an additional tool for decision-making by providing additional information and insight.

Figure 8.2 identifies how the CMP can be integrated into existing STIP processes. This diagram is based on discussions with the RIDSP and the State Planning Council/MPO Overview and Handbook.

Figure 8.2 Integration of the Congestion Management Process with the STIP



8.1.3 *Strategic Highway Safety Plan*

The Rhode Island SHSP is RIDOT's five-year transportation safety plan, with the latest plan developed to cover years 2017 to 2022. The SHSP uses data-driven analysis to identify a State's safety needs, set goals for reducing fatalities and injuries, and allocate investments in safety projects and programs in support of the State's Highway Safety Improvement Program.

The CMP relates to the SHSP in the following ways:

- The SHSP states that traffic incidents are an important concern in Rhode Island because they can result in a safety issue and cause nonrecurring congestion delays. The plan identifies strategies and action items that address congestion mitigation, such as implementing a Traffic Incident Management Plan and establishing or enhancing local incident management teams.

- The SHSP identifies strategies and action Items that address data issues related to congestion, such as implementing data uniformity, analysis procedures, accessibility, and distribution.
- The plan highlights training and policies to reduce congestion as it relates to traffic incidents.
- The CMP recommends development of a service patrols program to rapidly respond to and help clear incidents and reduce secondary incidents.
- The CMP includes incident management-focused performance measures to help assess the effectiveness of incident management strategies.

8.1.4 *Freight Forward: Freight and Goods Movement Plan*

The Rhode Island Freight Forward: Freight and Goods Movement Plan (2016, amended in 2017) is a comprehensive multimodal transportation plan that describes the immediate and long-range planning activities and investments associated with Rhode Island's freight system. This plan identifies the infrastructure used for freight and goods movement, freight needs, State economic development goals, and the investment strategies, policies, and data necessary to promote an efficient, reliable, and safe freight transportation network.

The CMP relates to the Freight and Goods Movement Plan in the following ways:

- The CMP's objective of improving freight and goods movement highlights the congestion issues facing freight and goods movement in Rhode Island. The CMP includes freight-focused performance measures that can be used to track the effectiveness of congestion management measures specifically at reducing congestion affecting freight movement.
- The CMP identifies the top 20 freight bottlenecks with information needed to comply with the 23 U.S.C 150 (e)(4) requiring State DOTs to report on addressing freight bottlenecks.
- The Freight And Goods Movement Plan identifies conditions and performance of the State's freight transportation system, including performance issues related to congestion.
- The plan inventories facilities with mobility issues, including bottlenecks, and identifies strategies to address them. It also identifies significant congestion or delay caused by freight movements and strategies to mitigate that congestion or delay. Congestion reduction strategies identified in the plan are included in the CMP. As with the LRTP, CMP, SHSP, and other modal plans, the STIP is the primary vehicle for programming projects identified in the Freight and Goods Movement Plan.
- The plan notes how CMAQ funding is used to support projects that contribute to air quality improvement and congestion relief.

8.1.5 *Corridor Plans, Project Development, and NEPA Analysis*

Corridor-and project-level plans, including environmental analysis under the National Environmental Policy Act (NEPA), are a primary vehicle for evaluating location-specific congestion management strategies, including traffic operations and capacity improvements, as well as travel demand management and land use strategies such as access management and bicycle and pedestrian improvements.

The CMP relates to corridor plans, project development, and NEPA analysis in the following ways:

- The CMP identifies the most congested corridors in the State and recommends corridors for further study that do not currently have significant congestion relief projects programmed or have not yet been studied in detail.
- The CMP Toolbox provides a universe of strategies to evaluate in addressing issues raised in corridor plans, project development, or NEPA analysis.
- The CMP Toolbox identifies the application scale for each strategy, noting which are appropriate for corridors or specific projects.
- The CMP provides congestion related performance data for use in corridor, project development, and NEPA plans.
- The CMP identifies tools and processes to evaluate the effects of project alternatives on congestion.

8.1.6 *Other Modal Plans*

In 2019 and 2020, Rhode Island has developed two other statewide modal plans: the TMP and the Statewide Bicycle Plan. These plans provide a detailed evaluation and recommendations of strategies related to transit and bicycle investment—two of the major categories of congestion management strategies. The CMP incorporates the recommendations of these plans by reference, rather than making its own detailed recommendations about transit and bicycle strategies. As with all other statewide plans, the STIP is the primary vehicle for implementing the strategies recommended in these plans. In addition, the CMP has several transit and bicycle-related performance measures to help assess the impacts of these statewide modal plans on congestion.

8.2 CMP Analysis Process

The following section presents the CMP analysis process for assessing the congestion reduction potential of CMP strategies in terms of established congestion management objectives and performance measures. 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 in the corridor. A quantitative analysis is required for projects that expand SOV capacity on the CMP network; otherwise a qualitative analysis is required for projects addressing a congestion problem and/or located on the CMP network.

8.2.1 *Preliminary Questions for All Projects*

Before determining which type of analysis to proceed with, project sponsors should complete the CMP Preliminary Questionnaire listed below and submit it as part of the CMP analysis for all STIP projects. These preliminary questions must be completed for all STIP projects, regardless of investment type. RDSP staff will review and approve the questionnaire and, if necessary, contact the submitting agency regarding any questions.

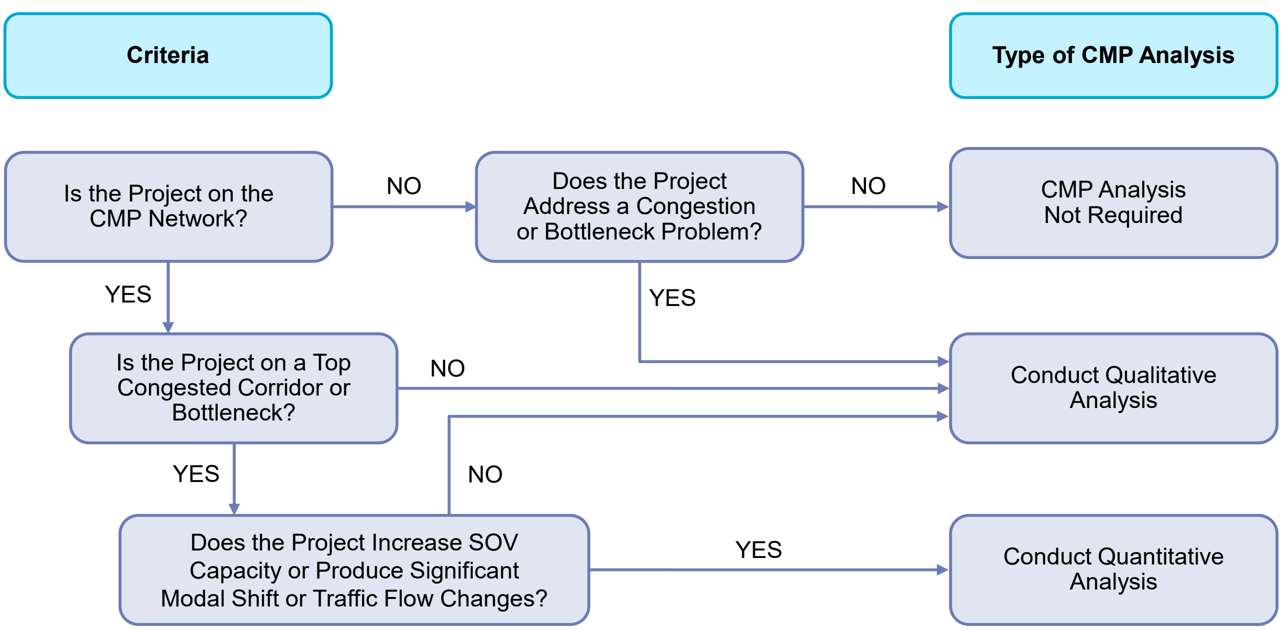
CMP Preliminary Questionnaire

- Describe the proposed improvement (facility, limits, project description).
- Does the project address bottleneck or congestion related issues? If yes, explain how.
- Is the project on the CMP strategy list (Table 7.1)? If yes, please note which strategy.
- Is the project located on the CMP network?
- Is the project located on an identified bottleneck or congested corridor?
- Does the project add significant SOV roadway capacity? If yes, explain how.
- Are there other congestion mitigation projects (e.g., TDM, land use, public transportation, ITS and operations, bicycle and pedestrian) within the project corridor that are programmed into the current STIP or otherwise underway or planned that will affect congestion at the project location? If yes, identify the project name(s).

8.2.2 *CMP Analysis Approach*

An overview of the CMP analysis process is provided in Figure 8.3. The figure depicts the criteria for determining the CMP analysis type. The following tables then outline the specific questions to be addressed for each CMP strategy type in a qualitative or quantitative analysis and identify tools that can be used for quantitative analysis.

Figure 8.3 CMP Analysis Approach



When would analysis not occur:

CMP analysis is not needed if the project does NOT address a congestion or bottleneck problem AND is NOT on the CMP Network.

When would qualitative analysis occur?

A qualitative analysis is needed if:

- The project is NOT on the CMP network but addresses a congestion or bottleneck problem.
- The project IS on the CMP network but does NOT address a top congestion or bottleneck problem.
- The project IS on the CMP network, addresses a top congestion or bottleneck problem, but does NOT increase SOV capacity or produce significant modal shift or traffic flow changes.

When would quantitative analysis occur?

A quantitative analysis is needed if the project meets all of the following four criteria:

- Is located on the CMP network.
- Is located on an identified top congested corridor or at a top bottleneck location.
- Increases SOV capacity or produces significant modal shift or traffic flow changes.

Based on the answers to these questions, and based on the project's CMP strategy type (per Table 7.1), the project sponsor will determine which set of analysis questions to answer, shown in Table 8.1 for qualitative analysis and Table 8.2 for quantitative analysis. As RIDSP develops its new E-STIP process, consideration will be given as to how these questions can be considered within that process.

Table 8.1 CMP Qualitative Analysis Questions

Strategy Type	Qualitative Analysis Questions
Transportation Demand Management	• Does the project strongly support or enhance TDM 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	• Does the project provide or demonstrate the potential for a transit connection? If yes, please explain. • Is the project located in an area where walking and/or bicycling to destinations is feasible? If yes, please explain.
Bicycle and Pedestrian	• Does the proposed facility meet AASHTO 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.

Strategy Type	Qualitative Analysis Questions
Public Transit	• Will the project make transit service faster or more reliable? If yes, please explain. • Does the project provide a 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 ITS 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. • Does the project make transit or access to it safer or more attractive? If yes, please explain.
ITS and Operations	• Is the project an integral part of an incident management system, or will it contribute to a reduction in incident clearance time? If yes, please explain. • Will the system utilize dynamic management of the facility to enhance travel time reliability (e.g., ramp metering, variable speed limits, variable pricing, etc.)? If yes, please explain. • Does the project coordinate traffic signal systems across jurisdictional boundaries and improve progression? 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.
Pricing	• Does the project include pricing structures (dynamic, carbon, congestion, impact, VMT, parking, etc.)? If yes, please explain and explain how these fees will be used.
Roadway/Mobility (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 AASHTO design guidelines? If yes, please explain. • Does the project integrate complete streets design principles? If yes, please explain.
Capacity Expansion	• Does the project provide a needed connection or additional capacity? If yes, please explain. • 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. • Have alternatives to the capacity expansion been comprehensively considered? Please explain.

Table 8.2 CMP Quantitative Analysis Questions and Tools

Strategy Type	Quantitative Analysis Questions	Analysis Tools/Processes
All Project Types	Describe how the project increases SOV capacity or produces a modal shift (change in capacity, change in speed, change in number of lanes etc.)	Statewide Travel Demand Model Traffic Simulation Models Highway Capacity Manual Regulations TOPS-BC TRIMMS
	Document which bottleneck or congested corridor is within the project limits.	CMP Process Document
	Document how the project is expected to affect congestion, as measured in travel speed, delay, or VMT change.	Statewide Travel Demand Model Traffic Simulation Models Highway Capacity Manual Regulations TOPS-BC TRIMMS
	Does the project increase vehicle emissions and if so, by how much?	CMAQ Emissions Calculator Toolkit TRIMMS Statewide Travel Demand Model + MOVES emission factors
	If the project adds SOV capacity, please justify reasons for not implementing other congestion mitigation strategies (or why other implemented strategies will not be sufficient to mitigate the problem) and justify the need for capacity expansion.	
	Describe any congestion mitigation alternatives to the proposed improvement that have been considered or will be evaluated to correct the deficiencies and manage the facility effectively (or facilitate its management in the future).	

8.3 Action Steps

This action plan details activities that Rhode Island agencies should undertake over the next five or more years to implement the Congestion Management Process.

Table 8.3 identifies the action, responsible agency, proposed timeframe, and the section of the plan providing justification for the proposed action. Actions are divided into the following groups:

- Planning Activities—Actions to more fully develop congestion management strategies in specific focus areas, such as TDM or corridor studies.
- Implementation Activities—Actions to implement projects to directly reduce congestion.
- Data Collection, Evaluation, and Monitoring—Developing better information and data to track the success of efforts to mitigate congestion.
- Coordination Activities—Ongoing intra and interagency coordination to implement the CMP.

Not listed in this table are actions already listed in other planning documents, including the Transit Master Plan, Statewide Bicycle Plan, and Freight and Goods Movement Plan. Implementing congestion-reducing projects listed in the STIP also is a critical action element to implement the CMP.

Table 8.3 Congestion Management Action Plan

Action	Responsibility	Timeframe	Source/Justification
Planning Activities			
Develop or revise STIP project selection criteria or considerations to incorporate factors related to each of the CMP objectives.	RIDSP and RIDOT	2020.	Section 7.4, Statewide Strategies: Land Use. Section 8.1, Integration with Existing Statewide Plans.
Conduct congestion mitigation studies on bottlenecks/ priority corridors listed in CMP.	RIDSP and RIDOT	2 corridors a year, 2021 to 2024.	Section 7.4, Corridors and Bottlenecks Not Covered by Planned Projects.
Develop a shared mobility and curb management strategic plan for Rhode Island.	RIDSP	2021.	Section 7.4, Statewide Strategies: TDM. Roadway/Mobility (Non-ITS) Strategies
Create a funding/technical assistance program to assist municipalities with transit-supportive plan and zoning changes.	RIDSP	2021.	Section 7.4, Statewide Strategies: Land Use.
Develop a TDM strategic plan for Rhode Island.	RIPTA and RIDSP	2022.	Section 7.4, Statewide Strategies: TDM.
Develop access management guidelines.	RIDSP and RIDOT	2022.	Section 7.4, Statewide Strategies: Land Use.
Develop a statewide pedestrian plan.	RIDSP, RIDOT, and RIPTA	2022.	Section 7.4, Statewide Strategies: Bicycle and Pedestrian.
Conduct feasibility study of pricing options for their ability to meet future statewide revenue needs, reduce congestion, and support economic development.	RIDSP and RIDOT	2023.	Section 7.4, Statewide Strategies: Pricing.
Consider information from the first monitoring reports when developing the next LRTP as well as updates of other modal and program plans.	RIDSP and RIDOT	As part of plan update cycles.	Section 7.2, Current and Planned Congestion Management Projects and Programs.
Update the Congestion Management Plan.	RIDSP with RIDOT and RIPTA	2025.	Section 5.3, Monitoring and Evaluation.
Implementation Activities			
Develop/expand the RI*STAR program to work with municipalities to retime traffic signals on arterial streets at least every five years.	RIDOT	2021.	Section 7.4, Statewide Strategies: ITS and Operations.
Implement remote monitoring and advanced signal control systems on top congested corridors.	RIDOT	Ongoing basis, may require more detailed corridor study to define requirements.	Section 7.4, Statewide Strategies: ITS and Operations.
Develop service patrols program to rapidly respond to and help clear incidents and reduce secondary incidents.	RIDOT		Section 7.4, Statewide Strategies: ITS and Operations.
Create funding/incentive program to assist municipalities in implementing Complete Streets concepts.	RIDSP		Section 7.4, Statewide Strategies: Roadway/ Mobility (Non-ITS) Strategies.

Action	Responsibility	Timeframe	Source/Justification
Data Collection, Evaluation, and Monitoring			
Prepare first Congestion Performance Monitoring Report (CPMR).	RIDSP with RIDOT and RIPTA	Complete in 2021, with 2020 data.	Section 5.2, Performance Monitoring; Track progress on CMP performance measures and implementation activities.
Update CPMR.	RIDSP with RIDOT and RIPTA	Every 2 years (2023, 2025, etc.).	Section 5.2, Performance Monitoring.
Establish baseline data and conduct postimplementation evaluation of selected projects identified in CMP.	RIDSP with RIDOT	First evaluations to be completed for inclusion in 2024 CPMR.	Section 5.2, Performance Monitoring.
Expand transit APC data collection to achieve more complete route coverage.	RIPTA	Complete coverage by 2024.	Section 5.2, Data Needs: Improve estimation of transit performance measures.
Develop a network of short-term and permanent bike traffic counting stations to systematically track usage over time and space.	RIDOT	Plan by end of 2021; phased implementation completes by 2025.	Section 5.2, Data Needs: Support estimation of bike path usage.
Develop data on accurate work zone limits using latitude/longitude.	RIDOT	2022.	Section 5.2, Data Needs: Support estimation of work zone delay and reliability.
Continue to expand coverage of incident data collection.	RIDOT	2022.	Section 5.2, Data Needs: Support estimation of incident-related delay and reliability.
Collect and routinely update data from local jurisdictions on intersections with advanced signal control and remote monitoring capability.	RIDOT, City of Providence	2022.	Section 5.2, Data Needs: Support estimation of intersection metrics.
Coordination Activities			
Formalize CMTF.	RIDSP, RIDOT, RIPTA	3rd quarter of 2020.	
Finalize CMTF Membership.	RIDSP, RIDOT, RIPTA	3rd quarter of 2020.	
Hold quarterly meetings of CMTF.	RIDSP, RIDOT, RIPTA	Ongoing.	
Coordinate with other task forces, including TSMO Task Force and Incident Management Task Force.	RIDOT and RIDSP	Ongoing.	
Coordinate with other planning studies led by RIDSP.	RIDSP	Ongoing.	

Appendix A

Performance Measure Definitions, Data Sources, and Calculation Procedures

APPENDIX A—PERFORMANCE MEASURE DEFINITIONS, DATA SOURCES, AND CALCULATION PROCEDURES

This appendix provides a detailed description with information on each of the recommended CMP performance measures. The table format used below was derived from the "Performance Target Documentation Guide" developed by the Tennessee Department of Transportation in May 2017 and modified to fit this report.

A. Improve Reliability of the Transportation System

Table 1 – A.1 Interstate Reliability

General	
Measure Title	Percent of Person-Miles Traveled on Interstate NHS that is Reliable. Also referred to as "Interstate Reliability."
Measure Description	This measure enables RIDOT to assess the percentage of Rhode Island's Interstate with "reliable" travel times, where the travel times do not exceed "normal" travel times by greater than 50 percent.
Technical Definition	Percent of person-miles traveled on Interstate roads where the Level of Travel Time Reliability (LOTTR) – the ratio of the 80th percentile travel time of a reporting segment to the "normal" (50th percent) travel time – is less than 1.50. Travel time reliability refers to the consistency or dependability of travel times from day to day or across different times of day.
Measure Reporting	Performance metrics are reported to FHWA annually via Highway Performance Monitoring System (HPMS). Monthly data is collected and evaluated internally by RIDOT Office of Performance Management (OPM) and reported to the Governor's Office of Management and Budget (OMB).
Data and Results	
Data Source	• National Performance Measurement Research Data Set (NPMRDS) provided by the University of Maryland's Center for Advanced Transportation Technology (CATT) Lab • HPMS - AADT/volumes collected by RIDOT at continuous and short-duration count locations statewide consistent with FHWA's Traffic Monitoring Guide used to assign annual volume to each reporting segment • Average Vehicle Occupancy (AVO) Factor (rural/urban) which comes from the most recently available data tables published by FHWA in April 2018. It is an aggregation of AVO factors for cars, buses and trucks from multiple data sources including National Household Travel Survey (NHTS). For all vehicle types the factor used for first Performance Period is **1.7**.
Data Collector	NPMRDS travel time data is downloaded each month and stored in a Microsoft SQL database called the Rhode Island System Performance Measures (RISPM) database. Monthly and annual measures are calculated by the Consultant under contract with RIDOT State Transportation Management Center (M. Wreh)
Algorithm Calculation	LOTTR shall be computed to the nearest tenth of a percent as follows: $100 \times \frac{\sum_{i=1}^{R} SL_i \times AV_i \times OF_j}{\sum_{i=1}^{T} SL_i \times AV_i \times OF_j}$ **Where**: **R** = is the total number of Interstate highway segments that report a LOTTR of below 1.50 during four time-periods for all days of the reporting period • Weekday AM period – 6AM to 10AM • Weekday Midday period – 10AM to 4PM • Weekday PM period – 4PM to 8PM • Weekend period – 6AM to 8PM Data is collected in 15-minute segments during all time periods between 6 a.m. and 8 p.m.

	I = Interstate System reporting segment ''i''; **SLi** = length, to the nearest thousandth of a mile, of Interstate System reporting segment ''i''; **AVi** = is the total annual traffic volume computed as AADT*365, where the AADT is the Annual Average Daily Traffic reported to the HPMS; **J** = geographic area in which the reporting segment ''i'' is located where a unique occupancy factor has been determined; **OFi** = occupancy factor for vehicles on the NHS within a specified geographic area within the State/Metropolitan planning area.; and **T** = total number of Interstate System reporting segments.

Table 2 – A.2 Non-Interstate NHS Reliability

General	
Measure Title	Percent of Person-Miles Traveled on Interstate NHS that is Reliable. Also referred to as "Non-Interstate NHS Reliability."
Measure Description	This measure enables RIDOT to assess the percentage of Rhode Island's Non-Interstate NHS with "reliable" travel times, where the travel times do not exceed "normal" travel times by greater than 50 percent.
Technical Definition	Percent of person-miles traveled on Non-Interstate NHS roads where the Level of Travel Time Reliability – the ratio of the 80^{th} percentile travel time of a reporting segment to the "normal" (50^{th} percent) travel time – is less than 1.50. Travel time reliability refers to the consistency or dependability of travel times from day to day or across different times of day.
Measure Reporting	Performance metrics are reported to FHWA annually via HPMS. Monthly data is collected and evaluated internally by RIDOT OPM and reported to the Governor's Office of Management and Budget.
Data and Results	
Data Source	• NPMRDS provided by the University of Maryland's CATT Lab • HPMS - AADT/volumes collected by RIDOT at continuous and short-duration count locations statewide consistent with FHWA's Traffic Monitoring Guide used to assign annual volume to each reporting segment • AVO Factor (rural/urban) which comes from the most recently available data tables published by FHWA in April 2018. It is an aggregation of AVO factors for cars, buses and trucks from multiple data sources including NHTS. For all vehicle types the factor used for first Performance Period is **1.7**.
Data Collector	NPMRDS travel time data is downloaded each month and stored in a Microsoft SQL database called the Rhode Island System Performance Measures database. Monthly and annual measures are calculated by the Consultant under contract with RIDOT State Transportation Management Center (M. Wreh)

Algorithm Calculation	LOTTR shall be computed to the nearest tenth of a percent as follows: $100 \times \frac{\sum_{i=1}^{R} SL_i \times AV_i \times OF_j}{\sum_{i=1}^{T} SL_i \times AV_i \times OF_j}$ **Where**: **R** = is the total number of Non-Interstate NHS highway segments that report a LOTTR of below 1.50 during four time-periods for all days of the reporting period • Weekday AM period – 6AM to 10AM • Weekday Midday period – 10AM to 4PM • Weekday PM period – 4PM to 8PM • Weekend period – 6AM to 8PM Data is collected in 15-minute segments during all time periods between 6 a.m. and 8 p.m. **I** = Non-Interstate NHS System reporting segment ''i''; **SLi** = length, to the nearest thousandth of a mile, of Non-Interstate NHS System reporting segment ''i''; **AVi** = is the total annual traffic volume computed as AADT*365, where the AADT is the Annual Average Daily Traffic reported to the HPMS; **J** = geographic area in which the reporting segment ''i'' is located where a unique occupancy factor has been determined; **OFi** = occupancy factor for vehicles on the NHS within a specified geographic area within the State/Metropolitan planning area.; and **T** = total number of Non-Interstate NHS System reporting segments.

Table 3 – A.3 CMP Network Reliability

General	
Measure Title	Percent of Person-Miles Traveled on the CMP Network that is Reliable. Also referred to as "CMP Network Reliability."
Measure Description	This measure enables RIDOT to assess the percentage of Rhode Island's CMP Network with "reliable" travel times, where the travel times do not exceed "normal" travel times by greater than 50 percent.
Technical Definition	Percent of person-miles traveled on CMP Network roads where the Level of Travel Time Reliability– the ratio of the 80^{th} percentile travel time of a reporting segment to the "normal" (50^{th} percent) travel time – is less than 1.50. Travel time reliability refers to the consistency or dependability of travel times from day to day or across different times of day.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.

Data and Results	
Data Source	• INRIX Probe Data Analytics (PDA) Suite provided by the University of Maryland's CATT Lab. The data from this source includes both travel time as well as directional ADT that the CATT Lab has conflated from RI's HPMS submission to the FHWA. • AVO Factor (rural/urban) which comes from the most recently available data tables published by FHWA in April 2018. It is an aggregation of AVO factors for cars, buses and trucks from multiple data sources including NHTS. For all vehicle types the factor used for first Performance Period is **1.7**.
Data Collector	INRIX PDA Suite travel time data is downloaded each month and stored within a Microsoft SQL database called the Rhode Island System Performance Measure by the Consultant under contract with RIDOT State Transportation Management Center (M. Wreh)
Algorithm Calculation	LOTTR shall be computed to the nearest tenth of a percent as follows: $100 \times \frac{\sum_{i=1}^{R} SL_i \times AV_i \times OF_j}{\sum_{i=1}^{T} SL_i \times AV_i \times OF_j}$ **Where**: **R** = is the total number of CMP Network highway segments that report a LOTTR of below 1.50 during four time-periods for all days of the reporting period • Weekday AM period – 6AM to 10AM • Weekday Midday period – 10AM to 4PM • Weekday PM period – 4PM to 8PM • Weekend period – 6AM to 8PM Data is collected in 15-minute segments during all time periods between 6 a.m. and 8 p.m. **I** = CMP Network reporting segment ''i''; **SLi** = length, to the nearest thousandth of a mile, of CMP Network reporting segment ''i''; **AVi** = is the total annual traffic volume computed as AADT*365, where the AADT is the Annual Average Daily Traffic available within the INRIX PDA Suite data download; **J** = geographic area in which the reporting segment ''i'' is located where a unique occupancy factor has been determined; **OFi** = occupancy factor for vehicles on the NHS within a specified geographic area within the State/Metropolitan planning area.; and **T** = total number of CMP Network reporting segments.

Table 4 – A.4 Reliability During Inclement Weather

General	
Measure Title	Percent of Person-Miles Traveled on the CMP Network that is Reliable during inclement weather. Also referred to as "Reliability During Inclement Weather."
Measure Description	This measure enables RIDOT to assess the impact of inclement weather on travel time reliability in terms of the percentage of Rhode Island's CMP Network with "reliable" travel times, where the travel times do not exceed "normal" travel times by greater than 50 percent. This measure is similar to A.3 CMP Network Reliability but applies to only those days with precipitation of 0.1 inches per hour during any one or more hours.
Technical Definition	Percent of person-miles traveled on CMP Network roads during days with inclement weather where the Level of Travel Time Reliability– the ratio of the 80th percentile travel time of a reporting segment to the "normal" (50th percent) travel time – is less than 1.50. Travel time reliability refers to the consistency or dependability of travel times from day to day or across different times of day. This measure is takes into account only those days with inclement weather defined to be any day with at least one hour with 0.1 inches per hour of precipitation.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	• INRIX Probe Data Analytics Suite provided by the University of Maryland's CATT Lab. The data from this source includes both travel time as well as directional ADT that the CATT Lab has conflated from RI's HPMS submission to the FHWA. • AVO Factor (rural/urban) which comes from the most recently available data tables published by FHWA in April 2018. It is an aggregation of AVO factors for cars, buses and trucks from multiple data sources including NHTS. For all vehicle types the factor used for first Performance Period is **1.7**. • Hourly precipitation report for each month maintained by RIDOT TMC as part of the Transportation Systems Management & Operations (TSMO) Performance Measures. Data is from the National Climatological Data Center (NCDC) of the National Oceanographic and Atmospheric Administration (NOAA) from four weather stations located in TF Green Airport Warwick, Newport Airport, North Central State Airport Smithfield, and Westerly Airport. This information is available for download as a PDF report and processed manually to identify the dates/hours when precipitation was at least 0.1 inches per hour. This information is then manually entered into the Microsoft SQL database called the Rhode Island System Performance Measures database by the RIDOT TMC Consultant.
Data Collector	INRIX PDA Suite travel time data and monthly precipitation reports are downloaded each month and stored within a Microsoft SQL database called the Rhode Island System Performance Measures by the Consultant under contract with RIDOT State Transportation Management Center (M. Wreh)
Algorithm Calculation	LOTTR shall be computed to the nearest tenth of a percent as follows: $100 \times \frac{\sum_{i=1}^{R} SL_i \times AV_i \times OF_j}{\sum_{i=1}^{T} SL_i \times AV_i \times OF_j}$ **Where**: **R** = is the total number of CMP Network highway segments that report a LOTTR of below 1.50 during four time-periods during those days with inclement weather of the reporting period • Weekday AM period – 6AM to 10AM • Weekday Midday period – 10AM to 4PM • Weekday PM period – 4PM to 8PM

	• Weekend period – 6AM to 8PM Data is collected in 15-minute segments during all time periods between 6 a.m. and 8 p.m for only those days with inclement weather. **I** = CMP Network reporting segment ‘‘i’’; **SLi** = length, to the nearest thousandth of a mile, of CMP Network reporting segment ‘‘i’’; **AVi** = is the total annual traffic volume computed as AADT*365, where the AADT is the Annual Average Daily Traffic available within the INRIX PDA Suite data download; **J** = geographic area in which the reporting segment ‘‘i’’ is located where a unique occupancy factor has been determined; **OFi** = occupancy factor for vehicles on the NHS within a specified geographic area within the State/Metropolitan planning area.; and **T** = total number of CMP Network reporting segments.

Table 5 – A.5 Reliability Through Work Zones

General	
Measure Title	Percent of Person-Miles Traveled on the CMP Network that is Reliable through work zones. Also referred to as “Reliability Through Work Zones.”
Measure Description	This measure enables RIDOT to assess the impact of work zones on travel time reliability in terms of the percentage of Rhode Island’s CMP Network with “reliable” travel times, where the travel times do not exceed “normal” travel times by greater than 50 percent. This measure is similar to A.3 CMP Network Reliability but applies to only those days and to only those highways with planned work zones involving lane closures.
Technical Definition	Percent of person-miles traveled on CMP Network roads during days and on highways with planned work zones involving lane closure where the Level of Travel Time Reliability – the ratio of the 80th percentile travel time of a reporting segment to the “normal” (50th percent) travel time – is less than 1.50. Travel time reliability refers to the consistency or dependability of travel times from day to day or across different times of day. This measure is takes into account only those days and highways with work zones defined as any planned work zone reported to the RIDOT’s Public Information Office (PIO) and the RIDOT TMC which involves a lane or shoulder closure.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	• INRIX Probe Data Analytics Suite provided by the University of Maryland’s CATT Lab. The data from this source includes both travel time as well as directional ADT that the CATT Lab has conflated from RI’s HPMS submission to the FHWA. • AVO Factor (rural/urban) which comes from the most recently available data tables published by FHWA in April 2018. It is an aggregation of AVO factors for cars, buses and trucks from multiple data sources including NHTS. For all vehicle types the factor used for first Performance Period is **1.7**. • Planned work zone data for each month maintained by RIDOT TMC as part of the Transportation Systems Management & Operations Performance Measures. Data is from reports of planned work zones submitted by RIDOT Resident Engineer or Contractor to the RIDOT Public Information Office

	or RIDOT TMC. This information is sent via email and the information is then manually entered into the Microsoft SQL database called the Rhode Island System Performance Measures database by the RIDOT TMC.
Data Collector	INRIX PDA Suite travel time data and planned work zone are downloaded each month and stored within a Microsoft SQL database called the Rhode Island System Performance Measures by the Consultant under contract with RIDOT State Transportation Management Center (M. Wreh)
Algorithm Calculation	LOTTR shall be computed to the nearest tenth of a percent as follows: $100 \times \frac{\sum_{i=1}^{R} SL_i \times AV_i \times OF_j}{\sum_{i=1}^{T} SL_i \times AV_i \times OF_j}$ **Where**: **R** = is the total number of CMP Network highway segments that report a LOTTR of below 1.50 during four time-periods during those days with planned work zones of the reporting period • Weekday AM period – 6AM to 10AM • Weekday Midday period – 10AM to 4PM • Weekday PM period – 4PM to 8PM • Weekend period – 6AM to 8PM Data is collected in 15-minute segments during all time periods between 6 a.m. and 8 p.m for only those days with planned work zones on any given TMC. **I** = CMP Network reporting segment ‘‘i’’ **SLi** = length, to the nearest thousandth of a mile, of CMP Network reporting segment ‘‘i’’; **AVi** = is the total annual traffic volume computed as AADT*365, where the AADT is the Annual Average Daily Traffic available within the INRIX PDA Suite data download; **J** = geographic area in which the reporting segment ‘‘i’’ is located where a unique occupancy factor has been determined; **OFi** = occupancy factor for vehicles on the NHS within a specified geographic area within the State/Metropolitan planning area.; and **T** = total number of CMP Network reporting segments.

Table 6 – A.6 RIPTA Bus Reliability

General	
Measure Title	Reliability of Travel on Rhode Island Public Transit Authority (RIPTA) Buses, also referred to “RIPTA Bus Reliability”
Measure Description	This measure indicates the extent to which RIPTA passengers are likely to experience high levels of delays.
Technical Definition	Consistent with how reliability is measured for highway travel, transit travel time reliability can be defined as the ratio of the 80th percentile travel time on a route segment to the 50th percentile travel time, during peak periods. This provides an indication of how travel time under the worst 20 percent of conditions compares with typical or average conditions. A larger ratio means a higher likelihood of unacceptably long delays compared to

	expected travel time. This accounts for both the effects of nonrecurring highway congestion and bus operations. The measure is weighted by passenger-miles.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	• RIPTA – Trip data from APC passenger counts and AVL data.
Data Collector	• RIPTA
Algorithm Calculation	To calculate the 50th and 80th percentile travel times, a unique ID for each trip segment must be created. This can be formed by combining the route number, variant number, segment name, day of week, and direction into a consolidated field using the "concatenate" function in Excel. The components of this unique ID can be changed based on how the user would like to define a segment. Inputting different elements into the segment definition (such as Block ID) will shift the results of the travel time ratio. To include only peak period trips, the simplest method is to filter on the Schedule Hour field in Excel, narrowing the entries to only include trips that are scheduled for between the hours of 6 AM and 10 AM or 3 PM and 7 PM. Because the Schedule Hour uses Coordinated Universal Time (UTC), this can be done in Excel using a formula like the example below: Define "Peak" as: =IF(OR(AND(SCHEDULE_HOUR>5,SCHEDULE_HOUR <10),AND(SCHEDULE_HOUR >14, SCHEDULE_HOUR <19)),"Yes","No") Further processing should be done using Python or another similar platform with advanced data processing capabilities to calculate the ratio after the segment is defined. The steps below show how the travel time ratio can be calculated once the run time data is uploaded into the statistical program. 1. Use a "groupby" function to calculate the median run time for each unique Segment ID. For example: RIPTA_seg_runtime_median = RIPTA_SEG.groupby(['SegID'])['RUNTIME_mean'].median() 2. Use a "groupby" function in conjunction with a quantile function to calculate 80th percentile travel time for each unique Segment ID. For example: RIPTA_seg_runtime_80 = RIPTA_SEG.groupby(['SegID'])['RUNTIME_mean'].quantile(.80) 3. Calculate the sum of passenger miles for each unique segment. For example: RIPTA_seg_pax_mi = RIPTA_SEG.groupby(['SegID'])['PASSMLS_mean'].sum() 4. In order to keep these new fields properly organized, create a new table based on Segment ID, with passenger miles, median run time, and 80th percentile run time. For example: RIPTA_TT_TABLE = pd.concat([RIPTA__seg_pax_mi, RIPTA_seg_runtime_median,RIPTA_seg_runtime_80], axis=1); RIPTA_TT_TABLE.columns = ['Pax_Miles', 'Median TT','80% TT'] 5. Create a new field for the 80th percentile/50th percentile ratio in the table. For example: RIPTA_TT_TABLE['80-50 Ratio']=RIPTA_TT_TABLE['80% TT']/RIPTA_TT_TABLE['Median TT']' 6. Create a weighted average of the ratio above using passenger miles. For example: TT_ratio_weighted_avg = (RIPTA_TT_TABLE['80-50 Ratio'] * RIPTA_TT_TABLE["Pax_Miles"]).sum() / RIPTA_TT_TABLE["Pax_Miles"].sum().

Table 7 –A.7 Incident Clearance Time

General	
Measure Title	Incident Clearance Time for each of the following Interstates, Other Freeways & Expressways : • I-95 (North) – From Mass State Line to Exit 22 (Downtown Providence) • I-95 (South) – From Exit 22 (Downtown Providence) to Route 4 • I-195 – From I-95 to Mass State Line • I-295 (South) – From I-95 to Route 6 • I-295 (North) – From Route 6 to Mass State Line • Route 6/10 – From I-95 (South) to I-95 (North) • Route 6 – From I-295 to Route 10 • Route 146 – From I-95 to I-295

	• Route 4 – From I-95 to Route 102 • Route 37 – From I-295 to US Route 1
Measure Description	This measure is intended to provide the effectiveness of RIDOT and State/Local Police's incident management in terms of time it takes to learn about, identify, respond, and clear an incident to restore lanes to normal traffic operations (all lanes are open) and the incident response team has left the scene.
Technical Definition	An incident for the purposes of this report is defined as ***any non-recurring unplanned event that causes a reduction of roadway capacity or an abnormal increase in demand***. This includes traffic crashes, disabled vehicles, spilled cargo, events related to highway infrastructure problem requiring emergency maintenance, and any other unplanned events. Average of the duration of each incident from the time a notification is received by the Transportation Management Center (TMC) to the time lanes are cleared and opened to traffic. The average will be computed for incidents that occur on each of the above Interstates and Expressways.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIDOT TMC's RhodeWAYS database
Data Collector	RIDOT Transportation Management Center.
Algorithm Calculation	Average of the duration of each incident from incident notification to re-opening of any lanes that were closed on each of the above highway segments and incident responders have left the scene

Table 8 – A.8 Incident Rate

General	
Measure Title	Number of incident per million vehicle miles for each of the following Interstates and Expressways: • I-95 (North) – From Mass State Line to Exit 22 (Downtown Providence) • I-95 (South) – From Exit 22 (Downtown Providence) to Route 4 • I-195 – From I-95 to Mass State Line • I-295 (South) – From I-95 to Route 6 • I-295 (North) – From Route 6 to Mass State Line • Route 6/10 – From I-95 (South) to I-95 (North) • Route 6 – From I-295 to Route 10 • Route 146 – From I-95 to I-295 • Route 4 – From I-95 to Route 102 • Route 37 – From I-295 to US Route 1
Measure Description	This measure is intended to provide the rate of incidents on the Interstates and Expressways
Technical Definition	An incident for the purposes of this report is defined as ***any non-recurring unplanned event that causes a reduction of roadway capacity or an abnormal increase in demand***. This includes traffic crashes, disabled vehicles, spilled cargo, events related to highway infrastructure problem requiring emergency maintenance, and any other unplanned events. Incident rate as defined by the number of incidents divided by the vehicle miles traveled on each highway segment
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	

Data Source	RIDOT TMC's RhodeWAYS database
Data Collector	RIDOT Transportation Management Center
Algorithm Calculation	Number of incidents divided by the sum of the products of Annual Average Daily Traffic, 365 (number of days in a year), and highway segment length in miles

B. Reduce Recurring Congestion

Table 9 – B.1 Peak Hour Excessive Delay (PHED)

General	
Measure Title	Annual Hours of Peak Hour Excessive Delay Per Capita, also referred to as "Peak Hour Excessive Delay" (PHED)
Measure Description	This measures the amount of excessive delay experienced by motorists on the NPMRDS network during weekday peak commute periods where excessive delay is defined as extra time spent in traffic when traveling a speed lower than a normal delay threshold speed.
Technical Definition	Annual hours of delay when traveling below 20 mph or 60% of the posted speed limit (whichever is greater) on weekdays between the hours of 6AM and 10AM and between 3PM and 7PM.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	National Performance Measurement Research Data Set provided by FHWA AADT to estimate annual percent share of traffic volume for cars, buses and trucks.
Data Collector	RIDOT Transportation Management Center
Algorithm Calculation	Excessive Delay Threshold Travel Time is calculated as follows: $\frac{Travel\ Time\ Segment\ Length_s}{Threshold\ Speed_s}$ Threshold Speed on each highway segment "s" is defined as the greater of the following: • 20 miles per hour, or • 60% of the posted speed limit For each highway segment "s" the Reporting Segment Delay (RSD) is computed for each 15 minute interval "b" for each hour for each day in a calendar year as follows: $RSD_{s,b} = Travel\ Time_{s,b} - Excessive\ Delay\ Threshold\ Travel\ Time_s$ The RSD $_{s,b}$ is set not to exceed 900 seconds. Compute Excessive Delay for each highway segment "s" for each 15-minute interval "b" in hours by dividing the above RSD $_{s,b}$ which is in seconds by 3600. The final step is to compute the Total Excessive Delay in person-hours by converting the total excessive delay in vehicle-hours by the average vehicle occupancy. The average vehicle occupancy is determined as a weighted average of the average occupancy of the following three vehicle classes: Cars, Buses, and Trucks. The total excessive delay in vehicle hours is computed by adding up the product of the excessive delay and hourly volume divided by 4 for each hour in a day for all 365 days in a calendar year. The hourly volumes are estimated by factoring the AADT. Three sets of factors will be used – monthly, daily and hourly. Separate factors will be utilized for Interstate and non-Interstate links. The above steps for computing the Total Excessive Delay is shown in the equation below: $AVO \times \sum_{d=1}^{t=TD} \left\{ \sum_{h=1}^{h=TH=24} \left[\sum_{b=1}^{b=TB=4} \left(Excessive\ Delay_{s,b,h,d} \times \left(\frac{hourly\ volume}{4}\right)_{s,b,h,d} \right) \right] \right\}$

Table 10 – B.2 PHED on CMP Network

General	
Measure Title	Annual Hours of Peak Hour Excessive Delay Per Capita on the CMP Network, also referred to as "PHED on CMP Network"
Measure Description	This measures the amount of excessive delay experienced by motorists on the CMP network during weekday peak commute periods where excessive delay is defined as extra time spent in traffic when traveling a speed lower than a normal delay threshold speed.

Technical Definition	Annual hours of delay when traveling below 20 mph or 60% of the posted speed limit (whichever is greater) on weekdays between the hours of 6AM and 10AM and between 3PM and 7PM.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	INRIX Probe Data Analytics Suite provided by the University of Maryland's CATT Lab. The data from this source includes both travel time as well as directional ADT that the CATT Lab has conflated from RI's HPMS submission to the FHWA.
Data Collector	RIDOT Transportation Management Center
Algorithm Calculation	Excessive Delay Threshold Travel Time is calculated as follows: $$\frac{Travel\ Time\ Segment\ Length_s}{Threshold\ Speed_s}$$ Threshold Speed on each highway segment "s" is defined as the greater of the following: • 20 miles per hour, or • 60% of the posted speed limit For each highway segment "s" the Reporting Segment Delay is computed for each 15 minute interval "b" for each hour for each day in a calendar year as follows: $$RSD_{s,b} = Travel\ Time_{s,b} - Excessive\ Delay\ Threshold\ Travel\ Time_s$$ The RSD $_{s,b}$ is set not to exceed 900 seconds. Compute Excessive Delay for each highway segment "s" for each 15-minute interval "b" in hours by dividing the above RSD $_{s,b}$ which is in seconds by 3600. The final step is to compute the Total Excessive Delay in person-hours by converting the total excessive delay in vehicle-hours by the average vehicle occupancy. The average vehicle occupancy is determined as a weighted average of the average occupancy of the following three vehicle classes: Cars, Buses, and Trucks. The total excessive delay in vehicle hours is computed by adding up the product of the excessive delay and hourly volume divided by 4 for each hour in a day for all 365 days in a calendar year. The hourly volumes are estimated by factoring the AADT. Three sets of factors will be used – monthly, daily and hourly. Separate factors will be utilized for Interstate and non-Interstate links. The above steps for computing the Total Excessive Delay is shown in the equation below: $$AVO \times \sum_{d=1}^{t=TD} \left\{ \sum_{h=1}^{h=TH=24} \left[\sum_{b=1}^{b=TB=4} \left(Excessive\ Delay_{s,b,h,d} \times \left(\frac{hourly\ volume}{4} \right)_{s,b,h,d} \right) \right] \right\}$$

Table 11 - B.3 PHED During Inclement Weather

General	
Measure Title	Annual Hours of Peak Hour Excessive Delay Per Capita on the CMP Network During Inclement Weather, also referred to as "PHED During Inclement Weather"
Measure Description	This measures the amount of excessive delay experienced by motorists on the CMP network during weekday peak commute periods during days with inclement weather where excessive delay is defined as extra time spent in traffic due to weather when traveling a speed lower than a normal delay threshold speed.
Technical Definition	Annual hours of delay during days with inclement weather when traveling below 20 mph or 60% of the posted speed limit (whichever is greater) on weekdays between the hours of 6AM and 10AM and between 3PM and 7PM.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	• INRIX Probe Data Analytics Suite provided by the University of Maryland's CATT Lab. The data from this source includes both travel time as well as directional ADT that the CATT Lab has conflated from RI's HPMS submission to the FHWA.

	• Hourly precipitation report for each month maintained by RIDOT TMC as part of the Transportation Systems Management & Operations Performance Measures. Data is from the National Climatological Data Center of the National Oceanographic and Atmospheric Administration from four weather stations located in TF Green Airport Warwick, Newport Airport, North Central State Airport Smithfield, and Westerly Airport. This information is available for download as a PDF report and processed manually to identify the dates/hours when precipitation was at least 0.1 inches per hour. This information is then manually entered into the Microsoft SQL database called the Rhode Island System Performance Measures database by the RIDOT TMC Consultant.
Data Collector	RIDOT Transportation Management Center (TMC)
Algorithm Calculation	Excessive Delay Threshold Travel Time is calculated as follows: $$\frac{Travel\ Time\ Segment\ Length_s}{Threshold\ Speed_s}$$ Threshold Speed on each highway segment "s" is defined as the greater of the following: • 20 miles per hour, or • 60% of the posted speed limit For each highway segment "s" the Reporting Segment Delay is computed for each 15 minute interval "b" for each hour for each day with at least one hour of 0.1 inches of precipitation in a calendar year as follows: $$RSD_{s,b} = Travel\ Time_{s,b} - Excessive\ Delay\ Threshold\ Travel\ Time_s$$ The RSD $_{s,b}$ is set not to exceed 900 seconds. Compute Excessive Delay for each highway segment "s" for each 15-minute interval "b" in hours by dividing the above RSD $_{s,b}$ which is in seconds by 3600. The final step is to compute the Total Excessive Delay in person-hours by converting the total excessive delay in vehicle-hours by the average vehicle occupancy. The average vehicle occupancy is determined as a weighted average of the average occupancy of the following three vehicle classes: Cars, Buses, and Trucks. The total excessive delay in vehicle hours is computed by adding up the product of the excessive delay and hourly volume divided by 4 for each hour in a day for all days with inclement weather in a calendar year. The hourly volumes are estimated by factoring the AADT. Three sets of factors will be used – monthly, daily and hourly. Separate factors will be utilized for Interstate and non-Interstate links. The above steps for computing the Total Excessive Delay is shown in the equation below: $$AVO \times \sum_{d=1}^{t=TD} \left\{ \sum_{h=1}^{h=TH=24} \left[\sum_{b=1}^{b=TB=4} \left(Excessive\ Delay_{s,b,h,d} \times \left(\frac{hourly\ volume}{4}\right)_{s,b,h,d} \right) \right] \right\}$$

Table 12 - B.4 PHED Through Work Zones

General	
Measure Title	Annual Hours of Peak Hour Excessive Delay Per Capita on the CMP Network Through Work Zones, also referred to as "PHED Through Work Zones"
Measure Description	This measures the amount of excessive delay experienced by motorists on the CMP network going through work zones during weekday peak commute periods where excessive delay is defined as extra time spent in traffic when traveling a speed lower than a normal delay threshold speed.
Technical Definition	Annual hours of delay when traveling through work zones at speeds below 20 mph or 60% of the posted speed limit (whichever is greater) on weekdays between the hours of 6AM and 10AM and between 3PM and 7PM.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	• INRIX Probe Data Analytics Suite provided by the University of Maryland's CATT Lab. The data from this source includes both travel time as well as directional ADT that the CATT Lab has conflated from RI's HPMS submission to the FHWA. • Planned work zone data for each month maintained by RIDOT TMC as part of the TSMO Performance Measures. Data is from reports of planned work zones submitted by RIDOT Resident Engineer or Contractor to the RIDOT Public Information Office or RIDOT TMC. This information is sent via

	email and the information is then manually entered into the Microsoft SQL database called the Rhode Island System Performance Measures database by the RIDOT TMC.
Data Collector	RIDOT Transportation Management Center
Algorithm Calculation	Excessive Delay Threshold Travel Time is calculated as follows: $$\frac{Travel\ Time\ Segment\ Length_s}{Threshold\ Speed_s}$$ Threshold Speed on each highway segment "s" with a planned work zone is defined as the greater of the following: • 20 miles per hour, or • 60% of the posted speed limit For each highway segment "s" with a planned work zone, the Reporting Segment Delay is computed for each 15 minute interval "b" for each hour for each day with a planned work zone in a calendar year as follows: $$RSD_{s,b} = Travel\ Time_{s,b} - Excessive\ Delay\ Threshold\ Travel\ Time_s$$ The RSD $_{s,b}$ is set not to exceed 900 seconds. Compute Excessive Delay for each highway segment "s" for each 15-minute interval "b" in hours by dividing the above RSD $_{s,b}$ which is in seconds by 3600. The final step is to compute the Total Excessive Delay in person-hours by converting the total excessive delay in vehicle-hours by the average vehicle occupancy. The average vehicle occupancy is determined as a weighted average of the average occupancy of the following three vehicle classes: Cars, Buses, and Trucks. The total excessive delay in vehicle hours is computed by adding up the product of the excessive delay and hourly volume divided by 4 for each hour in a day for all days with planned work zones in a calendar year. The hourly volumes are estimated by factoring the AADT. Three sets of factors will be used – monthly, daily and hourly. Separate factors will be utilized for Interstate and non-Interstate links. The above steps for computing the Total Excessive Delay is shown in the equation below: $$AVO \times \sum_{d=1}^{t=TD} \left\{ \sum_{h=1}^{h=TH=24} \left[\sum_{b=1}^{b=TB=4} \left(Excessive\ Delay_{s,b,h,d} \times \left(\frac{hourly\ volume}{4} \right)_{s,b,h,d} \right) \right] \right\}$$

Table 13 - B.5 Number of Bottlenecks

General	
Measure Title	Total Number of Bottlenecks on the CMP Network, also referred to as "Number of Bottlenecks"
Measure Description	This measure is the total number of bottlenecks identified on the CMP network using the INRIX PDA Suite portal.
Technical Definition	An "occurrence" of congestion is defined to occur on a TMC when the prevailing speed goes below 60% of the reference speed of the TMC. The delay through this occurrence of congestion is the difference in travel time at the reference speed and prevailing speed. Multiple occurrences in close spatial and temporal proximity are group together and the length of the queue resulting from the initial occurrence of congestion at the head TMC is determined. All occurrences of congestion at a particular head TMC is then averaged to determine the average delay and average queue length. A bottleneck for the purposes of the CMP in RI is defined as a congestion occurrence that satisfies the following two threshold criteria: • Average delay greater than or equal to 45 minutes • Average queue length greater than or equal to ¼ mile All occurrences that satisfy the above criteria are categorized as bottlenecks and the total number of bottlenecks are determined
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	

Data Source	The Bottleneck Ranking tool within the INRIX Probe Data Analytics Suite provided by the University of Maryland's CATT Lab.
Data Collector	Rhode Island Department of Statewide Planning
Algorithm Calculation	The Bottleneck Ranking tool is used to first generate a list of all congestion occurrences throughout the CMP Network in Rhode Island. The list may be exported into Excel for purposes of further analysis to determine which congestion occurrence satisfies the above two criteria for a bottleneck. The resulting number of bottlenecks are determined.

Table 14 - B.6 Total Delay at Bottlenecks

General	
Measure Title	Total Delay at Bottlenecks on the CMP Network, also referred to as "Total Delay at Bottlenecks"
Measure Description	This measure provides an estimate of the magnitude of delay at all bottlenecks identified on the CMP network using the INRIX PDA Suite portal in B.5 performance measure
Technical Definition	See technical description of a bottleneck for B.5 – Number of Bottleneck. The INRIX PDA Suite provides a "total delay" value for each of the identified bottleneck. This is sum of queue lengths over the duration of the bottleneck weighted by the difference between free-flow travel time and observed travel time multiplied by the average daily volume (AADT), adjusted by a day-of-the-week factor. This measures is the sum of the total delay at all bottlenecks identified in B.5 for the reporting period.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	The Bottleneck Ranking tool within the INRIX Probe Data Analytics Suite provided by the University of Maryland's CATT Lab.
Data Collector	Rhode Island Department of Statewide Planning
Algorithm Calculation	The Bottleneck Ranking tool is used to first generate a list of all congestion occurrences throughout the CMP Network in Rhode Island. The list may be exported into Excel for purposes of further analysis to determine which congestion occurrence satisfies the two criteria for a bottleneck described in B.5. The resulting number of bottlenecks are determined. The total delay field for each such identified bottleneck is added to determine the total delay resulting from all bottlenecks for the reporting period (typically for 1 year)

Table 15 - B.7 Transit Vehicle Load Factor

General	
Measure Title	**Transit Vehicle Load Factor**
Measure Description	This measure enables the RIDSP and RIPTA to estimate the extent to which transit operations and passenger mobility are impeded by operation of buses at crush loads.
Technical Definition	This measure is defined as the percent of RIPTA system passenger-hours when the load of the bus exceeds the seated capacity.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	• Passenger count data (boardings & alightings by stop) from automated passenger counters (APCs). • Vehicle position/location from automatic vehicle locators (AVL).
Data Collector	RIPTA

Algorithm Calculation	• Divide passenger-miles on each trip segment by average velocity (mi/hr) to get passenger-hours by segment. • Identify run segments where loads meet crush load threshold, based on bus capacity and APC passenger count data (standard 40' Gilligs buses have a seating capacity of 36). • Divide passenger-hours on segments exceeding load threshold by total passenger-hours to get % of passenger-hours exceeding load threshold.

Table 16 - B.8 Passenger-Hours of Delay on RIPTA Buses

General	
Measure Title	**Passenger-Hours of Delay on RIPTA Buses**
Measure Description	This measure enables RI DSP and RIPTA to estimate the amount of delay experienced by passengers on RIPTA buses as a result of congestion on bus routes and roadways.
Technical Definition	Delay is defined as the difference between "free-flow" and actual travel time, multiplied by the number of passengers affected. Delay can be calculated for various temporal and spatial aggregations. The proposed measure for statewide reporting is the total annual hours of passenger-delay.
Measure Reporting	Measures are reported annually as part of the Congestion Management Report.
Measurement Issues	"Free flow" time on bus routes may not be well measured or defined. One option applied here is to take the lowest hourly average travel time on a segment (typically occurring at the very beginning or end of service). Geographic and temporal units of aggregation need to be defined. Delay can be summed over routes and time, averaged over routes and time, or multiplied by load to compute passenger-hours of delay. The most granular estimate of delay would be created by summing delay over all stop-to-stop segments and time periods measured. However, this requires defining free flow travel times and measuring actual travel times and passenger counts for every segment. More aggregate segments (e.g., timepoint-to-timepoint or entire route) and more aggregate time periods (e.g., a.m. peak, p.m. peak, midday) would require less data but also be somewhat less accurate. APC data (passenger counts) may not be available on all routes to track passenger loads by segment. Delay can be estimated if route-level ridership estimates are available.
Data and Results	
Data Source	RIPTA – APC passenger counts and AVL data.
Data Collector	RIPTA
Algorithm Calculation	*Delay is defined as:* $N * (t_{x\%} - t_0)$ *Where N is the number of passengers, t is travel time, $t_{x\%}$ is a percentile travel time of interest and t_0 is a baseline travel time. The definition of these two travel times can vary.* For segment-level calculation: • Filter out all school trips (only include trips where "Trips is School" is "No") • Create a unique ID for each segment. This can be formed by combining the route number, variant number, segment name, day of week, and direction into a consolidated field using the "concatenate" function in Excel. The components of this unique ID can be changed based on how the user would like to define a segment. • Create a new field called "Low Run Time" to find the lowest scheduled run time for each unique trip segment. Use the MINIFS function in excel to query all segments to find the lowest run time per ID. For example: =MINIFS([Schedule_Run_Time],[UNIQUE_ID],"Specific Unique ID")

	• Create a new field called "Average Delay" that subtracts the "Low Run Time" from the average run time for each segment. • Crate a new field called "Average Delay >0" to isolate only the values from Average Delay that are above zero. If the average delay value is less than or equal to zero, set the value for the new field to zero. For example: =IF([Average Delay]>0, [Average Delay]>,0) • Create a new field called "Passenger Hours Delay" where the value in "Average Delay >0" is multiplied by the mean passenger hours for each segment. • To find the total passenger hours of delay for the desired time period, sum the new Passenger Hours Delay field. Then, divide the sum by the sum of mean passenger hours for all segments to find the percentage of total passenger hours.

C. Improve Freight and Goods Movement

Table 17 – C.1 Truck Reliability on Interstates

General	
Measure Title	Truck Travel Time Reliability Index (TTTR) on RI's Interstate System, also referred to as "Truck Reliability on Interstates"
Measure Description	This measure enables RIDOT to assess the percentage of Rhode Island's Interstate with "reliable" truck travel times, where the 95th percentile of truck travel times do not exceed "normal" truck travel times by greater than 50 percent.
Technical Definition	A weighted average of the maximum truck travel time reliability index, which is ratio of 95th percentile to 50th percentile truck travel times, among five time periods calculated for each reporting segment. This metric is reported to the nearest hundredth place.
Measure Reporting	Performance metrics are reported to FHWA annually via HPMS. Monthly data is collected and evaluated internally by RIDOT Office of Performance Management and reported to the Governor's Office of Management and Budget.
Data and Results	
Data Source	• NPMRDS provided by the University of Maryland's CATT Lab • HPMS - AADT/volumes collected by RIDOT at continuous and short-duration count locations statewide consistent with FHWA's Traffic Monitoring Guide used to assign annual volume to each reporting segment
Data Collector	NPMRDS travel time data is downloaded each month and stored in a Microsoft SQL database called the Rhode Island System Performance Measures database. Monthly and annual measures are calculated by the Consultant under contract with RIDOT State Transportation Management Center (M. Wreh)
Algorithm Calculation	TTTR shall be computed as follows: $\frac{\sum_{i=1}^{T}(SL_i \times \max TTTR_i)}{\sum_{i=1}^{T} SL_i}$ **Where**: **i =** An Interstate System reporting segment; **maxTTTRi** = The maximum TTTR of the five time periods in paragraphs (a)(1)(i) through (v) of § 490.611, to the nearest hundredth, of Interstate System reporting segment ''i''; **Five Total Time Periods:** • Weekdays (Mon-Fri) 6am - 10am • Weekdays (Mon-Fri) 10am - 4pm • Weekdays (Mon-Fri) 4pm - 8pm • Overnight (all days) 8pm - 6am • Weekends 6am - 8pm **SLi** = Segment length, to the nearest thousandth of a mile, of Interstate System reporting segment ''i''; and

	T= A total number of Interstate System reporting segments.

Table 18 – C.2 Travel Time Reliability on Freight Corridors

General	
Measure Title	Percent of Person-Miles Traveled on the state's primary freight corridor that is Reliable. Also referred to as "Travel Time Reliability on Freight Corridors."
Measure Description	This measure enables RIDOT to assess the percentage of Rhode Island's freight corridor with "reliable" travel times, where the travel times do not exceed "normal" travel times by greater than 50 percent. It is an indication of how reliable travel is for freight carriers on the highway network.
Technical Definition	Percent of person-miles traveled on freight corridor roads where the Level of Travel Time Reliability (LOTTR) – the ratio of the 80^{th} percentile travel time of a reporting segment to the "normal" (50^{th} percent) travel time – is less than 1.50. Travel time reliability refers to the consistency or dependability of travel times from day to day or across different times of day.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	• INRIX Probe Data Analytics Suite provided by the University of Maryland's CATT Lab. The data from this source includes both travel time as well as directional ADT that the CATT Lab has conflated from RI's HPMS submission to the FHWA. • AVO Factor (rural/urban) which comes from the most recently available data tables published by FHWA in April 2018. It is an aggregation of AVO factors for cars, buses and trucks from multiple data sources including NHTS. For all vehicle types the factor used for first Performance Period is **1.7**.
Data Collector	INRIX PDA Suite travel time data is downloaded each month and stored within a Microsoft SQL database called the Rhode Island System Performance Measure by the Consultant under contract with RIDOT State Transportation Management Center (M. Wreh)
Algorithm Calculation	LOTTR shall be computed to the nearest tenth of a percent as follows: $100 \times \frac{\sum_{i=1}^{R} SL_i \times AV_i \times OF_j}{\sum_{i=1}^{T} SL_i \times AV_i \times OF_j}$ **Where**: **R** = is the total number of highway segments on the freight corridor that report a LOTTR of below 1.50 during four time-periods for all days of the reporting period • Weekday AM period – 6AM to 10AM • Weekday Midday period – 10AM to 4PM • Weekday PM period – 4PM to 8PM • Weekend period – 6AM to 8PM

	Data is collected in 15-minute segments during all time periods between 6 a.m. and 8 p.m. **I** = Freight corridor reporting segment ''i''; **SLi** = length, to the nearest thousandth of a mile, of the freight corridor reporting segment ''i''; **AVi** = is the total annual traffic volume computed as AADT*365, where the AADT is the Annual Average Daily Traffic available within the INRIX PDA Suite data download; **J** = geographic area in which the reporting segment ''i'' is located where a unique occupancy factor has been determined; **OFi** = occupancy factor for vehicles on the NHS within a specified geographic area within the State/Metropolitan planning area.; and **T** = total number of freight corridor reporting segments.

Table 19 – C.3 Number of Freight Bottlenecks

General	
Measure Title	Total Number of Bottlenecks on the RI's Primary Freight Corridor on the CMP Network, also referred to as "Number of Freight Bottlenecks"
Measure Description	This measure is the total number of bottlenecks identified on the CMP network using the INRIX PDA Suite portal that are also on the state's primary freight corridor.
Technical Definition	See Technical Definition of Bottleneck under performance measure B.5. This measures overlays all the bottlenecks identified under B.5 on the state's primary freight corridor to determine the number of freight bottlenecks.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	The Bottleneck Ranking tool within the INRIX Probe Data Analytics Suite provided by the University of Maryland's CATT Lab.
Data Collector	Rhode Island Division of Statewide Planning
Algorithm Calculation	Using the Latitude/Longitude of bottlenecks identified in B.5, overlay the bottlenecks of the state's primary corridor freight network with GIS. Tag the bottlenecks that also fall on the freight network to determine the total number of freight bottlenecks.

Table 20 – C.4 Truck Congestion Costs

General	
Measure Title	**Truck Congestion Costs**
Measure Description	This measure enables RIDSP to estimate the cost of truck/freight congestion based on hours of delay and commercial value of time.
Technical Definition	This measure multiplies hours of truck delay by commercial vehicle value of time to calculate annual truck congestion costs. The measure will be reported for (1) Interstates and (2) freight corridors as defined in the Statewide Freight & Goods Movement Plan.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	

Data Source	• Truck hours of delay by system will be from INRIX data. • Commercial value of time will be taken from the Texas Transportation Institute Annual Urban Mobility Report. The value used in this report for 2018 is $52.14 (see: https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-report-2019-appx-c.pdf)
Data Collector	Rhode Island Department of Statewide Planning
Algorithm Calculation	Hours of Delay x Commercial Value of Time
Data Issues	• Commercial truck value of time includes driver wages, vehicle operating costs, and logistics costs. Valuation of logistics costs and reliability can be uncertain; estimates of logistics costs, in particular, vary widely. • Estimation of truck traffic by route is uncertain and truck percentages are extrapolated from a limited set of classification counts.

D. Increase Modal Choice and Competitiveness

Table 21 – D.1 Bike Facility Mileage

General	
Measure Title	Bike Facility Mileage
Measure Description	Measures the total lane miles of all bike facilities throughout the state including bike paths and bike lanes.
Technical Definition	Total lane miles of all bike facilities in the State of Rhode Island including bicycle paths, and bicycle lanes (separated or adjacent).
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	Rhode Island Geographic Information System (RIGIS) Bicycle System GIS Layer
Data Collector	Data collected by RIDOT, data processed and reported by Rhode Island Division of Statewide Planning
Algorithm Calculation	Total lane miles of all bike facilities in the State of Rhode Island including bicycle paths, and bicycle lanes (separated or adjacent).

Table 22 – D.2 Bike Path Usage [Future Measure]

General	
Measure Title	Bicycle Path Usage
Measure Description	A percentage measure of how often the facilities below are used by cyclists: • Blackstone River Bikeway • East Bay Bike Path • William C. O'Neill Bike Path • Washington Secondary Bike Path • Fred Lippitt Woonasquatucket River Bike Path • Ten Mile River Greenway • Quonset Bike Path • Warren Bike Path
Technical Definition	Ratio of days the facility is used to the total days in a year, multiplied by 100. The utilization of a facility will be determined based on bicycle counts. Any day with a count greater than 1 will be assumed to be a day that the facility was used by a bicyclist.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	Not yet identified, new permanent bicycle counting equipment will need to be installed on the above listed facilities
Data Collector	RIDOT, Rhode Island Department of Environmental Management (DEM), and Rhode Island Division of Statewide Planning
Algorithm Calculation	Bike Path Usage BPU = Average (Days BP_i Used/Annual Days*100) Where **I** is the bike path listed above

Table 23 – D.3 HOV/Dedicated Bus Lane Route Miles

General	
Measure Title	HOV/Dedicated Bus Lane Route Miles
Measure Description	This measure provides the assessment of the extent of facilities dedicated to encouraging the use of High Occupancy Vehicles (HOV) and buses and to shift mode share away from Single Occupant Vehicle (SOV)
Technical Definition	Total route miles of all HOV and lanes designated as Bus Only lanes in the State of Rhode Island.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIDOT Office of Transit, New Starts and Alternative Modes of Transportations RIPTA
Data Collector	Data collected by RIDOT Office of Transit, RIPTA and RIDSP
Algorithm Calculation	Total routes miles of all HOV and lanes designated as Bus Only lanes in the State of Rhode Island.

Table 24 – D.4 Percent of Non-Single Occupant Vehicle (SOV) Travel

General	
Measure Title	Percent of Non-Single Occupant Vehicle (SOV) Travel
Measure Description	This provides an indication of what percent of the travel is occurring on the transit system, car-pools, and other modes of transportation including walk and bikes.
Technical Definition	Ratio of non-SOV travel to total travel
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	American Community Survey
Data Collector	Rhode Island Division of Statewide Planning
Algorithm Calculation	Percent non-SOV Travel = 100 – Percent SOV travel Where SOV Travel as defined by ACS is “Car, truck, van – Drive Alone” $$Percent\ Non-SOV\ Travel = 100 \times \frac{(Volume_{Non-SOV})}{(Volume_{Non-SOV} + Volume_{SOV})}$$ Where: Percent of Non-SOV Travel = percentage of travel, to the nearest tenth of a percent, that is not occurring by driving alone in a motorized vehicle, including travel avoided by telecommuting $Volume_{Non-SOV}$= Annual volume of person travel occurring while driving alone in a motorized vehicle; and $Volume_{SOV}$ = Annual volume of person travel occurring on modes other than driving alone in a motorized vehicle, calculated as: $$\sum_{m=1}^{t} Volume_m$$ Where: m = travel mode (modes other than driving alone in a motorized vehicle, including travel avoided by telecommuting); Volume m = annual volume of person travel for each mode, ‘‘m’’; and t = total number of modes that are not driving alone in a motorized vehicle.

Table 25 – D.5 Annual Commuter Rail Ridership

General	
Measure Title	Annual Commuter Rail Ridership
Measure Description	This measure tracks the weekday ridership of MBTA commuter rail in Rhode Island by riders boarding and alighting at Providence Station, TF Green Airport, Wickford Junction, and any new stations opened in future.
Technical Definition	Total weekday passenger trips on the MBTA Providence commuter rail line originating or ending at Providence Station, TF Green Airport, Wickford Junction and any new stations opened in future within a quarter.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIDOT-commissioned quarterly counts. An average day is determined over a three-day observation period (Day 1 = AM, Day 2 = mid, Day 3 = PM). The average day is multiplied by 64 days, which is representative of 64 weekdays of rail service in a quarter.
Data Collector	RIDOT Office of Transit
Algorithm Calculation	

Table 26 – D.6 RIPTA Bus Ridership

General	
Measure Title	RIPTA Bus Ridership
Measure Description	This measure provides the level of usage of the RIPTA buses in Rhode Island.
Technical Definition	Number of average weekday daily trips averaged over a month on the entire RIPTA bus route system
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIPTA
Data Collector	RIDOA Division of Statewide Planning
Algorithm Calculation	Average weekday daily ridership on the entire RIPTA bus system in a month

Table 27 – D.7 Providence/Newport Ferry Ridership

General	
Measure Title	Providence/Newport Ferry Ridership
Measure Description	This measure tracks the ridership for the Providence – Newport Ferry by riders boarding at 25 India Street in Providence and Perrotti Park in Newport.
Technical Definition	Number of passenger trips on the state-sponsored Providence – Newport Ferry. Each trip equates to one rider boarding at either 25 India Street in Providence and Perrotti Park in Newport. The counts are conducted 7 days a week during the seasonal service.

Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	Weekly ridership reports prepared by the ferry operator and submitted to RIDOT. RIDOT will review and approve on a monthly basis.
Data Collector	RIDOT Office of Intermodal Planning
Algorithm Calculation	

E. Improve Intermodal Connectivity

Table 28 – E.1 Percent of Population with Transit Access

<table>
<tr><th colspan="2">General</th></tr>
<tr><td>Measure Title</td><td>Percent of Population with Transit Access</td></tr>
<tr><td>Measure Description</td><td>This measure provides the percent of the state's population that are within ¼ mile of a transit stop or station with high-frequency service.</td></tr>
<tr><td>Technical Definition</td><td>Total population within ¼ mile of a transit stop or station with high-frequency service (15 minutes or less during peak periods) divided by total state population.</td></tr>
<tr><td>Measure Reporting</td><td>Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.</td></tr>
<tr><td>Measurement Issues</td><td>Depending on geographic resolution of data source, may be approximations of how many people are actually within ¼ mile.
Location within ¼ mile of transit may not guarantee walkable access. Future improvements may include consideration of walk networks when data is available.</td></tr>
<tr><th colspan="2">Data and Results</th></tr>
<tr><td>Data Source</td><td>Transit stops and stations: RIPTA shapefiles.
Location of population: Census block group data from most recent 5-year ACS.</td></tr>
<tr><td>Data Collector</td><td>Rhode Island Division of Statewide Planning</td></tr>
<tr><td>Algorithm Calculation</td><td>Population within ¼ mile (method applied by RIDSP for 2018 analysis, which used 2016 ACS population and 2017 bus stop data):
Obtain the State's E911 Site layer
Divide site types into three categories: Residential, Commercial, and Other. Residential types include R1 - R6
Obtain latest year population estimates for census tracts from the American Community Survey
Assign population to residential addresses in each tract based on the census tract population, divided by the number of addresses
Obtain latest RIPTA bus stop GIS layer from RIGIS, select stops with frequent peak service (15 minute headways or less) within 50 feet of the centerline of each route, and create a 0.25 mi buffer around the stops
Select the residential address points within the service area (buffers)
Sum population within the high-frequency stop areas and divide by total state population
Population within ¼ mile (alternate method not using E911 data):
Download the RIPTA shapefile for bus stops
Select stops with a peak period service headway of 15 minutes or shorter on all routes combined
Download the TIGER shapefile for Block Groups in Rhode Island (https://www.census.gov/cgi-bin/geo/shapefiles/index.php)
Download population data for each Block Group in Rhode Island (https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml)
Join the two files in a GIS application</td></tr>
</table>

	○ Use the "buffer" GIS tool to identify block groups that are at least partially within ¼ mile of a bus stop [alternative approach: select block groups with centroid in buffer, or proportion BG population and jobs according to land area within buffer] ○ Use the spatial join procedure to tabulate population in these block groups ○ Sum and divide by total state population
Data Issues	• ACS population estimates are 5-year estimates at the block group level with 1-2 year reporting lag

Table 29 – E.2 Percent of Jobs with Transit Access

General	
Measure Title	**Percent of Jobs with Transit Access**
Measure Description	This measure provides the percent of the state's jobs that are within ¼ mile of a transit stop or station with high-frequency service.
Technical Definition	Total jobs within ¼ mile of a transit stop or station with high-frequency service (15 minutes or less during peak periods) divided by total state jobs.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Measurement Issues	Depending on geographic resolution of data source, may be approximations of how many jobs are actually within ¼ mile. Location within ¼ mile of transit may not guarantee walkable access. Future improvements may include consideration of walk networks when data is available.
Data and Results	
Data Source	• Transit stops and stations: RIPTA shapefiles. • Location of jobs: Estimates for statewide travel demand model prepared from Department of Labor data.
Data Collector	Rhode Island Division of Statewide
Algorithm Calculation	• Population within ¼ mile (method applied by RIDSP for 2018 analysis, using 2015 jobs data and 2017 bus stop data): ○ Obtain the State's E911 Site layer ○ Divide site types into three categories: Residential, Commercial, and Other. Residential types include B2, C1, C9, CF, CL, I1, P1 – P8 ○ Obtain employment data layer for traffic analysis zones (TAZ) from the RIDSP statewide model ○ Assign TAZ job totals to commercial addresses by dividing the total number of jobs in each TAZ by the number of commercial addresses and assigning result to each address in TAZ ○ Obtain latest RIPTA bus stop GIS layer from RIGIS, select stops with frequent peak service (15 minute headways or less) within 50 feet of the centerline of each route, and create a 0.25 mi buffer around the stops ○ Select the commercial address points within the service area (buffers) ○ Sum jobs within the high-frequency stop areas and divide by total state jobs • Jobs within ¼ mile (alternate method not using E911 data): ○ Download the RIPTA shapefile for bus stops

	○ Obtained the shapefile for Traffic Analysis Zones (TAZ) from the Rhode Island Statewide Model ○ Obtain employment data for each TAZ in the RISM ○ Join the two files in a GIS application ○ Use the "buffer" GIS tool to identify TAZ that are at least partially within ¼ mile of a bus stop [alternative approach: select TAZ with centroid in buffer, or proportion TAZ jobs according to land area within buffer] ○ Use the spatial join procedure to tabulate employment in these TAZs ○ Sum and divide by total state employment
Data Issues	• State employment data need cleaning and QA/QC and updated data are only developed every few years (most recent = 2015).

Table 30 - E.3 Bicycle System Connectivity Ratio

General	
Measure Title	Bike System Connectivity Ratio
Measure Description	Measures whether bike paths form a coherent network
Technical Definition	Ratio of longest contiguous conglomeration of bicycle paths to total bike path system mileage.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIDOT Bicycle System GIS Layer
Data Collector	Data collected by RIDOT, data processed and reported by RIDOA Division of Statewide Planning
Algorithm Calculation	BSC = Longest contiguous conglomeration of bicycle paths / Total lane miles of bicycle paths

F. Promote and Invest in Innovative Congestion Management Technologies

Table 31 – F.1 Number of Intersections with Advanced Traffic Control

General	
Measure Title	Number of Intersections with Advanced Traffic Control
Measure Description	This measures the state of the existing traffic signals within Rhode Island
Technical Definition	Number of traffic signals within the state which have the following characteristics: • Have a fully functional local vehicle detection system, and • Is able to update traffic signal timings on an on-going basis using information from the detection system. The algorithm to update the signal timing could exist either locally on a computer hardware within the cabinet or on a central computer server.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIDOT Office of Safety, and Cities/Towns within Rhode Island
Data Collector	Data collected by RIDOT and RIDSP
Algorithm Calculation	

Table 32 – F.2 Number of Intersections with Remote Monitoring

General	
Measure Title	Number of Intersections with Remote Monitoring
Measure Description	This measures the level to which existing traffic signals within Rhode Island have the capability to allow remote monitoring and control
Technical Definition	Number of traffic signals within the state which have the following characteristics: • Have a communication link between the cabinet and a central office of the public agency with all necessary hardware • The public agency has the necessary software to communicate with the traffic signal controller and monitor the traffic signal operations and extract available MOEs from the signal controller
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIDOT Office of Safety, and Cities/Towns within Rhode Island
Data Collector	Data collected by RIDOT and RIDSP
Algorithm Calculation	

Table 33 – F.3 Number of Real-time Travel Time Signs per Route Mile

General	
Measure Title	Number of Real-time Travel Time Signs per Route Mile
Measure Description	This measures the level to which RIDOT provides real-time travel time information to motorists on the state's highway system
Technical Definition	The measures is based on the number of hybrid guide signs that provide both destination/mileage as well as real-time travel time from the location of the sign to the destination(s) shown on the sign. It accounts for route

	mileage each sign covers. The measures would show an improvement if the number of signs increases. Furthermore, this measure would also show an improvement if there are more signs covering shorter distances than if there are fewer signs covering longer distances. The travel times are more accurate if the distances are shorter. It is important to note that this measure does not include any portable or permanent DMS that may be used to provide travel time information on an as-needed basis.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIDOT Transportation Management Center
Data Collector	RIDOT TMC
Algorithm Calculation	This measures is computed as a ratio. The numerator is the number of real-time travel time signs. The denominator is the sum of route mileage displayed on each sign. If the sign has more than one destination, then the farthest mileage may be considered.

Table 34 – F.4 Number of RIPTA Bus Routes with Transit Priority Treatment

General	
Measure Title	Number of RIPTA Bus Routes with Transit Priority Treatment
Measure Description	This measures the level to which RIPTA bus routes have utilized innovative technologies to improve transit operations and reliability
Technical Definition	The measure is the number of RIPTA bus routes that have any of the following transit priority treatments at any point along the route: • Transit Signal Priority (TSP) • Q Jump lanes (to allow buses to bypass vehicle queues at a traffic signal) • Have access to lanes restricted for bus use only, even if the restriction is only during peak periods
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIDOT Office of Transit and RIPTA
Data Collector	RIDOT Office of Transit, RIDSP, and RIPTA
Algorithm Calculation	

G. Promote Land Development and Infill Development /Redevelopment in Transportation-Efficient Locations

Table 35 – G.1 Percent of Permits in Transit Propensity Areas [Future Measure]

General	
Measure Title	Percent of Permits in Transit Propensity Areas
Measure Description	This measure provides the percent of land development permits that are requested by local land developers in areas where transit is more likely to be used by local residents and workers.
Technical Definition	High transit propensity, as defined in the Rhode Island Transit Master Plan, is proposed to be used as a proxy for smart growth/ transportation efficient locations. This measure would therefore be calculated as total permits within "high transit propensity areas" divided by total permits statewide. "High transit propensity areas" are

	defined based on population density, job density, and demographics at the census tract level in the Rhode Island Transit Master Plan.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	• High transit propensity areas: Rhode Island Transit Master Plan (shapefiles) • Rhode Island's E-Permits portal
Data Collector	RIDSP
Algorithm Calculation	• GIS: overlay STIP project shapefiles on high transit propensity areas shapefiles. • Geo-locate each development associated with a permit • Tabulate sum of land development projects inside and outside transit areas.

Table 35 – G.2 Transportation Funds Invested in Transit Propensity Areas

General	
Measure Title	Transportation Funds Invested in Transit Propensity Areas
Measure Description	This measure provides the percent of the state's transportation funds that are being invested in areas where transit is more likely to be used by local residents and workers.
Technical Definition	High transit propensity, as defined in the Rhode Island Transit Master Plan, is proposed to be used as a proxy for smart growth/ transportation efficient locations. This measure would therefore be calculated as total STIP funding for projects within "high transit propensity areas" divided by total STIP funding assigned to geographically located projects. "High transit propensity areas" are defined based on population density, job density, and demographics at the census tract level in the Rhode Island Transit Master Plan.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	• High transit propensity areas: Rhode Island Transit Master Plan (shapefiles) • STIP funding by project: RI DSP - STIP
Data Collector	RIDSP
Algorithm Calculation	• GIS: overlay STIP project shapefiles on high transit propensity areas shapefiles. • Measure length of project inside and outside transit area and assign "fraction inside" value to each project (alternative lower-effort but less accurate method: identify STIP projects based on whether their centroid falls within a high transit propensity area). • Tabulate sum of STIP project value inside and outside transit areas.

H. Reduce Emissions and Improve Air Quality

Table 36 – H.1 Total Vehicle Miles Traveled (VMT) Per Capita

General	
Measure Title	Total Vehicle Miles Traveled (VMT) Per Capita
Measure Description	This measure the level of vehicular travel in the state on a per capita basis.
Technical Definition	The level of travel within the state can be measured by VMT which is the total of all vehicle trips multiplied by trip length. VMT is computed by adding the product of the ADT and the length of all highway segments within the state. The VMT statistics for Rhode Island can be obtained from RIDSP or from the Federal Highway Administration Highway Statistics annual publication, and the latest population estimate can be obtained from the U.S. Bureau of the Census
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	• FHWA Annual Highway Statistics • US Bureau of Census
Data Collector	RIDSP
Algorithm Calculation	Total Statewide VMT ÷ Total Statewide Population

Table 37 – H.2 Emission Reduction by CMAQ Projects [Future Measure]

General	
Measure Title	Emission Reduction by CMAQ Projects
Measure Description	This measure helps assess the contribution by Congestion Mitigation and Air Quality Improvement Program (CMAQ) projects towards emission reductions and improvement in air quality.
Technical Definition	TBD
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIDEM
Data Collector	RIDEM
Algorithm Calculation	TBD

Table 38 – H.3 Counties in Regional Air Quality Attainment

General	
Measure Title	Counties in Regional Air Quality Attainment
Measure Description	This measure describes how many of the five Rhode Island counties are in attainment of national ambient air quality standards (NAAQS).
Technical Definition	Number of counties that are deemed to be air quality attainment during the report period.

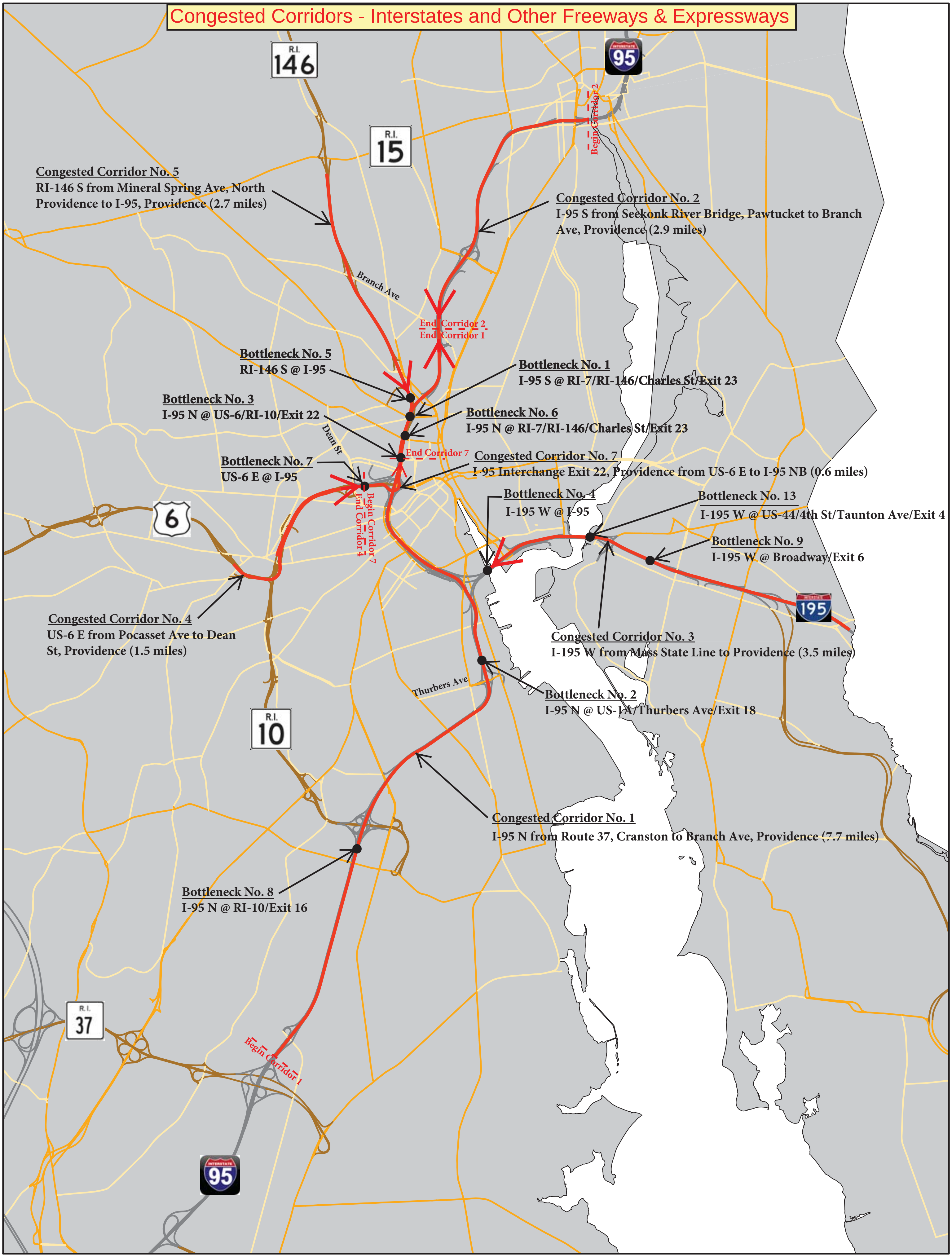
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIDEM
Data Collector	RIDEM
Algorithm Calculation	The official attainment status of Rhode Island counties can be obtained from the U.S. Environmental Protection Agency Green Book, https://www.epa.gov/green-book.

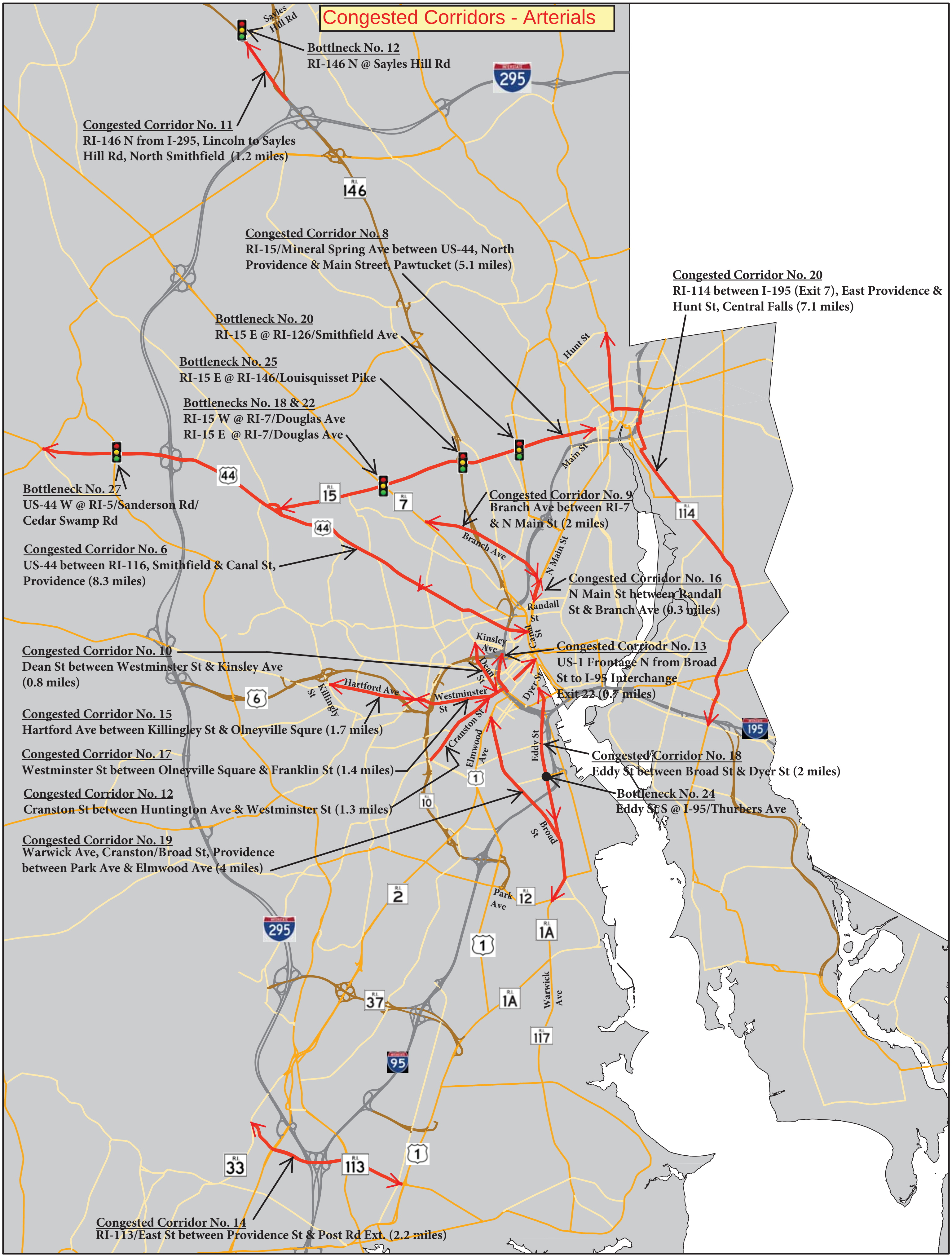
Table 39 – H.4 Greenhouse Gas Emissions [Future Measure]

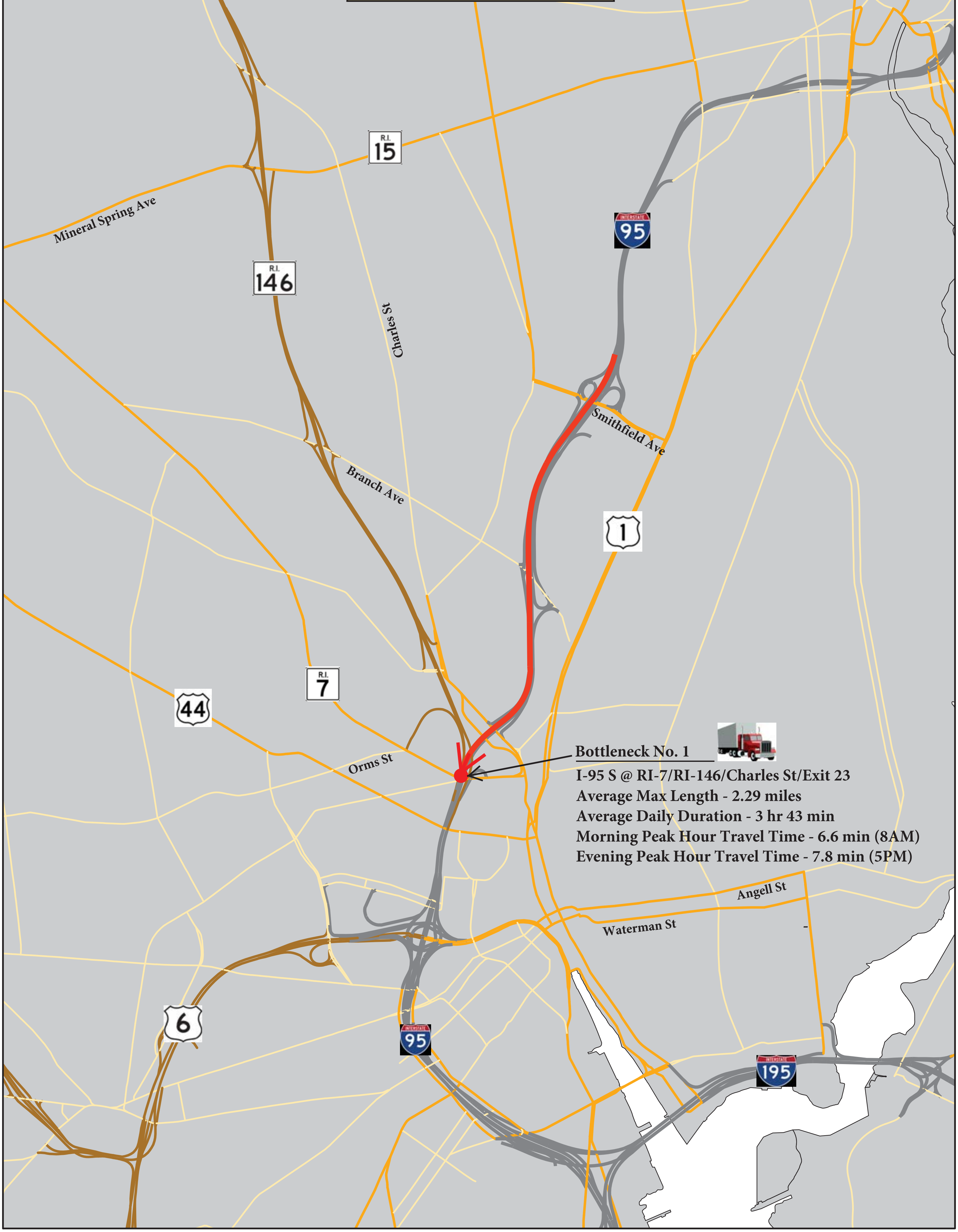
General	
Measure Title	Greenhouse Gas (GHG) Emissions
Measure Description	This measure provides the total greenhouse gas emissions from highway vehicles on the congestion management system network.
Technical Definition	This performance measure is intended to respond to the Resilient Rhode Island Act of 2014 related to climate change and GHG emissions as part of the Congestion Management Process. It is the total GHG emissions, expressed in million metric tons carbon dioxide equivalent (MMTCO2e), from highway vehicles traveling on the CMP network, including automobiles, motorcycles, trucks, and buses.
Measure Reporting	Performance metrics are reported for each update of the Congestion Management Process for Rhode Island.
Data and Results	
Data Source	RIDEM
Data Collector	RIDEM
Algorithm Calculation	TBD

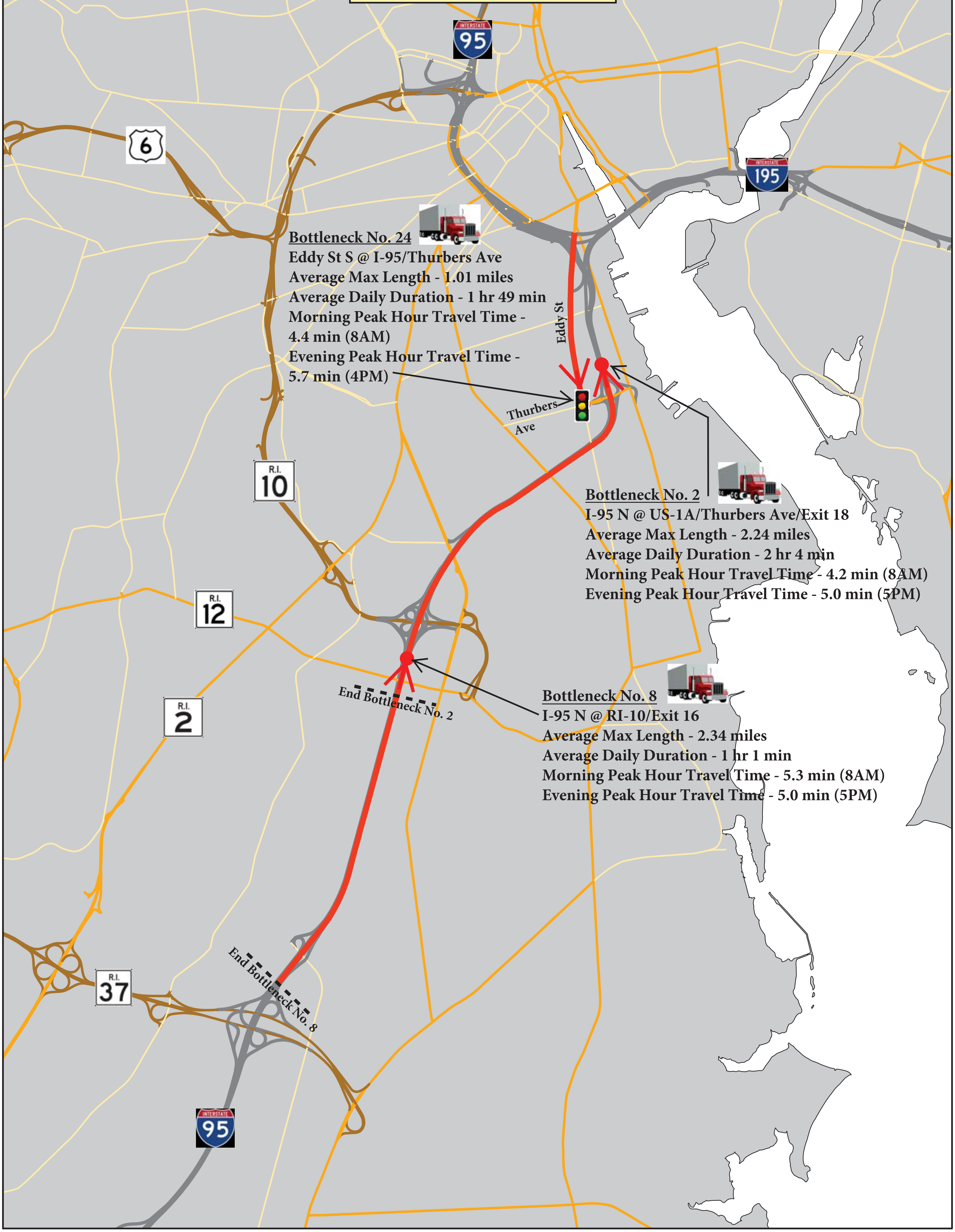
Appendix B

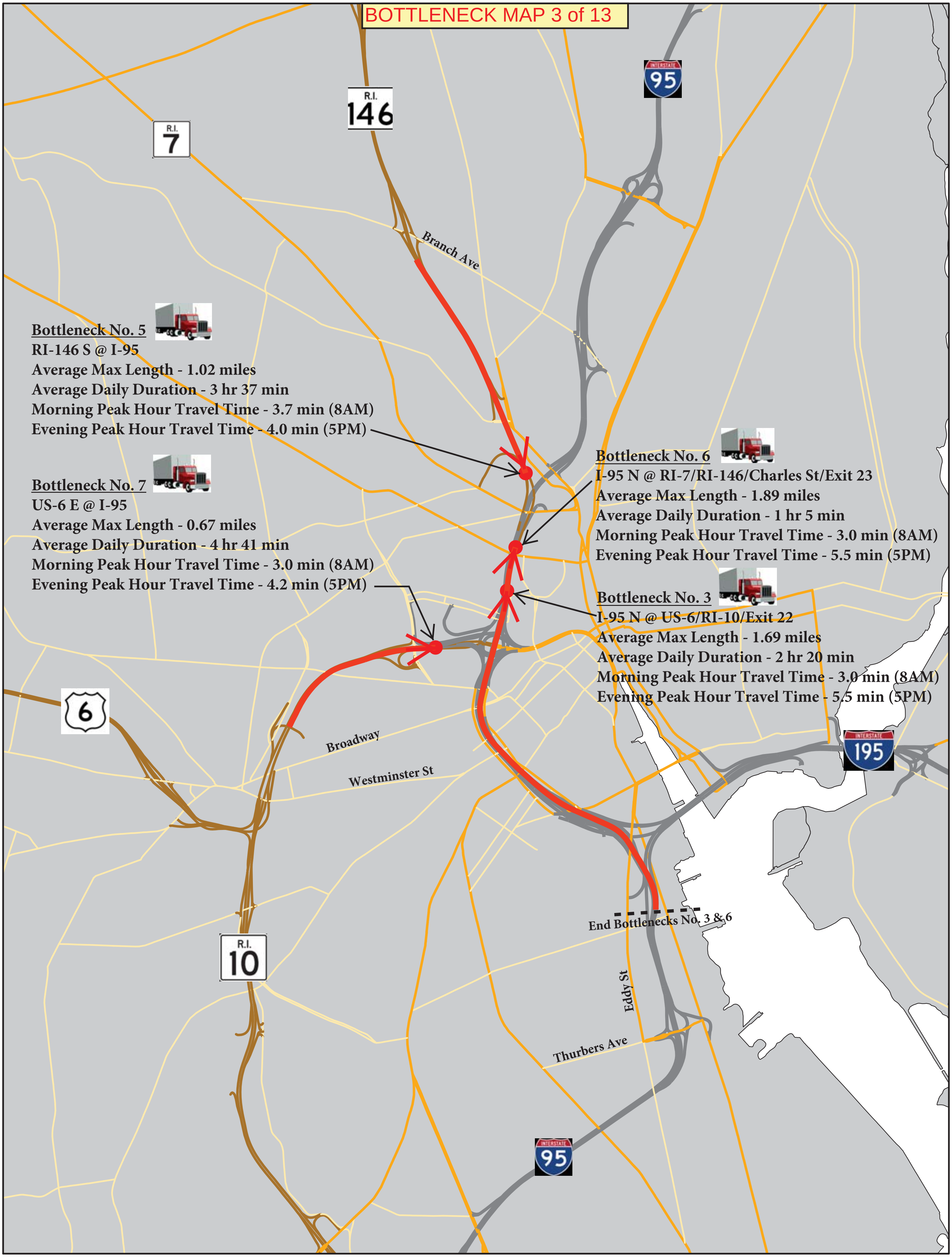
Maps of Top Bottlenecks and Congested Corridors


Congested Corridors - Interstates and Other Freeways & Expressways
R.I. 146
95
R.I. 15
Begin Corridor 2
Congested Corridor No. 5
RI-146 S from Mineral Spring Ave, North Providence to I-95, Providence (2.7 miles)
Congested Corridor No. 2
I-95 S from Seekonk River Bridge, Pawtucket to Branch Ave, Providence (2.9 miles)
Branch Ave
End Corridor 2
End Corridor 1
Bottleneck No. 5
RI-146 S @ I-95
Bottleneck No. 1
I-95 S @ RI-7/RI-146/Charles St/Exit 23
Bottleneck No. 3
I-95 N @ US-6/RI-10/Exit 22
Bottleneck No. 6
I-95 N @ RI-7/RI-146/Charles St/Exit 23
Dean St
End Corridor 7
Congested Corridor No. 7
I-95 Interchange Exit 22, Providence from US-6 E to I-95 NB (0.6 miles)
Bottleneck No. 7
US-6 E @ I-95
Begin Corridor 7
End Corridor 4
Bottleneck No. 4
I-195 W @ I-95
Bottleneck No. 13
I-195 W @ US-44/4th St/Taunton Ave/Exit 4
6
Bottleneck No. 9
I-195 W @ Broadway/Exit 6
195
Congested Corridor No. 4
US-6 E from Pocasset Ave to Dean St, Providence (1.5 miles)
Congested Corridor No. 3
I-195 W from Mass State Line to Providence (3.5 miles)
Thurbers Ave
Bottleneck No. 2
I-95 N @ US-1A/Thurbers Ave/Exit 18
R.I. 10
Congested Corridor No. 1
I-95 N from Route 37, Cranston to Branch Ave, Providence (7.7 miles)
Bottleneck No. 8
I-95 N @ RI-10/Exit 16
R.I. 37
Begin Corridor 1
95

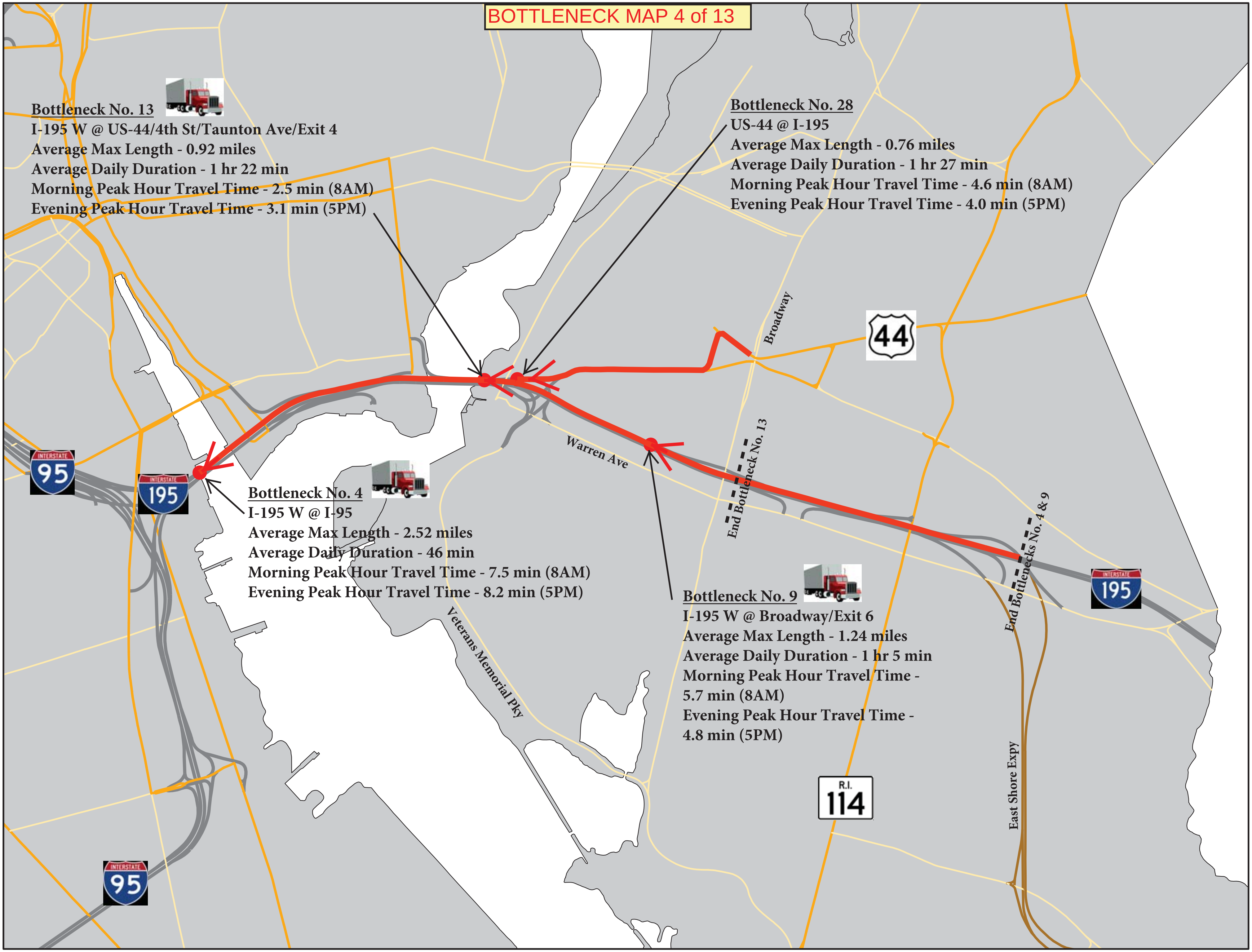

Congested Corridors - Arterials
Bottlneck No. 12
RI-146 N @ Sayles Hill Rd
Congested Corridor No. 11
RI-146 N from I-295, Lincoln to Sayles Hill Rd, North Smithfield (1.2 miles)
Congested Corridor No. 8
RI-15/Mineral Spring Ave between US-44, North Providence & Main Street, Pawtucket (5.1 miles)
Congested Corridor No. 20
RI-114 between I-195 (Exit 7), East Providence & Hunt St, Central Falls (7.1 miles)
Bottleneck No. 20
RI-15 E @ RI-126/Smithfield Ave
Bottleneck No. 25
RI-15 E @ RI-146/Louisquisset Pike
Bottlenecks No. 18 & 22
RI-15 W @ RI-7/Douglas Ave
RI-15 E @ RI-7/Douglas Ave
Bottleneck No. 27
US-44 W @ RI-5/Sanderson Rd/ Cedar Swamp Rd
Congested Corridor No. 9
Branch Ave between RI-7 & N Main St (2 miles)
Congested Corridor No. 6
US-44 between RI-116, Smithfield & Canal St, Providence (8.3 miles)
Congested Corridor No. 16
N Main St between Randall St & Branch Ave (0.3 miles)
Congested Corridor No. 10
Dean St between Westminster St & Kinsley Ave (0.8 miles)
Congested Corriodr No. 13
US-1 Frontage N from Broad St to I-95 Interchange Exit 22 (0.7 miles)
Congested Corridor No. 15
Hartford Ave between Killingley St & Olneyville Squre (1.7 miles)
Congested Corridor No. 17
Westminster St between Olneyville Square & Franklin St (1.4 miles)
Congested Corridor No. 18
Eddy St between Broad St & Dyer St (2 miles)
Congested Corridor No. 12
Cranston St between Huntington Ave & Westminster St (1.3 miles)
Bottleneck No. 24
Eddy St S @ I-95/Thurbers Ave
Congested Corridor No. 19
Warwick Ave, Cranston/Broad St, Providence between Park Ave & Elmwood Ave (4 miles)
Congested Corridor No. 14
RI-113/East St between Providence St & Post Rd Ext. (2.2 miles)
Sayles Hill Rd
Hunt St
Main St
Branch Ave
N Main St
Randall St
Canal St
Kinsley Ave
Dean St
Dyer St
Hartford Ave
Killingly St
Westminster St
Cranston St
Elmwood Ave
Eddy St
Broad St
Park Ave
Warwick Ave
295
146
44
15
7
114
6
195
1
10
2
12
1A
37
95
117
33
113

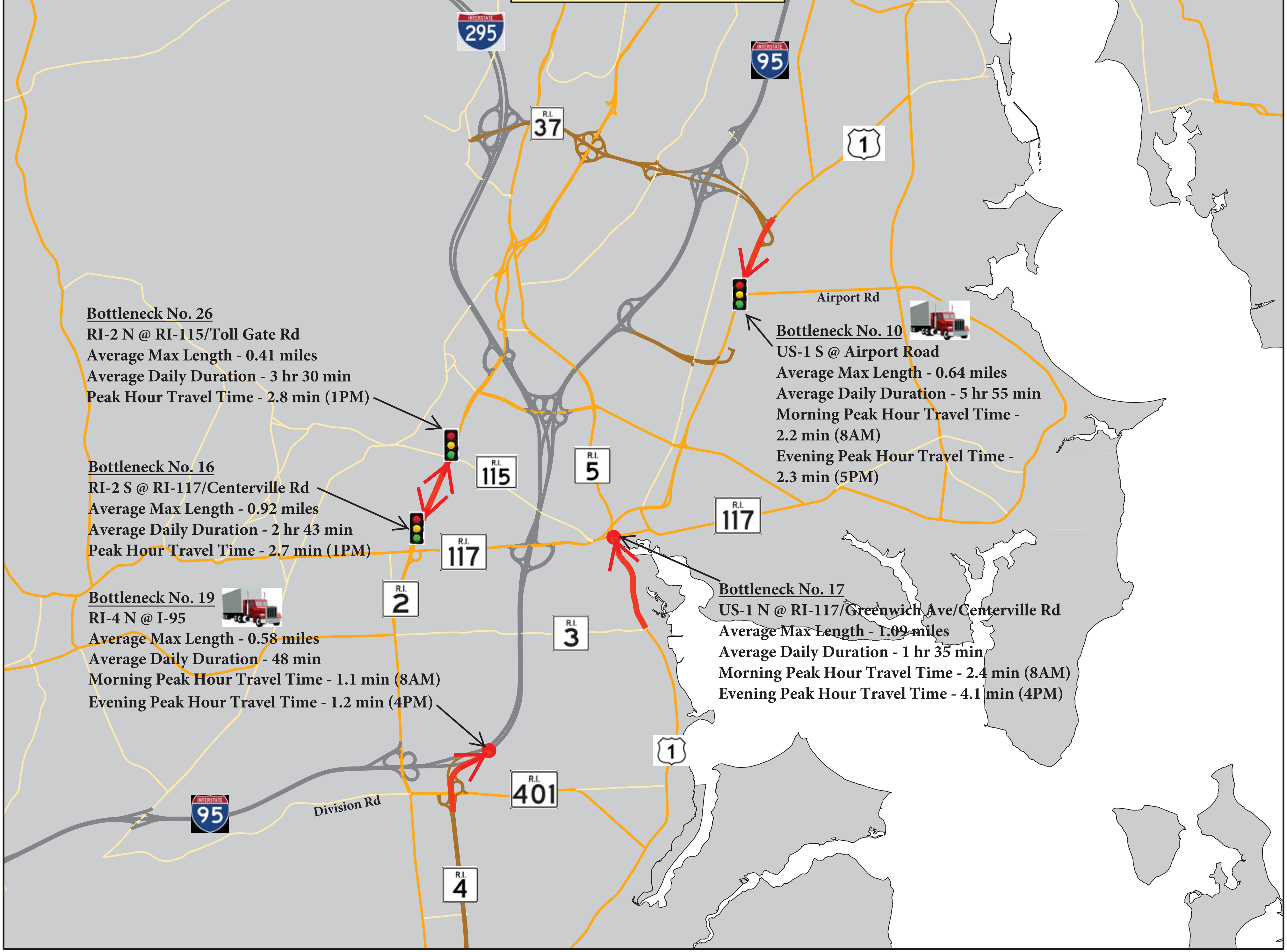

R.I. 15
Mineral Spring Ave
R.I. 146
Charles St
95
Smithfield Ave
Branch Ave
1
R.I. 7
44
Orms St
Bottleneck No. 1
I-95 S @ RI-7/RI-146/Charles St/Exit 23
Average Max Length - 2.29 miles
Average Daily Duration - 3 hr 43 min
Morning Peak Hour Travel Time - 6.6 min (8AM)
Evening Peak Hour Travel Time - 7.8 min (5PM)
Angell St
Waterman St
6
95
195

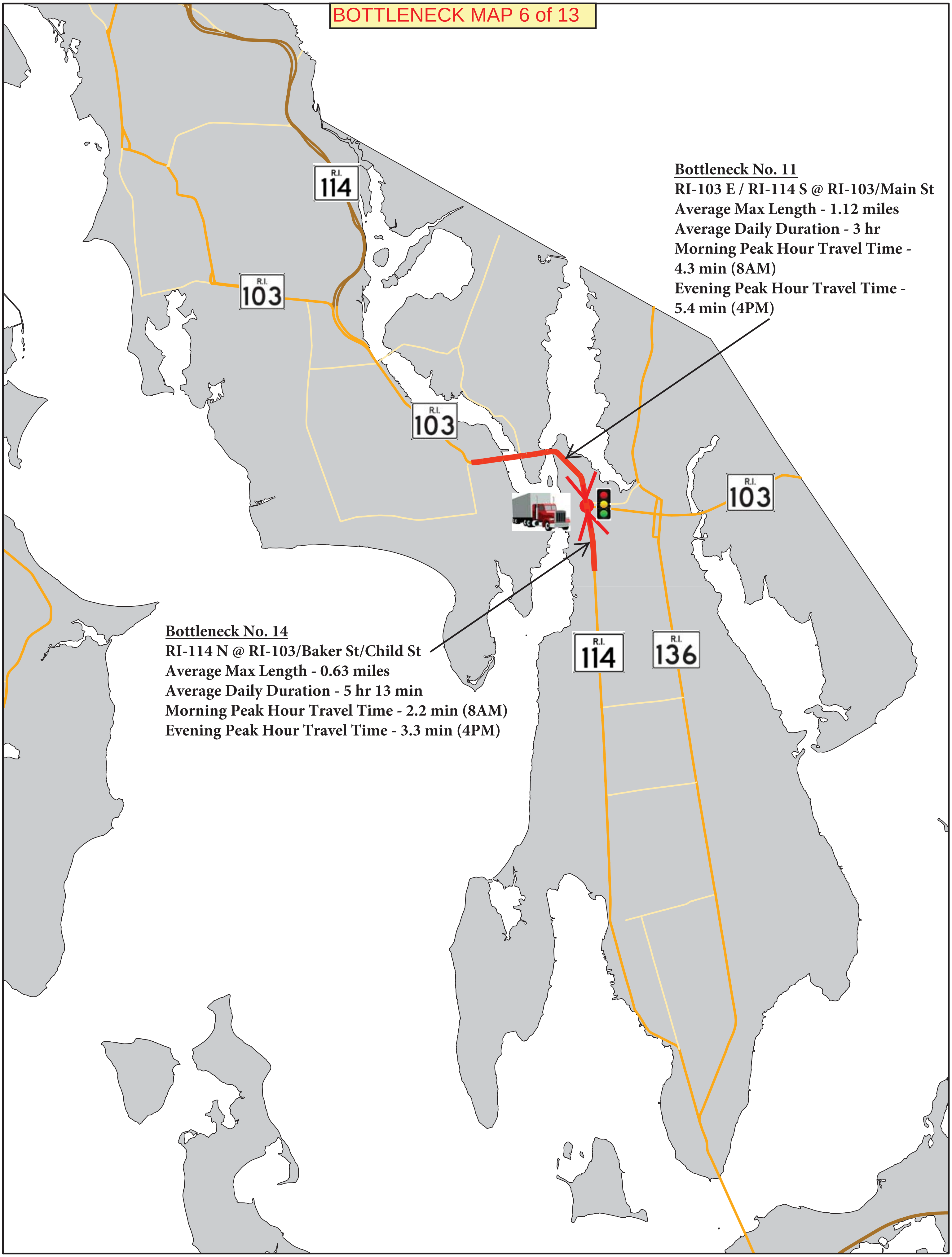

Bottleneck No. 24
Eddy St S @ I-95/Thurbers Ave
Average Max Length - 1.01 miles
Average Daily Duration - 1 hr 49 min
Morning Peak Hour Travel Time -
4.4 min (8AM)
Evening Peak Hour Travel Time -
5.7 min (4PM)
Eddy St
Thurbers Ave
Bottleneck No. 2
I-95 N @ US-1A/Thurbers Ave/Exit 18
Average Max Length - 2.24 miles
Average Daily Duration - 2 hr 4 min
Morning Peak Hour Travel Time - 4.2 min (8AM)
Evening Peak Hour Travel Time - 5.0 min (5PM)
End Bottleneck No. 2
Bottleneck No. 8
I-95 N @ RI-10/Exit 16
Average Max Length - 2.34 miles
Average Daily Duration - 1 hr 1 min
Morning Peak Hour Travel Time - 5.3 min (8AM)
Evening Peak Hour Travel Time - 5.0 min (5PM)
End Bottleneck No. 8
95
195
6
10
12
2
37
95

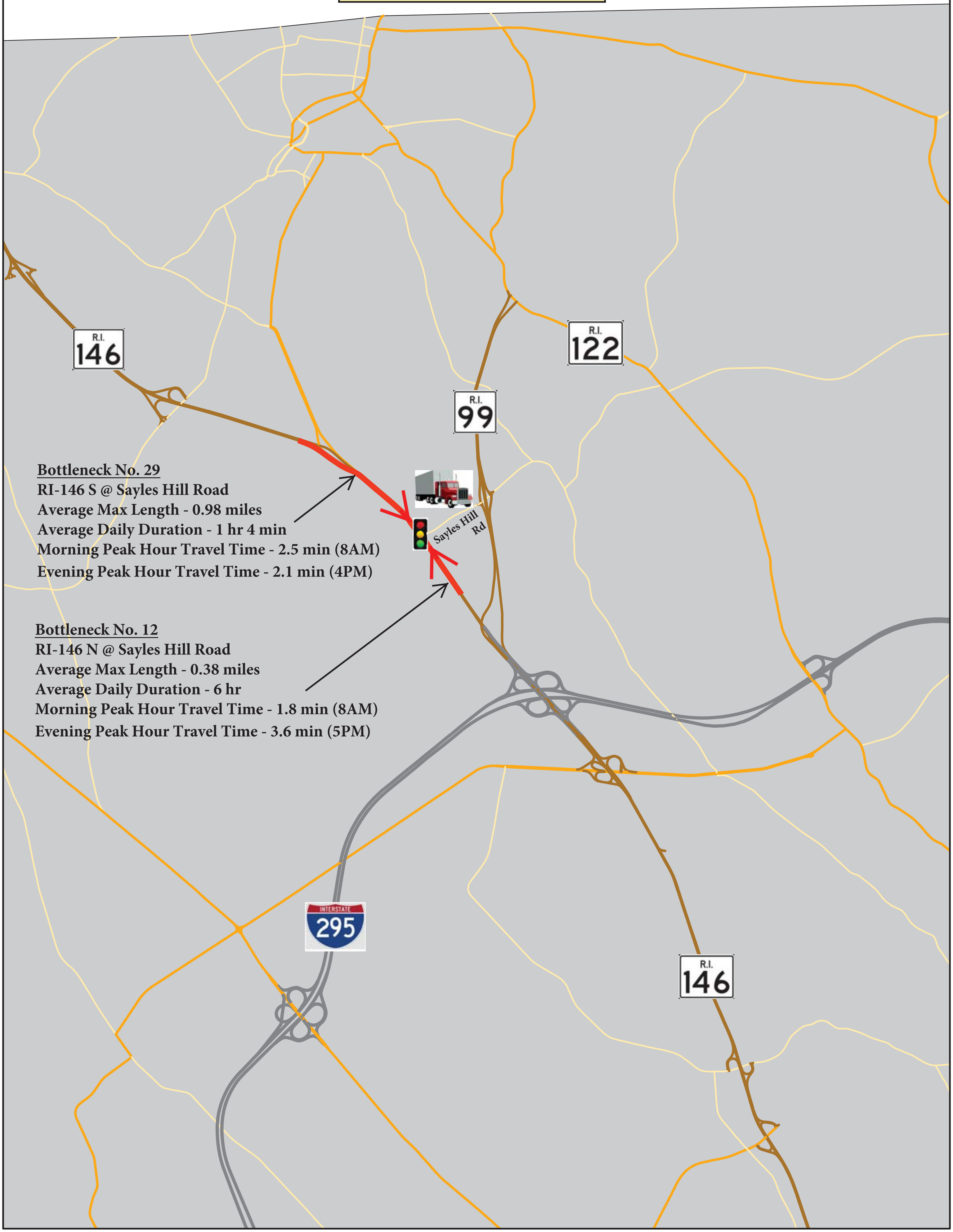


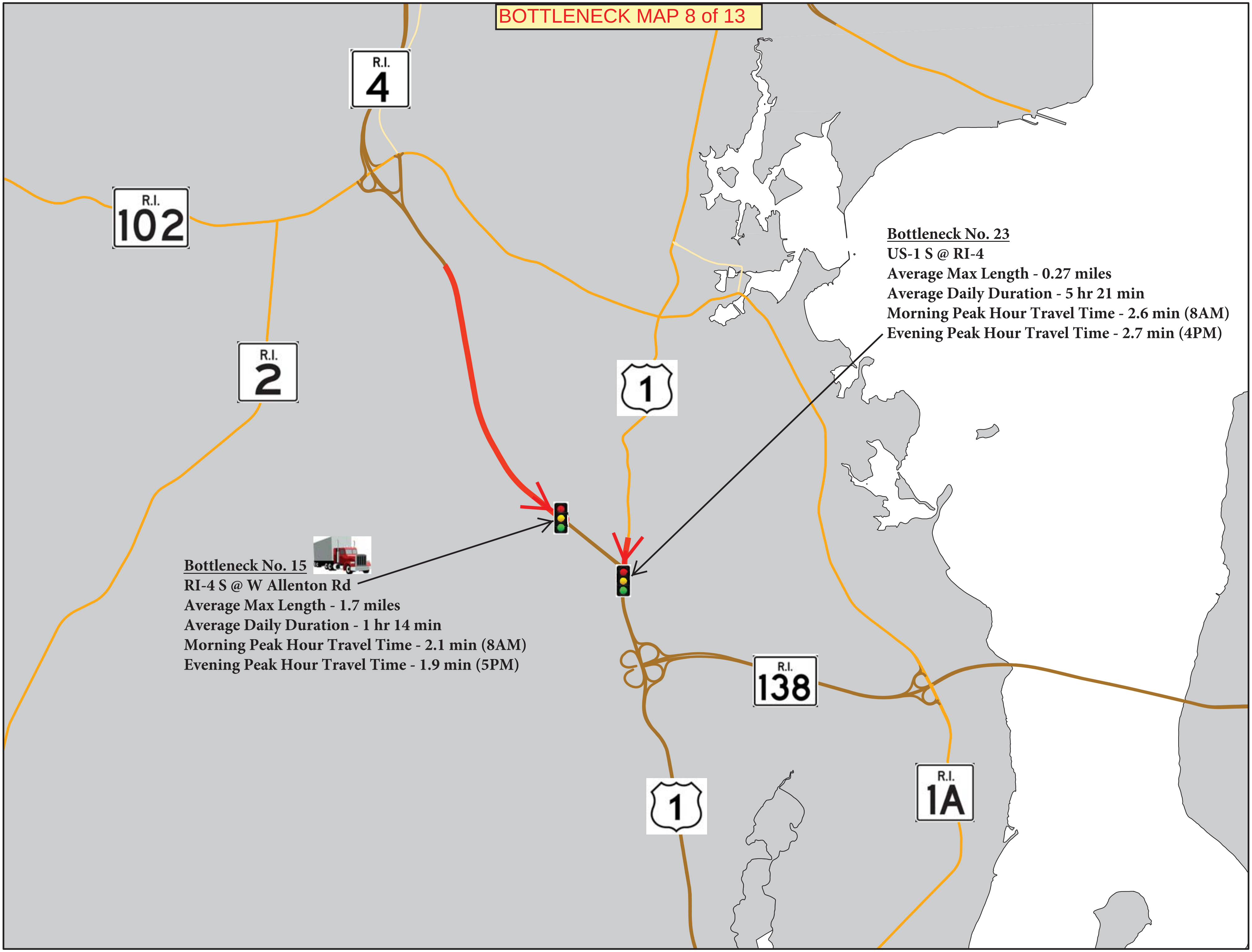
BOTTLENECK MAP 3 of 13
Bottleneck No. 5
RI-146 S @ I-95
Average Max Length - 1.02 miles
Average Daily Duration - 3 hr 37 min
Morning Peak Hour Travel Time - 3.7 min (8AM)
Evening Peak Hour Travel Time - 4.0 min (5PM)
Bottleneck No. 7
US-6 E @ I-95
Average Max Length - 0.67 miles
Average Daily Duration - 4 hr 41 min
Morning Peak Hour Travel Time - 3.0 min (8AM)
Evening Peak Hour Travel Time - 4.2 min (5PM)
Bottleneck No. 6
I-95 N @ RI-7/RI-146/Charles St/Exit 23
Average Max Length - 1.89 miles
Average Daily Duration - 1 hr 5 min
Morning Peak Hour Travel Time - 3.0 min (8AM)
Evening Peak Hour Travel Time - 5.5 min (5PM)
Bottleneck No. 3
I-95 N @ US-6/RI-10/Exit 22
Average Max Length - 1.69 miles
Average Daily Duration - 2 hr 20 min
Morning Peak Hour Travel Time - 3.0 min (8AM)
Evening Peak Hour Travel Time - 5.5 min (5PM)
End Bottlenecks No. 3 & 6
R.I. 146
R.I. 7
95
195
6
R.I. 10
Branch Ave
Broadway
Westminster St
Eddy St
Thurbers Ave

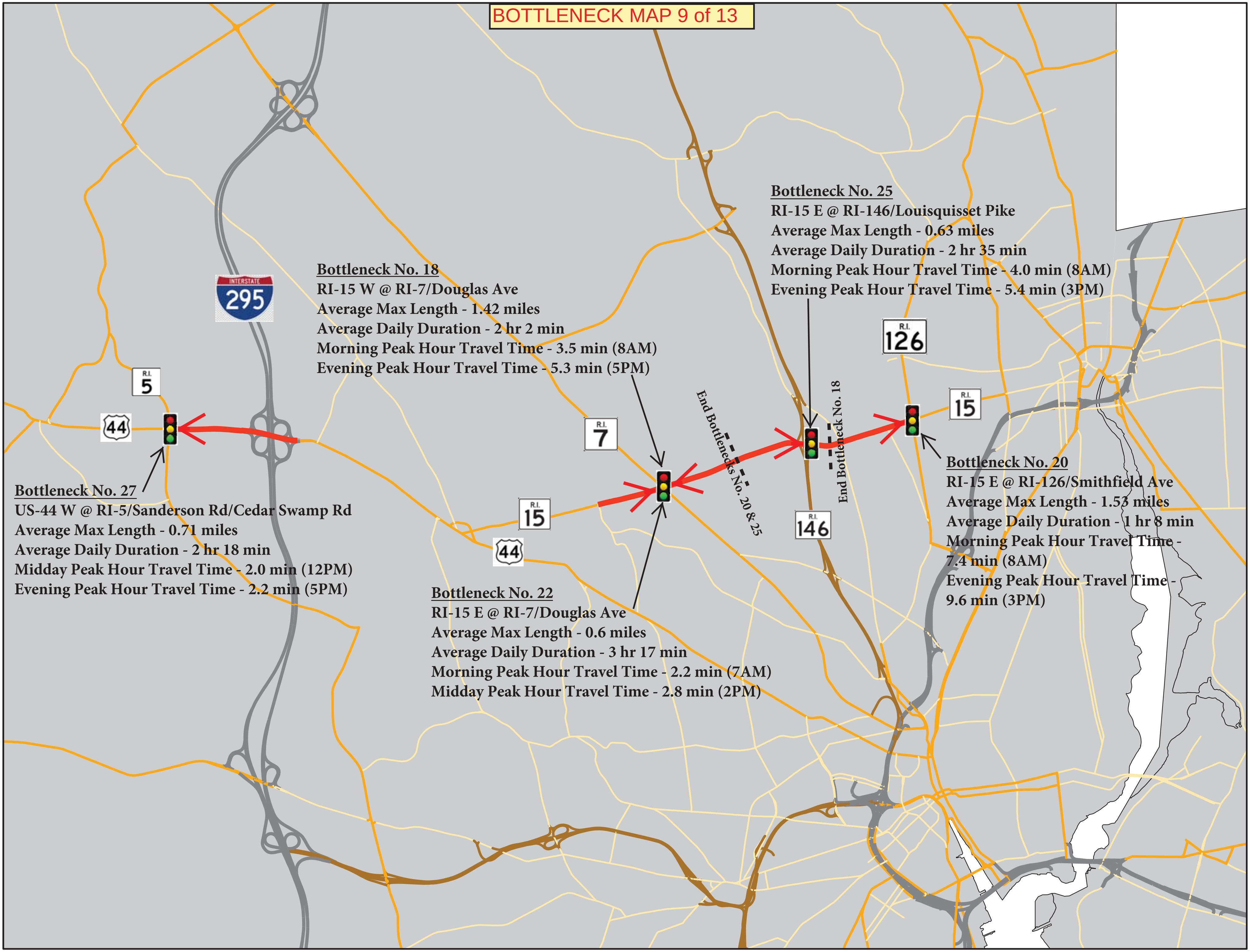

Bottleneck No. 13
I-195 W @ US-44/4th St/Taunton Ave/Exit 4
Average Max Length - 0.92 miles
Average Daily Duration - 1 hr 22 min
Morning Peak Hour Travel Time - 2.5 min (8AM)
Evening Peak Hour Travel Time - 3.1 min (5PM)
Bottleneck No. 28
US-44 @ I-195
Average Max Length - 0.76 miles
Average Daily Duration - 1 hr 27 min
Morning Peak Hour Travel Time - 4.6 min (8AM)
Evening Peak Hour Travel Time - 4.0 min (5PM)
Bottleneck No. 4
I-195 W @ I-95
Average Max Length - 2.52 miles
Average Daily Duration - 46 min
Morning Peak Hour Travel Time - 7.5 min (8AM)
Evening Peak Hour Travel Time - 8.2 min (5PM)
Bottleneck No. 9
I-195 W @ Broadway/Exit 6
Average Max Length - 1.24 miles
Average Daily Duration - 1 hr 5 min
Morning Peak Hour Travel Time -
5.7 min (8AM)
Evening Peak Hour Travel Time -
4.8 min (5PM)
Broadway
44
Warren Ave
End Bottleneck No. 13
End Bottlenecks No. 4 & 9
95
195
Veterans Memorial Pky
R.I.
114
East Shore Expy


Bottleneck No. 26
RI-2 N @ RI-115/Toll Gate Rd
Average Max Length - 0.41 miles
Average Daily Duration - 3 hr 30 min
Peak Hour Travel Time - 2.8 min (1PM)
Bottleneck No. 16
RI-2 S @ RI-117/Centerville Rd
Average Max Length - 0.92 miles
Average Daily Duration - 2 hr 43 min
Peak Hour Travel Time - 2.7 min (1PM)
Bottleneck No. 19
RI-4 N @ I-95
Average Max Length - 0.58 miles
Average Daily Duration - 48 min
Morning Peak Hour Travel Time - 1.1 min (8AM)
Evening Peak Hour Travel Time - 1.2 min (4PM)
Bottleneck No. 10
US-1 S @ Airport Road
Average Max Length - 0.64 miles
Average Daily Duration - 5 hr 55 min
Morning Peak Hour Travel Time - 2.2 min (8AM)
Evening Peak Hour Travel Time - 2.3 min (5PM)
Bottleneck No. 17
US-1 N @ RI-117/Greenwich Ave/Centerville Rd
Average Max Length - 1.09 miles
Average Daily Duration - 1 hr 35 min
Morning Peak Hour Travel Time - 2.4 min (8AM)
Evening Peak Hour Travel Time - 4.1 min (4PM)
Airport Rd
Division Rd
295
95
37
1
115
5
117
2
3
401
4

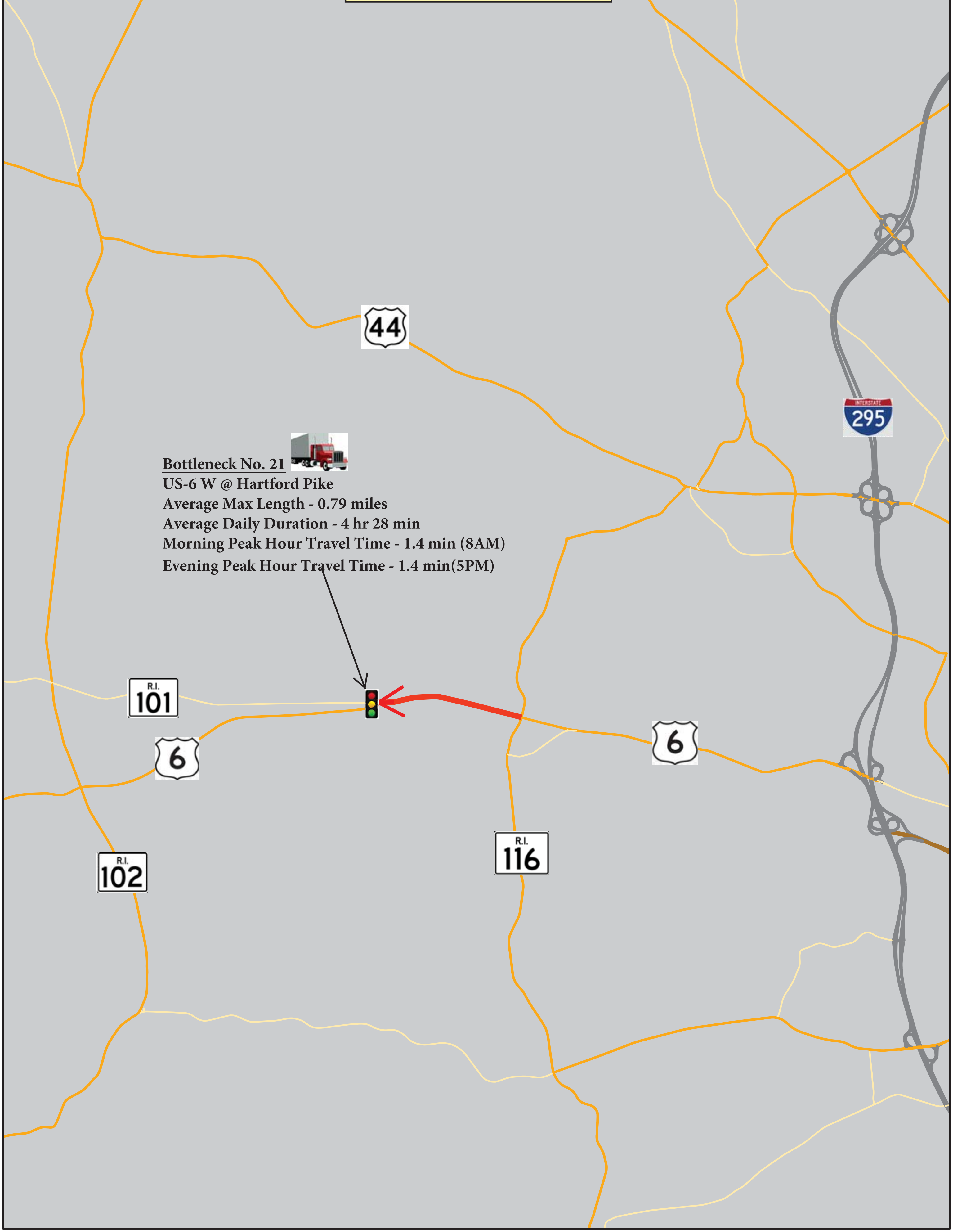

R.I. 114
R.I. 103
R.I. 103
R.I. 103
R.I. 114
R.I. 136
Bottleneck No. 11
RI-103 E / RI-114 S @ RI-103/Main St
Average Max Length - 1.12 miles
Average Daily Duration - 3 hr
Morning Peak Hour Travel Time - 4.3 min (8AM)
Evening Peak Hour Travel Time - 5.4 min (4PM)
Bottleneck No. 14
RI-114 N @ RI-103/Baker St/Child St
Average Max Length - 0.63 miles
Average Daily Duration - 5 hr 13 min
Morning Peak Hour Travel Time - 2.2 min (8AM)
Evening Peak Hour Travel Time - 3.3 min (4PM)

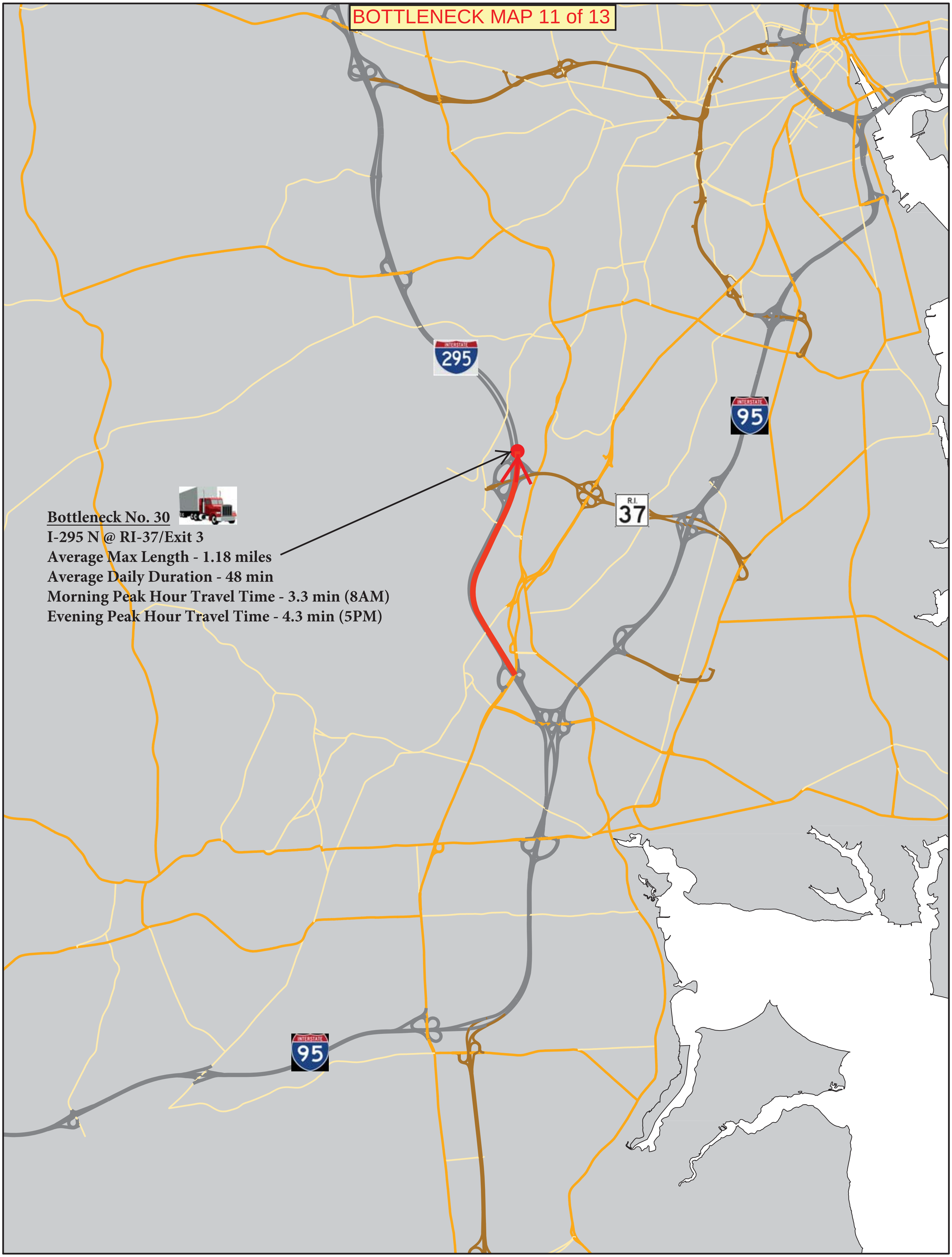

R.I. 146
R.I. 122
R.I. 99
Bottleneck No. 29
RI-146 S @ Sayles Hill Road
Average Max Length - 0.98 miles
Average Daily Duration - 1 hr 4 min
Morning Peak Hour Travel Time - 2.5 min (8AM)
Evening Peak Hour Travel Time - 2.1 min (4PM)
Sayles Hill Rd
Bottleneck No. 12
RI-146 N @ Sayles Hill Road
Average Max Length - 0.38 miles
Average Daily Duration - 6 hr
Morning Peak Hour Travel Time - 1.8 min (8AM)
Evening Peak Hour Travel Time - 3.6 min (5PM)
INTERSTATE 295
R.I. 146

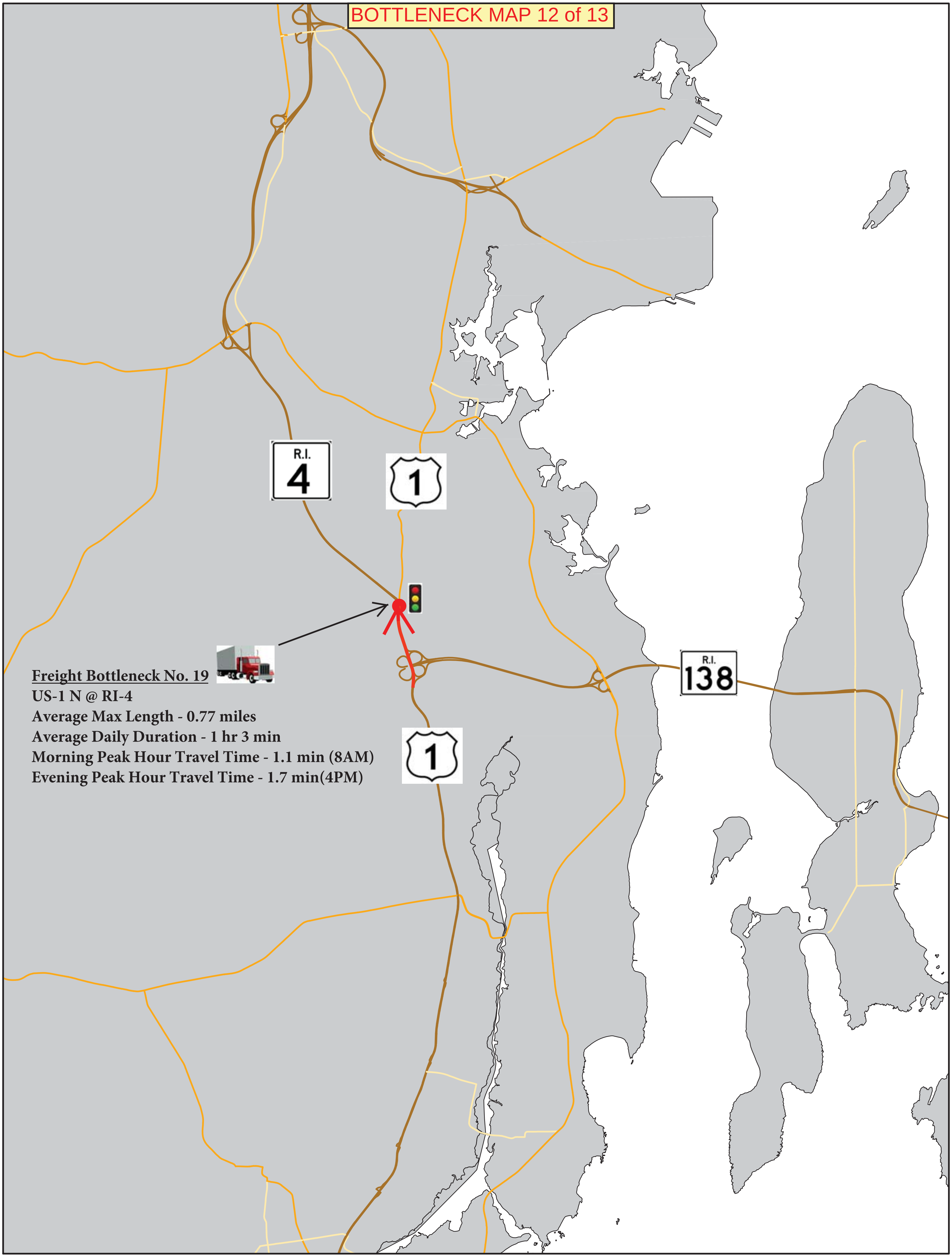

BOTTLENECK MAP 8 of 13
R.I. 4
R.I. 102
R.I. 2
1
Bottleneck No. 23
US-1 S @ RI-4
Average Max Length - 0.27 miles
Average Daily Duration - 5 hr 21 min
Morning Peak Hour Travel Time - 2.6 min (8AM)
Evening Peak Hour Travel Time - 2.7 min (4PM)
Bottleneck No. 15
RI-4 S @ W Allenton Rd
Average Max Length - 1.7 miles
Average Daily Duration - 1 hr 14 min
Morning Peak Hour Travel Time - 2.1 min (8AM)
Evening Peak Hour Travel Time - 1.9 min (5PM)
R.I. 138
1
R.I. 1A



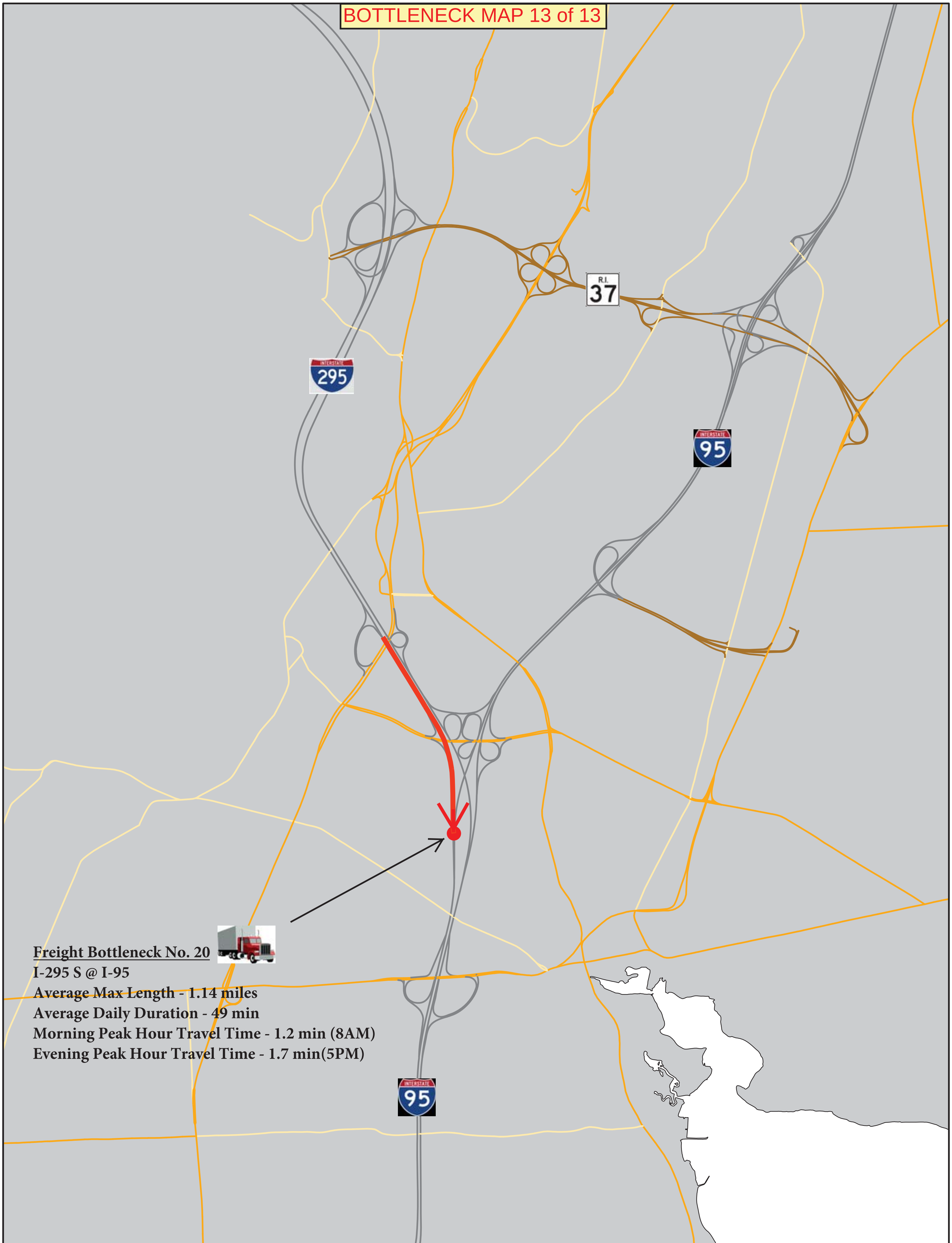
Bottleneck No. 18
RI-15 W @ RI-7/Douglas Ave
Average Max Length - 1.42 miles
Average Daily Duration - 2 hr 2 min
Morning Peak Hour Travel Time - 3.5 min (8AM)
Evening Peak Hour Travel Time - 5.3 min (5PM)
Bottleneck No. 25
RI-15 E @ RI-146/Louisquisset Pike
Average Max Length - 0.63 miles
Average Daily Duration - 2 hr 35 min
Morning Peak Hour Travel Time - 4.0 min (8AM)
Evening Peak Hour Travel Time - 5.4 min (3PM)
Bottleneck No. 27
US-44 W @ RI-5/Sanderson Rd/Cedar Swamp Rd
Average Max Length - 0.71 miles
Average Daily Duration - 2 hr 18 min
Midday Peak Hour Travel Time - 2.0 min (12PM)
Evening Peak Hour Travel Time - 2.2 min (5PM)
Bottleneck No. 22
RI-15 E @ RI-7/Douglas Ave
Average Max Length - 0.6 miles
Average Daily Duration - 3 hr 17 min
Morning Peak Hour Travel Time - 2.2 min (7AM)
Midday Peak Hour Travel Time - 2.8 min (2PM)
Bottleneck No. 20
RI-15 E @ RI-126/Smithfield Ave
Average Max Length - 1.53 miles
Average Daily Duration - 1 hr 8 min
Morning Peak Hour Travel Time - 7.4 min (8AM)
Evening Peak Hour Travel Time - 9.6 min (3PM)
End Bottlenecks No. 20 & 25
End Bottleneck No. 18
INTERSTATE 295
R.I. 5
44
R.I. 7
R.I. 15
R.I. 126
R.I. 146


44
Bottleneck No. 21
US-6 W @ Hartford Pike
Average Max Length - 0.79 miles
Average Daily Duration - 4 hr 28 min
Morning Peak Hour Travel Time - 1.4 min (8AM)
Evening Peak Hour Travel Time - 1.4 min(5PM)
INTERSTATE
295
R.I.
101
6
6
R.I.
116
R.I.
102


Bottleneck No. 30
I-295 N @ RI-37/Exit 3
Average Max Length - 1.18 miles
Average Daily Duration - 48 min
Morning Peak Hour Travel Time - 3.3 min (8AM)
Evening Peak Hour Travel Time - 4.3 min (5PM)
INTERSTATE 295
INTERSTATE 95
R.I. 37
INTERSTATE 95


BOTTLENECK MAP 12 of 13
R.I.
4
1
Freight Bottleneck No. 19
US-1 N @ RI-4
Average Max Length - 0.77 miles
Average Daily Duration - 1 hr 3 min
Morning Peak Hour Travel Time - 1.1 min (8AM)
Evening Peak Hour Travel Time - 1.7 min(4PM)
1
R.I.
138

BOTTLENECK MAP 13 of 13



Freight Bottleneck No. 20

I-295 S @ I-95

Average Max Length - 1.14 miles

Average Daily Duration - 49 min

Morning Peak Hour Travel Time - 1.2 min (8AM)

Evening Peak Hour Travel Time - 1.7 min(5PM)

Appendix C

Congestion Management Toolbox

Appendix C. Congestion Management Toolbox

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
1. Transportation Demand Management Strategies				
TMA—Nonprofit, member-controlled organizations that provide transportation services in a particular area, such as a commercial district, mall, medical center, or industrial park. They are generally public-private partnerships consisting primarily of area businesses with local Government support.	• Reduce VMT. • Reduce SOV trips. • Increase transit and alternative modes share.	• Statewide.	• First-year implementation costs for private-sector (per employee equipment). • Second-year costs tend to decline. • Requires interagency and private sector coordination.	• Employer-based. • Short term: 1 to 5 years.
Alternative Work Hours—This allows workers to arrive and leave work outside of the traditional commute period. It can be on a scheduled basis or a true flex-time arrangement. Can also include a compressed work week.	• Reduce peak-period VMT. • Reduce peak-period SOV trips.	• Statewide.	• No capital costs. • Agency costs for outreach and publicity. • Employer costs associated with accommodating alternative work schedules.	• Employer based. • Short term: 1 to 5 years.
Telecommuting—Policies or incentives to encourage employees to work at home or regional telecommute center instead of going into the office. They might do this all the time, or only one or more days per week. Also include teleconferencing and videoconferencing—The live exchange of information among several persons and machines linked by telecommunications.	• Reduce peak-period VMT. • Reduce peak-period SOV trips.	• Statewide.	• First-year implementation costs for private-sector (per employee for equipment). • Second-year costs tend to decline.	• Employer-based. • Short term: 1 to 5 years.
Ridesharing—Programs to promote carpooling and vanpooling, including ride-matching services and policies that give ridesharing vehicles priority in traffic and parking. Typically arranged/encouraged through regional agencies, employers, or TMAs that provide ride-matching services.	• Reduce commuter-based VMT. • Reduce peak-period SOV trips. • Reduce parking congestion.	• Statewide.	• Low to moderate. • Savings per carpool and vanpool riders. • Costs per year per free parking space provided. • Administrative costs.	• Employer-based. • Short term: 1 to 5 years.
Guaranteed Ride Home Policies—Provides a guaranteed ride home at no cost to the employee for occasional needs.	• Reduce commuter-based VMT. • Reduce SOV trips.	• Statewide. • Project.	• Requires administrative support from employers. • Potential to be costly	• Employer-based. • Short term: 1 to 5 years.

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Trip Reduction Requirements—Regulations instituted to reduce the use of SOVs for commuting by requiring employers (typically larger employers only) to meet trip reduction or mode share goals.	• Reduce VMT. • Reduce SOV trips. • Increase transit and alternative modes share.	• Statewide.	• First-year implementation costs for private-sector (per employee equipment). • Second-year costs tend to decline. • Requires interagency and private sector coordination.	• Employer-based. • Short term: 1 to 5 years.
Alternative Travel Mode Events and Assistance—Variety of events that promote, encourage and educate people about alternative travel modes (e.g., Bike to Work Day, transit promotions, employer transportation fairs). Programs that provide free or low-cost transit services or other incentives.	• Fewer single-occupant vehicles on the road and less overall traffic congestion. • Lower commuting costs.	• Statewide.	• Low. • Cost can be relatively low, depending on the level of participation from employers and sponsors.	• Short term.
Tolling—Payment charged for passage on roads, bridges or ferries that carry cars. Primary use as a revenue generator, but also can reduce travel demand and improve congestion.	• Improve mobility/reduce congestion on freeways.	• Statewide. • Corridor.		• Midterm (3 to 10 years) for implementation. • Long term (11+ years) before strategy becomes effective.
Conversion of Lanes to Managed or HOT Lanes—Projects that incentivize travelers to increase vehicle occupancy or shift to transit by making travel time more competitive for these modes or pay a fee to avoid congestion by using a managed lane.	• Improve mobility. • Decrease peak-period VMT. • Decrease SOV trips. • Utilize unused roadway capacity.	• Statewide. • Corridor.		• Short term: 1 to 5 years.
Car Sharing—Program in which automobile rental services are used to substitute private vehicle use and ownership. Includes both peer to peer and commercial (such as Zip Car).	• Provide cost savings to users. • Reduce parking congestion. • Promote transit, biking, and walking.	• Statewide.		• Near-Term to Midterm. • Implemented within 1 to 2 years or between 3 to 10 years depending on the level of service changes and magnitude of project.
Shared Mobility Management—Policies to limit additional VMT created by shared mobility services such as TNC. May include trip-based fees, fees differentiated by trip occupancy, or spatial or temporal restrictions on service	• Reduce VMT. • Reduce local congestion from pick ups/drop offs. • Encourage HOVs. • Tax TNCs at higher rates.	• Statewide.	• Low costs for enforcement, may be offset by fee revenues.	• Short term: 1 to 5 years.

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
2. Land Use Strategies				
Mixed-Use Development—This allows many trips to be made without automobiles. People can walk to restaurants and services rather than use their vehicles.	• Increase walk trips. • Decrease SOV trips. • Decrease trip lengths.	• Statewide.	• Public costs to set up and monitor appropriate ordinances. • Economic incentives used to encourage developer buy-in.	• Short to long term.
Infill and Densification—This takes advantage of infrastructure that already exists, rather than building new infrastructure on the fringes of the urban area.	• Decrease trip lengths. • Increase transit, walk, and bicycle.	• Statewide.	• Public costs to set up and monitor appropriate ordinances. • Economic incentives used to encourage developer buy-in.	• Short to long term.
Transit-Oriented Development—This clusters housing units and/or businesses near transit stations in walkable communities.	• Decrease SOV share. • Shift carpool to transit. • Increase transit trips. • Decrease trip lengths. • Increase transit mode share.	• Statewide	• Public costs to set up and monitor appropriate ordinances. • Economic incentives used to encourage developer buy-in.	• Short to long term.
Policies to Limit Sprawl—Areawide policies and strategies that result in a more transportation-efficient regional development pattern, e.g., urban growth boundary or other restrictions or incentives limiting development in less accessible outlying areas.	• Reduce trip lengths. • Reduce SOV trips. • Increase alternative modes share.	• Statewide.	• Low to moderate for planning costs. Can be cost savings from reduced infrastructure and municipal service expenses. • Costs can vary widely and are difficult to calculate, as they will be shared by local governments, developers, home buyers, businesses and customers.	• Short to long term. • Small-scale retrofit practices, rezonings or comprehensive plan amendments can be done in a short to moderate timeframe. • Regional-scale policy changes may take a long time to adopt and result in development changes.
3. Bicycle and Pedestrian Strategies				
New Sidewalks and Designated Bicycle Lanes—Enhancing the visibility of bicycle and pedestrian facilities increases the perception of safety. In many cases, bike lanes can be added to existing roadways through restriping.	• Increase nonmotorized mode shares. • Separate slow moving bicycles from motorized vehicles. • Reduce bicycle- and pedestrian-involved incidents.	• Statewide. • Corridor. • Project.	• Design and construction costs for paving, striping, signals, and signing. • ROW costs if widening necessary. • Bicycle lanes may require improvements to roadway shoulders to ensure acceptable pavement quality.	• Short term: 1 to 5 years (includes planning, engineering, and construction).

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Improved Bicycle Facilities at Transit Stations and Other Trip Destinations—Bicycle racks and bike lockers at transit stations and other trip destinations increase security. Additional amenities such as locker rooms with showers at workplaces provide further incentives for using bicycles.	• Increase bicycle mode share. • Reduce motorized vehicle congestion on access routes.	• Corridor. • Project.	• Capital and maintenance costs for bicycle racks and lockers, locker rooms.	• Short term: 1 to 5 years (includes planning, engineering, and construction).
Design Guidelines for Pedestrian-Oriented Development—Maximum block lengths, building setback restrictions, and streetscape enhancements are examples of design guidelines that can be codified in zoning ordinances to encourage pedestrian activity.	• Increase pedestrian mode share. • Discourage motor vehicle use for short trips.	• Statewide. • Corridor.	• Capital costs largely borne by private sector; developer incentives may be necessary. • Public sector may be responsible for some capital and/or maintenance costs associated with ROW improvements. • Ordinance development and enforcement costs.	• Short term: 1 to 5 years.
Improved Safety of Existing Bicycle and Pedestrian Facilities—Maintaining lighting, signage, striping, traffic control devices, and pavement quality, and installing curb cuts, curb extensions, median refuges, and raised crosswalks can increase bicycle and pedestrian safety.	• Increase nonmotorized mode share. • Reduce bicycle- and pedestrian-involved incidents.	• Statewide. • Corridor. • Project.	• Increased monitoring and maintenance costs. • Capital costs of sidewalk improvements and additional traffic control devices.	• Short term: 1 to 5 years.
Exclusive Nonmotorized Rights-of-Way—Abandoned rail rights-of-way and existing parkland can be used for medium- to long-distance bike trails, improving safety and reducing travel times.	• Increase nonmotorized mode shares. • Reduce congestion on nearby roads. • Separate slow-moving bicycles from motorized vehicles. • Reduce bicycle- and pedestrian-involved incidents.	• Statewide. • Corridor.	• ROW costs. • Construction and engineering costs. • Maintenance costs.	• Medium term: 5 to 10 years (includes planning, engineering, and construction).
Bike Sharing Programs—Short term bicycle rental program supported by a network of automated rental stations or dockless shared bikes.	• Increase nonmotorized mode share. • Discourage motor vehicle use for short trips.	• Statewide. • Corridor. • Project.	• Capital, operations, and maintenance costs for bicycles and rental stations (may be recouped in user fees).	• Short term: 1 to 5 years.

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Promote Bicycle and Pedestrian Use Through Education and Information Dissemination—Bicycle and pedestrian use can be promoted through educational programs and through distribution of maps of bicycle facility/multi-use path maps.	• Shift trips into non-SOV modes such as walking, bicycling, transit. • Increase bicycle/pedestrian mode share.	• Statewide. • Corridor.	• First-year implementation costs for private sector. • Second-year costs tend to decline.	• Employer based. • Short term: 1 to 5 years.
Micromobility Services—Programs to provide "micromobility" services such as electric scooters.	• Increase nonmotorized mode share. • Discourage motor vehicle use for short trips.	• Statewide. • Corridor.	• Capital, operations, and maintenance costs for equipment (may be recouped in user fees).	• Short term: 1 to 5 years.
4. Public Transportation Strategies				
Reducing Transit Fares—This encourages additional transit use, to the extent that high fares are a real barrier to transit.	• Increase transit ridership. • Reduce vehicle trips.	• Statewide.	• Loss in revenue per rider, may be offset by ridership increases. • Operating subsidies may be needed to replace lost fare revenue or alternative financial arrangements negotiated with donor agencies.	• Short term: Less than one year.
Increasing Bus Route Coverage or Frequencies—This provides better accessibility to transit to a greater share of the population. Increasing frequency makes transit more attractive to use. May require investment in new buses. May also include new routes or extensions to existing routes.	• Increase transit ridership. • Reduce vehicle trips.	• Statewide.	• Capital costs—new bus purchases likely. • Operating costs per additional trip or route-mile.	• Short term: 1 to 5 years (includes planning, engineering, and construction).
Park-and-Ride Lots—These can be used in conjunction with HOV lanes and/or express bus services. They are particularly helpful for encouraging HOV use for longer distance commute trips.	• Reduce SOV trip lengths. • Increase vehicle occupancy. • Increased transit boardings and mode share.	• Corridor. • Project.	• Very low cost (signage, enforcement) if existing underutilized parking can be used. • Higher costs for new facilities (land acquisition, paving, structure costs for transit stations).	• Short term: Less than one year (existing lots—negotiate agreements with owner). • Medium term: 5 to 10 years (includes planning, engineering, and construction).

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
HOV Lanes—This increases corridor capacity while at the same time provides an incentive for single-occupant drivers to shift to ridesharing. These lanes are most effective as part of a comprehensive effort to encourage HOVs, including publicity, outreach, park-and-ride lots, and rideshare matching services.	• Reduce regional VMT. • Reduce regional trips. • Increase vehicle occupancy. • Increase transit use and improve bus travel times.	• Corridor.	• HOV, separate ROW costs. • HOV, barrier separated costs. • HOV, contraflow costs. • Annual operations and enforcement.	• Medium term: 5 to 10 years (includes planning, engineering, and construction).
Rail Transit—This best serves dense urban centers where travelers can walk to their destinations. Rail transit from suburban areas can sometimes be enhanced by providing park-and-ride lots.	• Reduce daily VMT. • More consistent and sometimes faster travel times versus driving. • Reduce SOV trips.	• Statewide. • Corridor.	• High capital costs. • Increased operating costs.	• Long term: 10 or more years (includes planning, engineering, and construction).
BRT/New Fixed Guideway Busways—Exclusive guideways for BRT devoted to increasing the person-carrying capacity and transit travel speed within a travel corridor.	• More consistent and faster travel times for transit passengers versus driving. • Increased person throughput capacity within a corridor due to mode switching. • Stimulation of efficient mixed-use or higher-density development.	• Corridor.	• Moderate to high capital costs. Implementation cost will vary, but cost could be high due to acquisition of rights-of-way, materials and infrastructure. • Operating costs could decrease if bus productivity increases.	• Medium to long term. • Medium term: 5 to 10 years for a new busway (includes planning, engineering, and construction). • Short term: 1 to 5 years for on-street conversion of travel lanes to BRT.
Dedicated Rights-of-Way for Transit—Reserved travel lanes or rights-of-way for transit operations, including use of shoulders during peak periods.	• Increase transit ridership. • Decrease travel time.	• Corridor.	• Costs vary by type of design.	• Short term: 1 to 5 years.
Employer Incentive Programs—Encourages additional transit use through transit subsidies of mass transit fares provided by employers	• Increase transit ridership. • Decrease travel time. • Decrease daily VMT.	• Statewide.	• Cost of incentives to employers offering employee benefits for transit use plus any discounts offered by transit agency.	• Short term: 1 to 5 years.
Electronic Payment Systems and Universal Fare Cards—Interchangeable smartcard payment system (including radio-frequency identification) that can be used as a fare payment method for multiple transit agencies throughout the region.	• Increase transit ridership. • Decrease travel time.	• Statewide.	• High, but decreasing. • Implementation costs vary based on system design and functionality.	• Short term: 1 to 5 years.

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Realigned Transit Service Schedules and Stop Locations—Service adjustments to better align transit service with ridership markets.	• Increase transit ridership. • Decrease daily VMT.	• Statewide.	• Planning costs (analysis, outreach, etc.). • Operating costs per trip, may be net increase or decrease.	• Short term: 1 to 5 years.
Intelligent Transit Stops—Ranges from kiosks, which show static transit schedules, to real-time information on schedules, locations of transit vehicles, arrival time of the vehicle, and alternative routes and modes.	• Increase ridership. • Decrease daily VMT.	• Statewide. • Corridor. • Project.	• Low to moderate capital costs per passenger.	• Short term: 1 to 5 years.
Transit Intersection Queue Jump Lanes and Signal Priority—Additional travel lane at a signalized intersection that allows buses to proceed via their own "green-time" before other vehicles. Done by restriping within existing road footprint or new construction.	• Reduced bus travel delays due to traffic signals and traffic congestion. • Increased ridership and reduced congestion due to time savings. • Safer driving conditions for all vehicles due to fewer severe and sudden lane changes by buses.	• Corridor. • Project.	• Low to moderate. • Installation and operation cost of queue jump lane and signal equipment is low. • Constructing a new designated transit lane has a higher cost. • Implementation costs vary based on system design and functionality and type of equipment.	• Short term: 1 to 5 years. • All phases–planning, engineering and implementing–a queue-jump lane can be reasonably completed in less than one year. • Longer time is needed if new lane must be constructed.
Enhanced Transit Amenities—Includes vehicle replacement/upgrade, which furthers the benefits of increased transit use.	• Increase ridership.	• Statewide. • Corridor. • Project.	• Capital costs. • Some improvements may be incorporated as part of regular vehicle replacement programs.	• Short term: 1 to 5 years (includes planning, engineering, and construction).
Improved Bicycle and Pedestrian Facilities at Transit Stations—Includes improvements to facilities that provide access to transit stops as well as provisions for bicycles on transit vehicles and at transit stops (bicycle racks and lockers)	• Increase bicycle and transit mode share. • Decrease motorized vehicle congestion on access routes.	• Statewide. • Corridor. • Project.	• Capital and maintenance costs for bicycle racks and lockers.	• Short term: 1 to 5 years (includes planning, engineering, and construction).
Express Bus Service Expansion—Bus service with high-speed operations, usually between two commuter points.	• Reduce SOV trips. • Increase transit ridership and mode share.	• Statewide. • Corridor.	• Operating costs per trip. • New bus purchases.	• Short term: 1 to 5 years (includes planning, engineering, and construction).
Local Circulator Expansion—Fixed-route service within an activity area, such as a CBD or campus, designed to reduce short trips by car.	• Reduce SOV trips • Increase transit ridership and boardings.	• Statewide. • Corridor. • Project.	• Operating costs per trip. • New bus purchases.	• Short term: 1 to 5 years (includes planning, engineering, and construction).

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
5. ITS and Operations Strategies				
Traffic Signal Coordination and Modernization—This improves traffic flow and reduces emissions by minimizing stopped delay on arterial streets. Enhancements to timing/coordination plans and equipment to improve traffic flow and decrease the number of vehicle stops. May include: • Modern technology that provides for real-time traffic and transit management • Equipment that may permit immediate knowledge of malfunctions. • Responsive control that allows traffic signals to alter timing in response to immediate traffic flow conditions, rather than at predetermined times. • Transit signal priority system that can extend “green-time” a few seconds to allow buses to progress through an intersection.	• Improve travel time. • Reduce the number of stops. • Reduce VMT by vehicle miles per day, depending on program. • Reduce VHD and person-hour traveled. • Increase "capacity" of an intersection to handle vehicles, reduced number of vehicle strategies.	• Statewide. • Corridor. • Project.	• Low to moderate (Costs include initial investment of equipment, software, and communication network and connections. Varies depending on required equipment). • Operations and maintenance (O&M) costs per signal. • Signalized intersections per mile costs variable.	• Short term: 1 to 5 years (includes planning, engineering, and implementation).
Reversible Traffic Lanes—These are appropriate where traffic flow is highly directional.	• Increase peak direction capacity. • Reduce peak travel times.	• Corridor.	• Barrier separated costs per mile. • Operation costs per mile. • Maintenance costs variable.	• Medium to long term: likely 10 years or more.
Targeted and Sustained Enforcement of Traffic Regulations—Improves traffic flow by reducing violations that cause delays; Includes automated enforcement (e.g., red light cameras).	• Decrease the number of stops and improve speed of travel.	• Statewide. • Corridor. • Project.	• Increased labor costs per officer.	• Short term: 1 to 5 years.
Freeway Incident Detection and Management Systems—This is an effective way to alleviate nonrecurring congestion. Systems typically include video monitoring, dispatch systems, and sometimes roving service patrol vehicles.	• Reduce travel delay due to incidents. • Reduce the risks of secondary accidents to motorists. • Improved emergency response time and information distribution. • Reduce travel time.	• Statewide. • Corridor.	• Capital costs variable and substantial. • Annual operating and maintenance costs.	• Short term: 1 to 5 years.

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Service Patrols—Service vehicles patrol heavily traveled segments and congested sections of the freeways that are prone to incidents to provide faster and anticipatory responses to traffic incidents and disabled vehicles.	• Reduce travel delay due to incidents. • Reduce incident duration time. • Restore full freeway capacity. • Reduce the risks of secondary accidents to motorists.	• Statewide. • Corridor.	• Costs vary based on the number of vehicles used by the patrol, number of routes that the patrol operates, and the population of the area in which the program operates.	• Short term: 1 to 5 years.
Ramp Metering—This allows freeways to operate at their optimal flow rates, thereby speeding travel and reducing collisions. May include bus or HOV bypass lanes. May require ramp widening to avoid extensive vehicle queuing.	• Decrease travel time. • Improve traffic flow on major facilities. • Improved speed on freeway. • Decreased crash rate on freeway.	• Corridor. • Project.	• O&M costs. • Significant costs associated with enhancements to centralized control system. • Capital costs.	• Medium term: 5 to 10 years.
Advanced Traveler Information Systems—This provides an extensive amount of data to travelers, such as real time speed estimates on the web or over wireless devices, and transit vehicle schedule progress. Provides travelers with real-time information that can be used to make trip and route choice decisions. Information accessible on the web, dynamic message signs, 511 systems, Highway Advisory Radio, or handheld wireless devices.	• Reduce travel times and delay. • Some peak-period travel and mode shift.	• Statewide. • Corridor. • Project.	• Design and implementation costs variable. • Operating and maintenance costs variable.	• Short term: 1 to 5 years.
Special Events and Work Zone Management—Includes a suite of strategies, including temporary traffic control, public awareness and motorist information, and traffic operations.	• Minimize traffic delays. • Improve mobility. • Maintain access for businesses and residents.	• Statewide. • Corridor. • Project.	• Design and implementation costs variable.	• Short term: 1 to 5 years.
Road Weather Management—Identifying weather and road surface problems and rapidly targeting responses, including advisory information, control measures, and treatment strategies.	• Improve safety due to reduced crash risk. • Increased mobility due to restored capacity, delay reductions, and more uniform traffic flow.	• Statewide. • Corridor. • Project.	• Design and implementation costs variable. • Operating and maintenance costs variable.	• Short term: 1 to 5 years.

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Traffic Surveillance and Control Systems—Often housed within a Traffic Management Center (TMC), monitors volume and flow of traffic by a system of sensors, and further analyzes traffic conditions to flag developing problems, and implement adjustments to traffic signal timing sequences, in order to optimize traffic flow estimating traffic parameters in real time.	• Decrease travel times and delay. • Some peak-period travel and mode shift.	• Statewide. • Corridor. • Project.	• High; design and implementation costs variable. • Installation of video surveillance cameras may be less expensive than magnetic loop detectors, which require disruption and digging of the road surface.	• Medium term: 5 to 10 years.
Communications Networks and Roadway Surveillance Coverage—Base infrastructure (fiber, cameras, etc.) required to support all operational activities. Communications networks that allow remote roadway surveillance and system control from a TMC and provision of data for immediate management of transportation operations and distribution of information.	• Increased capability for regional-level coordination of operations and traveler information.	• Statewide. • Corridor. • Project.	• Moderate. • Communication networks are not low-cost or high-profile items, but essential to get the most efficiency and capacity out of the existing transportation system. • Cost can be reduced when done in conjunction with a larger scale construction project.	• Medium to long term. • Small-scale items and opportunistic expansion can be done quickly. Larger-scale regional network components require more time for planning and funding.
Transit Vehicle Travel Information—Communications infrastructure, global positioning system technology, vehicle detection/monitoring devices and signs/ media/Internet sites for providing information to the public such as the arrival times of the next vehicles.	• More satisfied customers and increased ridership due to enhanced and reliable information sources. • Improved operations and management of transit service.	• Statewide.	• Moderate • Costs are dependent upon communication networks, changing technologies and the number of fleet vehicles to be equipped.	• Short term: 1 to 5 years Time is required for detailed planning, design and funding procurement.
Speed Harmonization—Changes traffic speed limits on links that approach areas of congestion, bottlenecks, incidents, special events, and other conditions that affect traffic flow.	• Reduced delay. • Improved safety.	• Statewide. • Corridor. • Project.	• Moderate, depending on existing communications infrastructure and operations management capabilities.	• Short term: 1 to 5 years.
6. Pricing Strategies				
Road Pricing—Involves pricing facilities to encourage off-peak or HOV travel and includes time-variable congestions pricing and cordon (area) tolls, high occupancy/ HOT lanes, and vehicle-use fees.	• Decrease peak-period VMT. • Decrease SOV trips.	• Statewide. • Corridor.	• First-year implementation costs for public sector but covered by fee revenue.	• Short term: 1 to 5 years.

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Cordon Area Congestion Fees—An established cordon area or zone in which vehicles are charged a fee to enter. Such a fee can be variable (by time of day) or dynamic (based on real-time congestion conditions). Should include electronic payment/collection methods using cameras or transponders.	• Reduced congestion within the cordon area. • Revenues for roadway maintenance and new transit, bicycle and pedestrian facilities. • Overall reduced congestion due to less VMT. • Provide incentive to use transit, bike, or walk.	• Statewide.	• High, but covered by fee revenue. • The cost to implement infrastructure and devices for a large-scale electronic fee collection system can be high (e.g., in Stockholm, Sweden and London, England).	• Medium to long term. • Extensive time is required for the entire process, including political and public discussions, possible ballot measures, construction and implementation.
Congestion Pricing—Controls peak-period use of transportation facilities by charging more for peak-period use than for off-peak. Congestion pricing fees are charged to drivers using congested roadways during specific times of the day.	• Decrease peak-period VMT. • Decrease SOV trips. • Increase transit and nonmotorized mode shares.	• Statewide. • Corridor.	• Implementation and maintenance costs vary. • Costs covered by fee revenue.	• Medium term: 5 to 10 years.
Carbon Pricing/Motor Fuel Tax—Carbon pricing considers an economy wide or system strategy set either as a fuel tax or as a result of a cap-and-trade system. Motor fuel taxes, currently the primary source of revenue for highways, would increase to higher levels to generate more revenue to highways. Very high levels of either carbon prices or motor fuel taxes may affect fuel efficiency or fuel types, as well as travel demand.	• Generate revenue to maintain its system and to address transportation improvements regionwide. • Reduce congestion by increasing general cost of travel. • Provide incentive to use transit, bike, or walk.	• Statewide.		• Medium term: 5 to 10 years.
VMT fee—A VMT fee is charged based on how many miles a car is driven.	• Generate revenue to maintain its system and to address transportation improvements regionwide. • Reduce congestion by increasing general cost of travel. • Incentive to use transit, biking, and walking.	• Statewide.	• Depends on implementation mechanism. • Costs covered by fee revenue.	• Midterm. • Implementation should take between 3 to 10 years.

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Traffic Impact Fee—A charge on new development to cover the full cost of the additional transportation capacity, including transit, required to serve the development. While fee strategies may vary, in most cases, only those new developments that result in an increase in vehicle trips would be charged, and fees would be proportional to traffic impacts.	• Generate revenue to maintain its system and to address transportation improvements regionwide. • Provide Incentive for developers and property owners to encourage vehicle trip reduction.	• Statewide.	• Low to moderate administrative costs and revenue potential. • Cost to developers.	
PAYD Insurance (State level)—PAYD insurance considers charging drivers insurance premium costs based in part on annual vehicle miles traveled. All drivers would have the opportunity to save money (reduced insurance fees) by driving fewer miles. The State could require insurance companies to offer PAYD insurance at lower rates and require companies to offer higher rates to encourage fewer vehicle miles traveled.	• Reduce overall VMT. • Promote transit, biking and walking.	• Statewide.	• Costs to private sector depend on implementation mechanism. • Costs likely offset by reduced premiums.	• Midterm: 3 to 10 years for implementation and long term for strategy to become effective.
Preferential or Free Parking for HOVs and Parking Pricing—Strategies include reducing the availability of free parking spaces, particularly in congested areas, or providing preferential or free parking for HOVs. A strategy could include a downtown employee parking payroll tax (e.g., all downtown workers pay for parking, $5/day average for users not already paying). Other strategies include dynamic pricing, higher fees on free parking lots, parking permits (see strategies above for Parking Pricing).	• Reduce work VMT. • Increase vehicle occupancy.	• Corridor. • Project.	• Relatively low costs, primarily borne by the private sector, include signing, striping, and administrative costs. • Costs covered by fee revenue for new parking pricing.	• Short term: 1 to 5 years.

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Local and Regional Parking Excise Taxes—A flat fee-per-space on parking spaces provided by businesses designed to discourage automobile-dependent development, encourage more efficient land use, and—to the extent the fees are passed on to parkers—encourage nonmotorized and transit choices. The revenue generated by such a tax (on parking spaces, not their use) could be used for transit and other transportation investments not eligible for highway dollars.	• Generate revenue to maintain its system and to address transportation improvements regionwide. • Promote transit, biking, and walking. • Increase vehicle occupancy.	• Statewide.	• Administrative costs. • Costs covered by fee revenue for new parking pricing.	• Midterm: 3 to 10 years for implementation and long term for strategy to become effective.
7. Roadway/Mobility (Non-ITS) Strategies				
Access Management—Planning and design practices that identify existing and future land use and arterial access points to maximize traffic safety and mobility. Strategies include medians, turn lanes, side/rear access points between businesses, shared access, and local land use ordinances to control access.	• Reduction in crashes along a roadway. • Improved roadway capacity; greater vehicle throughput. • Decreased corridor delay.	• Statewide. • Corridor. • Project.	• Low to high (Costs and complexity of strategies can vary widely and may depend on whether access controls are implemented before development occurs or as a retrofit).	• Short to medium term. • Some access management strategies can be implemented quickly if there are cooperating property owners. Major access management plans require a greater amount of time. Capital construction efforts (e.g., medians) take a moderate amount of time.
Restricting Turns at Key Intersections—Limits turning vehicles, which can impede traffic flow and are more likely to be involved in crashes.	• Increase capacity, efficiency on arterials. • Improve travel times and decrease delay for through traffic. • Decrease incidents.	• Corridor. • Project.	• Implementation and maintenance costs vary; range from new signage and striping to more costly permanent median barriers and curbs.	• Short term: 1 to 5 years (includes planning, engineering, and implementation).
Converting Streets to One-Way Operations—Establishes pairs of one-way streets in place of two-way operations. Most effective in downtown or very heavily congested areas.	• Increase traffic flow.	• Corridor. • Project.	• Conversion costs include adjustments to traffic signals, striping, signing and parking meters.	• Short term: 1 to 5 years (includes planning, engineering, and implementation).

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Roadway Signage Improvements—Adequate or additional signage that facilitates route-finding and the decision-making ability of roadway users. Signs with clearer/larger lettering that can be read from a greater distance.	• Reduced level of driver uncertainty and fewer erratic driving maneuvers. • Reduced delay for upstream approaching vehicles. • Psychological encouragement to unsure motorists. • Less chance of crashes caused by sudden lane changes, extremely slow-moving vehicles or sudden stops.	• Statewide. • Corridor. • Project.	• Low.	• Short term. • Production of signs and installation can occur shortly after site visits and design of new signing plans. Design should follow the guidance of the Manual on Uniform Traffic Control Devices.
Geometric Design Improvements—This includes bottleneck improvements such as roadway widening to provide shoulders, improved sight lines, auxiliary lanes to improve merging and diverging. Interchange modifications to decrease weaving sections on a freeway, paved shoulders and realignment of intersecting streets. Intersection modifications such as adding turning lanes at an intersection, realignment of intersection streets, intersection channelization, or modifying intersection geometrics to improve overall efficiency and operation.	• Increase mobility. • Reduce congestion by improving bottlenecks. • Increase traffic flow and improve safety. • Decrease incidents due to fewer conflict points.	• Corridor. • Project.	• Costs vary by type. • Design, implementation, O&M costs vary by type of design.	• Short term: 1 to 5 years (includes planning, engineering, and implementation).
Grade Separations (Nonadded Capacity)—Also called Super Street Arterials, this involves converting existing major arterials with signalized intersections into "super streets" that feature grade-separated intersections and overpasses (nonadded capacity).	• Improve mobility. • Reduce congestion by improving bottlenecks at intersections.	• Corridor.	• Construction and engineering substantial for grade separation. • Maintenance variable based on area.	• Medium term: 5 to 10 years (includes planning, engineering, and implementation).

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Acceleration/Deceleration Lanes—Deceleration lane provided on a freeway just before an exit off-ramp allowing vehicles to reduce speed outside the through-lanes. Acceleration lane provided as an extension of a freeway on-ramp or an arterial street turn-lane for vehicles to increase speed and merge more smoothly into the through-lane.	• Slower-moving turning or exiting vehicles are removed from through lanes resulting in fewer delays for upstream traffic. • Accelerating vehicles are provided more distance to reach the speed of through traffic, resulting in fewer delays caused by merging and weaving vehicles. • In certain situations, can greatly reduce delays (caused by braking) for upstream vehicles during peak traffic flow periods.	• Corridor. • Project.	• Low to moderate. • Cost is relatively low if ROW or bridge widening is not required.	• Medium term. • ROW is an important factor in the time required for implementation and construction.
Encourage Local Complete Streets Policies—Policy that takes into account all users of streets rather than just autos, with a goal of completing the streets with adequate facilities for all users. A "Complete Street" is one designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities.	• Increase safety and reduce crash-related delays by improving the overall (pedestrian and bicycle) transportation system environment. • Increase access to and use of alternative modes.	• Statewide. • Corridor.	• Low to moderate if included as part of routine street resurfacing and reconstruction. • Higher for off-cycle projects that include moving curbs or other costlier improvements.	• Near term (1 to 2 years).
Curb Management—Policies to limit congestion related to curbside passenger and freight pick-up and drop-off and/or otherwise make the most effective use of curb space (e.g., conversion of parking lanes to travel lanes or bus queue jump lanes in peak periods).	• Reduce local congestion from stopped vehicles. • Encourage mode shift.	• Corridor. • Project.	• Low to moderate for planning and enforcement.	• Near term (1 to 2 years).

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
8. Roadway Capacity Expansion Strategies				
New Freeways—Construction of new, access-controlled, high-capacity roadways in areas previously not served by freeways.	• Reduce arterial street network congestion. • Reduce travel times and delay. • Increased capacity to serve developing areas. • Reduced traffic and congestion on parallel streets due to vehicles diverted to the new road.	• Corridor.	• High. • Costs vary by type of highway constructed; cost depends on amount of ROW needed and the scale of construction impediments; in dense urban areas can be very expensive. • Can create environmental and community impacts.	• Medium to long term (includes planning, engineering, and construction). • Completion of a new roadway project can take from five to 25 years, including planning, engineering, environmental analysis and construction phases.
Increasing Number of Lanes without Highway Widening—This takes advantage of “excess” width in the highway cross section used for breakdown lanes or median.	• Increase capacity. • Reduce congestion by improving bottlenecks.	• Corridor. • Project.	• Construction and engineering. • Maintenance.	• Short term: 1 to 5 years (includes planning, engineering, and implementation).
Highway Widening by Adding Lanes—This is the traditional way to deal with congestion.	• Increase capacity, reducing congestion in the short term. • Long-term effects on congestion depend on local conditions. • Reduced traffic and congestion on parallel streets.	• Corridor.	• Costs vary by type of highway constructed; in dense urban areas can be very expensive.	• Long term: 10 or more years (includes planning, engineering, and construction).
New Arterial Streets—Construction of new, higher-capacity roads designed to carry large volumes of traffic between areas in urban settings.	• Provide connectivity. • Carry traffic from local and collector streets to other areas.	• Corridor.	• Construction and engineering costs substantial (grade separate, other design features). • Maintenance variable based on urban region.	• Medium term: 5 to 10 years (includes planning, engineering, and construction.
Grade Separations (Added Capacity)—This involves converting existing major arterials with signalized intersections into “super streets” that feature grade-separated intersections and overpasses with added capacity.	• Increase capacity. • Improve mobility.	• Corridor.	• Construction and engineering substantial for grade separation. • Maintenance variable based on area.	• Medium term: 5 to 10 years (includes planning, engineering, and implementation).

Project/Mode Type	Congestion Impacts	Application Scale	Implementation Costs	Implementation Timeframe
Grade Separated Railroad Crossings—Roadway underpass or overpass of a railroad line.	• Significant reduction in travel delays at high volume locations. • Likely elimination of car-train crashes.	• Corridor. • Project.	• High—Cost is very high to provide either a roadway or railroad bridge or tunnel.	• Medium to long term. • Implementation requires significant negotiation with railroads and local communities.
Major Intersection/Interchange Improvements—This includes major intersection/interchange improvements or adding through lanes to provide additional capacity.	• Increase mobility. • Reduce congestion by improving bottlenecks. • Increase traffic flow and improve safety.	• Corridor. • Project.	• Costs vary by type. • Design, implementation, O&M costs vary by type of design.	• Short term: 1 to 5 years (includes planning, engineering, and implementation).

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

Appendix D

FFY2018 to 2027 STIP Projects Addressing Congestion

Appendix D. FFY2018 to 2027 STIP Projects Addressing Congestion

Project Name	STIP ID	Location	Year Funded	Amount ($M)	Description	Intervention Type	Addresses Top Bottlenecks/ Corridors?
Bridge Group 51A	6638; 6639; 6770	Coventry, Cranston, Warwick	2018	$72.18	Safety Improvements to Pontiac Avenue, Sockanosset Cross Road, and the Route 37 on- and off-ramps, including the introduction of dual left-turn lanes northbound onto Sockanosset Cross Road, widening of the Route 37 West off-ramp onto Pontiac Avenue (TIP ID 6770, Bridge #126401), and signal improvements to improve traffic flow.	ITS and Operations	Other
Bridge Group 95	6748	East Greenwich	2019	$2.50	This line item will support design and development of a potential future project to address the "missing move" between Route 4 and I-95.	Roadway Capacity Expansion	
Transportation Management Center	7505	Statewide	2018	$35.00	This program provides ITS throughout the State, including variable message boards and real-time monitoring of traffic. The TMC's broad-based information gathering and sharing capability enables the TMC to identify highway incidents and congestion with the primary goal of minimizing the environmental and economic impacts of planned and unplanned incidents and events and to improve roadway safety.	ITS and Operations	Other; statewide
Two Mile Corner	1356	Middletown	2018	$3.90	Reconstruction of Two Mile Corner (Routes 138/114) East Main Road (West Main Rd to Bailey Brook) and West Main Rd (Smythe St to Maplewood Rd), Middletown. Remove and replace pavement structure, widening to accommodate additional turn lanes, new drainage system, new traffic signal systems, and new sidewalk/ADA improvements.	New Capacity; ITS and Operations	Other
Pell Bridge Ramps, Phase 1	1364	Middletown, Newport	2018	$15.25	Full reconstruction of JT Connell & Coddington Highway, miscellaneous safety and traffic signal improvements in preparation for Phase 2, and the construction of a shared use path.	ITS and Operations; Bicycle and Pedestrian	Other

Project Name	STIP ID	Location	Year Funded	Amount ($M)	Description	Intervention Type	Addresses Top Bottlenecks/ Corridors?
Pedestrian and Bicycle Safety Improvements—Exchange Street	1461	Providence	2018	$1.30	This project utilizes Federal Transit Administration grant funding and highway safety improvement program funding to provide connections for bicycle and pedestrian traffic along this heavily traveled corridor providing access to Providence Station, along Exchange Street in Providence between Fulton Street/Finance.	Bicycle and Pedestrian	Other
Arterial Traffic Signal Improvements—Allens Avenue	1510	Providence	2019	$3.20	This line item includes transit signal priority improvements to Allens Avenue corridor.	Transit Operations	Other
RI*STARS—Localized Bottleneck Improvements to I-295	1531	Cranston	2021	$5.69	This line item includes installation of an additional lane on between Exit 3 (Route 37) and Exit 4 (Route 14).	New Capacity	I-295 N @ RI-37/Exit 3 (F18/R30)
Arterial Traffic Signal Improvements to Route 1 and Route 3	1536	East Greenwich, West Warwick	2021	$1.40	This line item includes establishing the coordination and communication between appropriate traffic signals on selected arterial corridors with the purpose of improving traffic operations and enabling improved traffic management.	ITS and Operations	Other
Arterial Traffic Signal Improvements—Warwick Ave	1537	Cranston, Warwick	2021	$2.80	This line item includes improvements to corridor travel efficiency by coordinating the operation of adjacent signals.	ITS and Operations	Other
Roundabout at Intersection of RT. 138 and RT. 112	5219	Richmond	2018	$3.50	Install new roundabout to alleviate congestion and safety hazards at this intersection.	Roadway/ Mobility (Non-ITS)	Other
Pawtucket/ Central Falls Transit Center	5011	Pawtucket	2019	$50.91	Proposed MBTA commuter rail station adjacent to downtown Pawtucket, and potential TOD, providing convenient access to employment centers in Boston and Providence. Project currently is in the final engineering and construction procurement phase.	Transit Operations	Potential: commuter traffic along I-95 into Providence; potential RI-15 E @ RI-126/ Smithfield Ave (R20)
Providence Intermodal Transit Center	5204	Providence	2018	$29.75	Creation of an expanded state-of-the-art transportation center/bus hub serving rail and bus passengers at the existing Amtrak and MBTA station.	Transit Operations	Potential: traffic along I-95 near Providence

Project Name	STIP ID	Location	Year Funded	Amount ($M)	Description	Intervention Type	Addresses Top Bottlenecks/ Corridors?
RIPTA Passenger Infrastructure Enhancement	5256	Statewide	2020	$9.60	Establish new hubs at key destinations, including two new hubs in downtown Providence and at 6 locations throughout the State; implement a Passenger Experience Enhancement Plan, bringing bus stop amenities up to the levels established by RIPTA's board-adopted Service Standards; address bus shelters, seating, signage and other amenities in a coordinated statewide campaign.	Transit Operations	Potential: traffic along I-95 near Providence
Kennedy Plaza	1460	Providence	2019	$2.70	The project will include improvements necessary to consolidate bus service in Kennedy Plaza (downtown Providence) and conduct associated improvements to the streets and spaces within and surrounding the Plaza.	Transit Operations	Other
Urban Bike Route Markings and Amenities (Green Economy Bond)	5023	Statewide	2022	$0.30	Pavement marking and signage for on-road bike routes in urban areas, projects to be determined (TBD).	Bicycle and Pedestrian	Other; statewide
Providence Bicycle Infrastructure Enhancements	5199	Providence	2023	$1.80	Design and construction of approx. 20 miles of on road bicycle lanes, shared lane markings, bicycle boxes, bicycle signal loops, bicycle racks and other related bicycle infrastructure. RIDOT/City are developing a Vulnerable User Safety Action Plan.	Bicycle and Pedestrian	Potential: traffic along I-95 near Providence
Main Street Improvements	5309	Woonsocket	2019	$5.00	Repaving Sidewalks, elongated bump out for pedestrian crossings, lighting improvements, new crosswalks, ADA ramps, bike parking facilities, shared lane markings, signage, street trees, creation of roundabouts, and bike/ped connections to river.	Bicycle and Pedestrian	Other
Passenger Initiatives	7016	Statewide	2018	$5.00	This program's funds are used towards distribution of timetables and transit marketing materials at intermodal facilities, on the web, and other key points within the State's transportation network.	Demand Management	Other; statewide
Mobility Technology	7017	Statewide	2018	$6.67	This program's funds are used to support programs that attract riders by bringing new amenities to transit stations.	Demand Management	Other; statewide

Project Name	STIP ID	Location	Year Funded	Amount ($M)	Description	Intervention Type	Addresses Top Bottlenecks/ Corridors?
Commuter Resources	7018	Statewide	2018	$7.27	The program includes commuter outreach and education, travel training, promotion of transit incentive programs, and transit fare subsidies or similar efforts.	Demand Management	Other; statewide
Passenger Facilities	7012	Statewide	2019	$21.85	This program funds improvements to bus stops, hubs, and intermodal facilities.	Transit Operations	Other; statewide
Pawtucket Transit Center	7024	Pawtucket	2019	$7.04	Development of bus facilities at the planned Pawtucket/Central Falls MBTA Commuter Rail station. Project also is associated with TIP ID 5011.	Transit Operations	Potential: traffic along I-95 near Providence
Transit Corridor Development	5254	Statewide	2021	$5.35	Fixed guideway corridors, such as BRT, rail, light rail, and enhanced bus; adding bus on shoulder capability for key choke points in the system, such as Rt 146 and Rt 195; upgrading traffic signals.	Transit Operations	Potentially bottlenecks on Rt 146 and Rt 195: RI-146 S @ I-95 (R5/F5); I-195 W @ I-95 (R4/F4); I-195 W @ Broadway/ Exit 6 (R9/F9); I-195 W @ U.S. 44/4th St/ Taunton Ave/Exit 4 (R13/F13); U.S. 44 W @ I-195 (R28)
Downtown Transit Connector	7020	Providence	2019	$16.80	This project will provide scheduled, frequent bus service through Downtown Providence along a 1.4-mile corridor. Project also is associated with TIP ID 5184.	Transit Operations	Potential: commuter traffic along I-95 into Providence; potential RI-15 E @ RI-126/ Smithfield Ave (R20)
T-Link	5074	Statewide	2018	$6.13	This program will allow the redesign and expansion of the fixed route bus.	Transit Operations	Other; statewide
					Service to complement MBTA operated commuter rail.		
Vanpool	7023	Statewide	2019	$2.79	This program supports expansion of vanpooling in the State of Rhode Island.	Demand Management	Other; statewide

Project Name	STIP ID	Location	Year Funded	Amount ($M)	Description	Intervention Type	Addresses Top Bottlenecks/ Corridors?
Providence Viaduct, I-95 NB and SB at U.S. 6 Woonasquatucket River, Amtrak	6357	Providence	2018	$245.91	The proposed project will transform the I-95 Northbound for motorists, as RIDOT currently is seeking to reconstruct the viaduct's six bridges, as well as rehabilitate five bridges, and construct three new bridge structures, along with the reconfiguration of a series of ramps to separate conflicting lanes of traffic. The construction of a new collector distributor road will also eliminate merging conflicts. The new configuration is expected to significantly improve traffic safety and also reduce backup from the Route 6/10 approach by up to 96 percent.	Roadway Capacity Expansion	I-95 N @ U.S. 6/ RI-10/Exit 22 (R/F/3); U.S. 6 E @ I-95 (R/F/7)

Appendix E

Projects Addressing Congestion in Other Statewide Plans

Appendix E. Projects Addressing Congestion in Other Statewide Plans

Project Name	Location	Description	Intervention Type	Addresses Top Bottlenecks/Corridors?	Notes
2040 LRTP					
Route 4 and I-95 Interchange Connectivity		Connect I-95N to Rt 4 S, Rt 4N to I-95S	Roadway	Other	TIP 4.16.18 edit—Unfunded, page 43
I-195 Interchange: Taunton and Warren Avenue		Connectivity to/from Interstate in East Providence	Roadway	I-195 W @ U.S. 44/ 4th St/Taunton Ave/Exit 4 (R/F/13)	TIP 4.16.18 edit—Unfunded, page 43
Route 146 at Sayles Hill Road		Eliminate the traffic signal using grade separation. RIDOT requested $90 million in INFRA 2020 application.	Roadway	RI-146 @ Sayles Hill Rd (R/F/12)	TIP 4.16.18 edit—Unfunded, page 43
Route 403 Deferred Ramps		Construct additional ramps to remove traffic from Devil's Foot Rd and Post Road	Roadway	Other	TIP 4.16.18 edit—Unfunded, page 43
Route 4 traffic light removal		Grade separation to remove traffic signals from Route 4.	Roadway	Other	TIP 4.16.18 edit—Unfunded, page 43; need more information on location
Allens Ave and I-95 Southbound		There currently is no direct connection between Allens Ave and I-95 South.	Roadway	I-95 N @ U.S. 1 ALT/ Thurbers Ave/Exit 18 (R/F/2)	2017 Amended Freight and Goods Movement Plan Page 152
Create Access from ProvPort to I-95 Southbound		Current condition involves travel on local roads to access I-95 SB. Current configuration requires use of local roads with turning radius issues. Solution could add direct access to I-95 SB, identify alternate route, or add pavement/restriping to improve turning radii. Would improve marine port access.	Roadway/Port	Other; Potential U.S. 1 S @ Airport Rd (R/F/10)	2017 Amended Freight and Goods Movement Plan Page 159
Widen I-295 as bypass		I-295 has been discussed as freight bypass around Providence. This project would add capacity by increasing lane capacity from 2 lanes to 3 lanes in each direction along the southern segment of this interstate.	Roadway	I-295 S @ I-95 (F20); I-295 N @ RI-37/Exit 3 (R30/F18)	2017 Amended Freight and Goods Movement Plan Page 160

Project Name	Location	Description	Intervention Type	Addresses Top Bottlenecks/Corridors?	Notes
Alleviate Bottleneck on I-195 WB @ Broadway		I-195 WB has a lane drop between Broadway and the Washington bridge, creating a bottleneck and high congestion. Solution would add a lane to increase capacity. Note, current ROW is constrained and would require significant rebuild of retaining wall.	Roadway	I-195 W @ Broadway/ Exit 6 (R/F/9)	2017 Amended Freight and Goods Movement Plan Page 160
Widen I-295 Northbound at Route 37		Bottleneck/congestion issue on I-295 NB where Route 37 merges on and extending as far north as Route 6, where 3 lane section begins. Solution could involve climbing lane or other capacity enhancements.	Roadway	Other	2017 Amended Freight and Goods Movement Plan Page 160
Improve Ramps @ I-95 SB/Route 37		Traffic backs up onto I-95 from Route 37 ramp, due to short weaving direction before ramp splits to go to 37 EB or WB. Serves airport related traffic, plus surrounding area has increased in population, employment. Volumes exceed capacity of exit ramp. Ramp from 37 WB to Pontiac Avenue also backs up affecting I-95 off ramp.	Roadway	Other	2017 Amended Freight and Goods Movement Plan Page 161
Add Capacity to Airport Road @ Post Road		Many traffic signals in close proximity cause congestion on Airport Road. Signal timing and coordination would help add capacity on Airport Road, better connecting T.F. Green Air freight terminal to main roads.	Roadway	U.S. 1 S @ Airport Rd (R/F/10)	2017 Amended Freight and Goods Movement Plan Page 161
Improve Intersection at Route 114 and Mink Street in East Providence		Improve truck access by grade separation to resolve turning and access issues. Access to/from I-195 towards Fall River requires trucks to pass through commercial district on Route 6.	Roadway	Potential I-195 W @ Broadway/Exit 6 (R/F/9)	2017 Amended Freight and Goods Movement Plan Page 163
Improve Ramp from Post Road NB to Route 37		Heavy volume of trucks and other vehicles heading to 37WB from Post Road NB back up down the ramp onto Post Road. Trucks divert through surrounding neighborhood for access to Rt 37. Solution to congestion issue may be geometry or capacity enhancements.	Roadway	Potential U.S. 1 S @ Airport Rd (R/F/10)	2017 Amended Freight and Goods Movement Plan Page 163
Facilitate Truck Movements from Route 146 to Admiral Street		Trucks serving the USPS facility and West River industrial area have difficulty turning left off Route 146 onto Admiral, due to need for wide turn which conflicts with auto traffic.	Roadway/ Freight	RI-146 @ Sayles Hill Rd (R/F/12)	2017 Amended Freight and Goods Movement Plan Page 163

Project Name	Location	Description	Intervention Type	Addresses Top Bottlenecks/Corridors?	Notes
Improve Truck Access from Jefferson Blvd to Airport Connector		Poor turning radii from Jefferson Boulevard onto Airport Connector WB ramps limits truck access in surrounding industrial area.	Freight/Airport	Other	2017 Amended Freight and Goods Movement Plan Page 164
Aquidneck Island additional bus service		Extend on-Island bus service window on Route 60 (West Main and East Main Roads). Provide more off-Island limited stops or express service between Newport and TF Green Airport/Kingston Amtrak Station. Expand Flex Service areas and allow for same day scheduling.	Bus	Other	Aquidneck Island Transportation Study (2011) Page ES-4
Implement Rapid Bus Service for Aquidneck Island		Enhance the attractiveness of the service through new branded buses/stops and providing more frequent service. Implement transit signal priority on Route 60 along West Main Road and East Main Road, with queue jump lanes where possible. Reduce travel times by consolidating or eliminating closely spaced stops.	Bus	Other	Aquidneck Island Transportation Study (2011) Page ES-4
Strengthen and Expand Aquidneck Island Multimodal centers		Upgrade Newport Gateway Center and create new multimodal hubs at Pell Bridge ramps and Melville. Create bicycle/ pedestrian/taxi/car sharing connections. Expand accessibility of transit passes at multimodal hubs. Integrate motor coach and intercity bus parking where appropriate. Include complementary non-transportation uses when appropriate which could help generate revenue and transit use.	General Transit	Other	Aquidneck Island Transportation Study (2011) Page ES-5
Traffic Signal Optimization in Aquidneck Island		Coordinate Island traffic signals along major corridors.	Technology	Other	Aquidneck Island Transportation Study (2011) Page ES-8
West Main Road Left-Turn Lanes		Widen West Main Road to provide left-turn lanes at Oliphant Lane and Forest Avenue. Extend existing left-turn lanes at Gate 17 Access Road, Valley Road, and Admiral Kalbfus Road.	Roadway	Other	Aquidneck Island Transportation Study (2011) Page ES-9
Burma Road Improvements		Construct new Burma Road connections to the north and south.	Roadway	Other	Aquidneck Island Transportation Study (2011) Page ES-9

Project Name	Location	Description	Intervention Type	Addresses Top Bottlenecks/Corridors?	Notes
East Main Road Roundabouts		Construct three roundabouts with medians for access management along East Main Road between Turnpike Avenue and Middle Road at Portsmouth Town Hall.	Roadway	Other	Aquidneck Island Transportation Study (2011) Page ES-9
I-95 South at Route 146 South		Resolving merge/weave bottleneck with Route 6/10 by installing a Collector Distributor Road.	Roadway	I-95 N @ U.S. 6/RI-10/ Exit 22 (R/F/3); U.S. 6 E @ I-95 (R/F/7)	RI*STARS Bottleneck Program Update 030718—CMTF
I-95 South at Route 37		Resolving weave/queue that extends from Pontiac Ave by mitigating queue from Pontiac Avenue	Roadway	Other	RI*STARS Bottleneck Program Update 030718—CMTF
I-95 South at I-295 South		Resolving merge/weave bottleneck with Route 117/Route 4. Mitigation to be determined.	Roadway	I-295 S @ I-95 (F20)	RI*STARS Bottleneck Program Update 030718—CMTF
Route 6 East at I-95		Resolving merge/weave bottleneck with Route 146 North by using a Collector Distributor Road.	Roadway	I-95 N @ U.S. 6/RI-10/ Exit 22 (R/F/3); U.S. 6 E @ I-95 (R/F/7)	RI*STARS Bottleneck Program Update 030718—CMTF
Route 2 between I-295 and Route 401		Resolving bottleneck. Mitigation to be determined.	Roadway	RI-2 S @ RI-117/Centerville Rd (R16); RI-2 N @ RI-115/ Toll Gate Rd (R26)	RI*STARS Bottleneck Program Update 030718—CMTF
Route 117 between Route 2 and Route 1		Resolving bottleneck. Mitigation to be determined.	Roadway	U.S. 1 N @ RI-117/ Greenwich Ave/ Centerville Rd (R17); RI-2 S @ RI-117/Centerville Rd (R16); RI-2 N @ RI-115/ Toll Gate Rd (RI26)	RI*STARS Bottleneck Program Update 030718—CMTF
Route 5 between Route 14 and Route 6A		Resolving bottleneck. Mitigation to be determined.	Roadway	Other	RI*STARS Bottleneck Program Update 030718—CMTF
Route 15 between Smithfield Ave and Route 246		Resolving bottleneck. Mitigation to be determined.	Roadway	Other	RI*STARS Bottleneck Program Update 030718—CMTF
Route 1 between Route 37 and Airport Connector		Resolving bottleneck. Mitigation to be determined.	Roadway	U.S. 1 S @ Airport Rd (R/F/10)	RI*STARS Bottleneck Program Update 030718—CMTF
Extend Shore Line East Commuter Rail Service to Rhode Island		Extend Shore Line East service from its eastern terminus in New London to Providence.	Railway	Other	Feasibility Study for Intercity Service to T.F. Green Page 9

Project Name	Location	Description	Intervention Type	Addresses Top Bottlenecks/Corridors?	Notes
Implement Bus on Shoulder on Hwy 146 Southbound		Implement bus on shoulder on 146 SB from Mineral Spring to Downtown (2.3 miles). Concerns about the southern limit/terminus at I-95.	Bus	RI-15 E @ RI-146/ Louisquisset Pike (R25)	RIPTA Bus on Shoulder Feasibility Study PowerPoint #2 Page 15/18
Right turn lane at intersection of SB Rt 1 and Rte. 102—North Kingstown			Traffic Safety	Other	2017-2028 10-Year STIP, Future Projects Unfunded and STIP Projects with Additional Funding Needs
Branch River 146 Access—North Smithfield			Traffic Safety	Other	2017-2028 10-Year STIP, Future Projects Unfunded and STIP Projects with Additional Funding Needs
Mt. Hope Greenway Walking and Bike Path—Tiverton			Bike/Ped	Other	2017-2028 10-Year STIP, Future Projects Unfunded and STIP Projects with Additional Funding Needs
Marine Highway Project Designation at Port of Davisville		Establish regular barge service between Quonset Development Corp (at Port of Davisville) and Port Authority of NY/NJ (at Red Hook Terminal), known as the North Atlantic Marine Highway Alliance, for service along the existing M-95 Marine Highway Corridor.	Port/Freight	Other	2017 Application to Funding Opportunity for America's Marine Highway Projects
Transit Master Plan					
Smith	Providence	Transit priority.	Transit Operations	Other	
Smith	Providence	Transit priority.	Transit Operations	Other	
Chalkstone	Providence	Transit priority.	Transit Operations	Other	

Project Name	Location	Description	Intervention Type	Addresses Top Bottlenecks/Corridors?	Notes
I-95	Providence/ Cranston/ Warwick	TMP Bus on shoulder at Rt. 37 and Thurbers.	Transit Operations	Other	Potential impacts to other Rt. 37 bottlenecks
I-95	Warwick	TMP Bus on shoulder at I-295 and Rt. 4.	Transit Operations	I-295 S @ I-95 (F20); RI-4 N @ I-95 (R19/F15)	
I-95_Rt. 4	Warwick	TMP Bus on shoulder at 401 and Merge.	Transit Operations	RI-4 N @ I-95 (R19/F15)	
Rt. 4	North Kingstown	TMP Bus on shoulder Lafayette and W. Allenton.	Transit Operations	RI-4 S @ W Allenton Rd (R15/F14)	
I-195	Providence/ East Providence	TMP Bus on shoulder Broadway and S. Main.	Transit Operations	I-195 W @ Broadway/ Exit 6 (R/F/9)	
Henderson	Providence/ East Providence	TMP Bus on shoulder at Broadway and E. Bridge End.	Transit Operations	Other	
Henderson ROW	Providence/ East Providence	TMP Bus on shoulder at N Broadway and Pawtucket.	Transit Operations	Other	
Rt. 146	Providence/ North Providence	TMP Bus on shoulder at Mineral Spring and I-95.	Transit Operations	RI-146 S @ I-95 (R/F/5)	
Rt. 146	Lincoln/North Smithfield	TMP Bus on shoulder at Rt. 99 and Sayles Hill.	Transit Operations	Other	
Rt. 146	Lincoln/North Smithfield	TMP Bus on shoulder at Rt. 146A and Sayles Hill.	Transit Operations	RI-146 N @ Sayles Hill Rd (R12)	
Routes 6 to 10	Providence	TMP Bus on shoulder Rt. 6 and I-95.	Transit Operations	I-95 N @ U.S. 6/RI-10/ Exit 22 (R/F/3); U.S. 6 E @ I-95 (R/F/7)	
Prospect	Pawtucket	Transit priority at Bev. Hill and Main.	Transit Operations	Other	
School-Bev. Hill	Pawtucket	Transit priority at Prospect and Prospect.	Transit Operations	Other	
Bald Hill	Warwick	Transit priority at Rt. 113 and Division.	Transit Operations	Other	
Warwick	Cranston/ Warwick	Transit priority at Sandy and Broad.	Transit Operations	Other	

Project Name	Location	Description	Intervention Type	Addresses Top Bottlenecks/Corridors?	Notes
Post	Warwick	Transit priority at Warwick and Airport.	Transit Operations	Other	
Exchange	Pawtucket	Transit priority Goff and Roosevelt.	Transit Operations	Other	Under development.
Bus Tunnel	Providence	Transit priority N. Main and Thayer.	Transit Operations	Other	Already in service.
Downtown Transit Connector	Providence	Transit priority at Providence Station and Point.	Transit Operations	Other	Under development.
Social-Clinton	Woonsocket	Transit priority at Main and Cumberland.	Transit Operations	Other	
Hartford	Providence	Transit priority at Rt. 6 and Killingly.	Transit Operations	Other	
Westminster	Providence	Transit priority at 6-10 and Dave Gavitt.	Transit Operations	Other	
N Main	Providence/ Pawtucket	Transit priority at KP and Pawtucket.	Transit Operations	Other	
Broadway	Providence	Transit priority at 6-10 and Empire.	Transit Operations	Other	
Elmwood-Reservoir	Providence/ Cranston/ Warwick	Transit priority at CCRI and Dave Gavitt.	Transit Operations	Other	
113	Providence/ Cranston/ Warwick	Transit priority at CCRI and CCRI.	Transit Operations	Other	
113	Providence/ Cranston/ Warwick	Transit priority at CCRI and CCRI.	Transit Operations	Other	
Park	Cranston	Transit priority at CCRI and Greenwich and adding crosstown service.	Transit Operations	Other	
I-295 and U.S. 6	Johnston	TMP Park and Rides at Warwick and Cranston.	Transit Operations	Other	
RI-146A and Smithfield Rd	North Smithfield	TMP Park and Rides at RI-146 and Smithfield Road.	Transit Operations	Other	
CCRI	Lincoln	TMP Park and Rides.	Transit Operations	Other	

Project Name	Location	Description	Intervention Type	Addresses Top Bottlenecks/Corridors?	Notes
Pascoag	Burrillville	TMP Park and Rides.	Transit Operations	Other	
Mount Hope Bridge	Portsmouth	TMP Park and Rides.	Transit Operations	Other	
Providence-CCRI Warwick via T.F. Green	Providence/ Cranston/ Warwick	BRT.	Transit Operations	Other	
Central Falls-CCRI Warwick	Central Falls to Warwick	Light Rail Transit/BRT.	Transit Operations	Other	
R-Line Broad St—N Main St	Providence	Rapid Bus/BRT/LRT.	Transit Operations	Other	
Elmwood Ave—T.F. Green Airport	Providence/ Cranston/ Warwick	Rapid Bus.	Transit Operations	Other	
Broadway—Manton	Providence, North Providence, Johnston	Rapid Bus.	Transit Operations	Other	
Chalkstone Avenue	Providence	Rapid Bus.	Transit Operations	Other	
Beverage Hill Ave—East Providence	Providence, East Providence, Pawtucket	Rapid Bus.	Transit Operations	Other	
Attleboro-Pocasset/Dyer Ave via KP	Pawtucket, Providence, Cranston	Rapid Bus.	Transit Operations	Other	
Cranston Street	Providence to Cranston	Rapid Bus.	Transit Operations	Other	
West Bay	Providence to Newport (West)	Regional Rapid.	Transit Operations	Other	
Lincoln—Woonsocket	Providence to Woonsocket	Regional Rapid.	Transit Operations	Other	

Project Name	Location	Description	Intervention Type	Addresses Top Bottlenecks/Corridors?	Notes
Providence—Newport	Providence to Newport (East)	Regional Rapid.	Transit Operations	Other	
URI—Galilee	Providence to Narragansett	Regional Rapid.	Transit Operations	Other	
East Side—Brown to Pawtucket Ave (EP)	Providence to East Providence	Transit Emphasis Corridor.	Transit Operations	Other	
Olneyville to Downtown via Broadway	Providence	Transit Emphasis Corridor.	Transit Operations	Other	
Amtrak Service To T.F. Green Airport	Providence	Intercity Rail.	Transit Operations	I-95 NB (R2/F2, R8/F8)	
Increase Rail Service Frequency Boston—Providence	Providence	Intercity Rail.	Transit Operations	I-95 SB (R1/F1)	
Bicycle Master Plan					
Woonasquatucket Greenway	Providence	Connect existing bike facilities in Johnston and Providence into a continuous protected bike path from Johnston to Waterplace Park in downtown Providence. Would serve to connect vulnerable populations in Olneyville to jobs in downtown. Upgrade Broadway to protected bike lanes.	Bicycle and Pedestrian	Other	Also, Providence Great Streets Plan
East Coast Greenway: Western Providence Segment	Providence	Create protected bike facilities from the current end of the Washington Secondary Bike Path in Cranston to an intersection with the Wonnasquatucket Greenway in Olneyville via the new paths being constructed as part of the 6 and 10 interchange project.	Bicycle and Pedestrian	Other	Also, Providence Great Streets Plan
East Coast Greenway: Eastern Providence Segment	Providence	Create protected bike facilities to connect Waterplace Park with the Pawtucket border. Fill gaps between Waterplace Park and new bike/ped bridge. Fill gaps between new East Side bike path and Blackstone Boulevard. Upgrade Blackstone Boulevard to create protected bike facilities. Create protected spur to connect to Allens Avenue.	Bicycle and Pedestrian	Other	Also, Providence Great Streets Plan

Project Name	Location	Description	Intervention Type	Addresses Top Bottlenecks/Corridors?	Notes
East Coast Greenway: Pawtucket/Central Falls Segment	Providence	Create protected bike route from Blackstone Boulevard in Providence to southern terminus of Blackstone Valley Greenway in Central Falls.	Bicycle and Pedestrian	Other	Also, Providence Great Streets Plan
South Side/Broad St	Providence	Create protected bike corridor connecting Waterplace Park and Roger Williams Park via either Broad Street or Elmwood Avenue	Bicycle and Pedestrian	Other	Also, Providence Great Streets Plan
North Providence Corridor	Providence	Create a protected bikeway from Waterplace Park to Mineral Spring Avenue Candidate Corridors include Admiral St, The West River Greenway, and Smith St.	Bicycle and Pedestrian	Other	Also, Providence Great Streets Plan

Appendix F

Transit Corridor Screening Tool

Appendix F—Transit Corridor Screening Tool

TO: Rhode Island Congestion Management Working Group

FROM: Chris Porter

DATE: April 17, 2020

RE: Rhode Island Transit Corridor Screening Tool Documentation

Tool Overview

The Rhode Island Transit Corridor Screening Tool is a simple spreadsheet tool designed to estimate the potential transit ridership, travel time savings, and traffic congestion impacts of operational and service improvements to a transit corridor. The tool is designed to assist with prioritizing corridors for transit improvements as part of the Congestion Management Process.

The tool uses elasticities (a percent change in ridership with respect to a percent change in some service variable) to estimate the effects of service changes on ridership, and subsequently on vehicle traffic volumes. Volume-delay functions are used to estimate the effects of changes in auto traffic volumes and roadway capacity on congestion.

Three types of service improvements can be considered:

- Reductions in travel time.
- Changes in fares.
- Added trips (reduced headways).

In addition, changes in roadway capacity that might result from transit improvements (such as converting a general purpose lane to a high-occupancy vehicle lane) can be evaluated.

Using the Tool

1. Copy the master worksheet ('00_Master') and rename it.
2. If desired, provide user-input values of any constants in the yellow cells on the "Constants" tab. If the user input cells are left blank, the defaults will be used. Note that this tab is referenced by all scenario worksheets in this workbook.
3. Enter scenario data in yellow cells on the renamed worksheet. Include any notes on data sources or assumptions in the "Analyst Notes" column.

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4. Review outputs on this worksheet.

5. Note that cells that are colored blue are calculations performed by the tool.

6. To avoid accidental overwrite of formulas, all cells are protected except for the yellow user input cells. If it is necessary to change formulas, formatting, etc., the password is “ripta.”

Key Assumptions

The tool is based on the following key assumptions, which can be changed by the user on the “Constants” tab:

- Ridership elasticity with respect to travel time change of -0.4 based on midpoint of typical range of 0.3 to 0.5 found in literature (Transit Cooperative Research Program Report 95 Chapter 12).

- Ridership elasticity with respect to service level (frequency or headway) of 0.7, based on range of elasticities of 0.3 to 1.0 found in the literature (TCRP Report 95 Chapter 12).

- Ridership elasticity with respect to fare of -0.30 for medium (500,000—1 million) metro area based on data cited in Mayworm, Lago, & McEnroe (1980) as cited in TCRP Report 95 Chapter 12.10.

- Prior drive mode share (i.e., percent of new transit riders who would otherwise have been an auto driver) of 47 percent based on assumptions used by the project team in work for the Georgetown Climate Center in support of the Transportation and Climate Initiative, considering a variety of transit rider surveys and other data sources.

- Average auto occupancy of 1.7 (all trip purposes), consistent with Rhode Island performance measurement reporting to the Federal Highway Administration.

- Annualization factor of 250 (weekday analysis).

- Volume-delay function using the standard Bureau of Public Roads curve with alpha = 0.15, beta = 4.00, consistent with the Rhode Island Statewide Travel Demand Model.[1]

Inputs

The tool requires the following user inputs. It is important that the time period and direction for which the data are entered are consistent. The tool is set up to accept input data for a consistent roadway type and cross-section (e.g., four-lane arterial, six-lane limited-access highway). If the corridor of interest includes segments with very different capacity and volume characteristics, multiple segments will need to be analyzed separately, and the results added.

[1] Predicted Speed = Free-flow Speed / [1 + alpha * (Volume / Capacity)^beta]

Input	Description/Source
Roadway Information	
Corridor Route Name:	Name of corridor/routes.
Start (cross-street):	Geographic marker for one end of the corridor. It is recommended that the corridor start at the beginning of a route or another RIPTA time point.
End (cross-street):	Geographic marker for the other end of the corridor. It is recommended that the corridor start at the end of a route or another RIPTA time point.
Roadway length (mi):	Length of affected corridor in miles; may be measured using Google Earth. This should be the length of the primary roadway segment(s) on which the transit route operates and corresponding to the volume and capacity inputs. It is most important that it covers any bottlenecks at which traffic will be affected. It does not need to include every road segment on the RIPTA route.
Direction:	Could be unidirectional (NB, SB, EB, WB) or bi-directional.
Number of Lanes:	Total number of traffic lanes in the affected direction(s).
Time Period:	The time period for which the user is entering volume and capacity data (e.g., AM Peak, PM Peak, Daily).
Length of Period (hrs):	Length of period for which service, ridership, and traffic volume data are being entered.
Traffic Volume:	Total traffic volume for analysis time period, from counts or travel demand model, for the direction(s) and time period of interest.
Capacity:	Total capacity (all lanes) for analysis time period, from counts or travel demand model, for the direction(s) and time period of interest.
Free-flow Speed (mi/hr):	The average auto travel speed across the length of the corridor, accounting for signal delay but not congestion. It could be taken from the RI Statewide Travel Demand Model, for early morning hours from INRIX data using the PDA Suite or estimated from Google Maps. Note that while free-flow speed should ideally be measured at an off-peak time (e.g., midnight), the BPR equation does not do a good job of capturing delay from added traffic on arterials. For purposes of this tool it is better to have an accurate estimate of the actual travel time than the actual free-flow speed.
Roadway Capacity Change (%):	User-entered value for a project that reduces roadway capacity.
Transit Information	
Route Number:	Transit route number(s) being evaluated. The spreadsheet currently allows for up to four routes at once. Separate directional inputs could be provided to evaluate inbound and outbound trips separately.
Trips:	Total transit trips (1-way runs) in service period being evaluated.
Service period length (hrs):	Should correspond to roadway "time period" of doing peak period analysis. For daily, use first daily run start time subtracted from last daily run start time.
Ridership (pax):	Total number of riders using the bus in the direction(s) of interest in the peak period. This may be calculated from RIPTA data on boardings for the

Input	Description/Source
Roadway Information	
	corridor. if the evaluation corridor does not begin at the start of the route, pre-corridor ridership can be added by subtracting total alightings from total boardings on the route segments before the evaluation corridor.
Travel Time (min):	Average run time across the corridor, which may be taken from RIPTA trip or segment level data.
Travel Speed (mi/hr):	Average travel speed across the corridor, which may be taken from RIPTA trip or segment level data.
Fare ($ one-way):	Base fare, currently $2.00 for RIPTA fixed-route services.
Travel Time Change (min):	Change in corridor travel time estimated as a result of the proposed corridor improvements. This could be based on an intersection-by-intersection analysis of operations changes, or by looking at observed travel time savings from similar improvements implemented elsewhere.
# of Additional Vehicle Trips:	Number of additional trips added in the peak period (for service increase).
Fare Change:	Reduction in fare, for fare reduction strategies.

Outputs

The tool provides the following outputs:

- Auto travel speed (mi/hr) before and after improvements.
- Auto travel time (min) before and after improvements.
- Change in auto trips.
- New traffic volume and v/c ratio.
- Auto travel time change (%).
- Transit travel speed (mi/hr) before and after improvements.
- Ridership change and total new riders.
- Travel time savings for auto drivers/passengers (hrs per year).
- Travel time savings for transit riders (hrs per year).

Sample Application

A sample application was developed for improvements on the north end of the R line, from Kennedy Plaza to Pawtucket Transit Center. Ridership and traffic volumes for the PM peak period (3 p.m. to 6 p.m.) were entered, with analysis conducted for both directions. The R line runs at 10 minute headways during this time, with an approximate run time of 25 minutes over 4.8 miles. The predominant character of the roads along which the line runs are four-lane arterials. Pending analysis of data from the regional model, a capacity of 900 vehicles per lane per hour was assumed.

Northbound and southbound transit service were evaluated separately; a travel time savings of 5 minutes was assumed northbound (direction of peak traffic) and 2 minutes southbound (against peak traffic). These savings might result from improvements such as queue jump lanes and transit signal priority. No other changes to service levels or fares were assumed.

The estimated change in ridership is 45 new riders northbound and 15 new riders southbound, adding to the existing 561 and 474 riders, respectively. With just under half these new riders having switched from driving, there are a total of 28 auto trips reduced.

Existing transit riders save about 15,600 hours per year collectively, or 15 percent of their total travel time on this segment of the route.

In this instance the hourly bi-directional volume of 1,900 vehicles[2] was much less than the hourly capacity of 3,600 vehicles. Thus, only a very small congestion effect on travel speed was calculated—0.2 percent travel time savings, resulting in 413 hours saved per year.

2 Counts conducted by TrafInfo in 2018; other counts obtained from RIDSP indicated 478 vehicles.