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ADDENDUM #1

RFP #7606823 **TITLE: PROFESSIONAL SERVICES AN ITS TECHNICAL SUPPORT TO THE RIDOT TMC**

SUBMISSION DEADLINE: 8/11/2020 – 11:30 A.M.

See attached.

Lisa Hill

Lisa Hill
Assistant Administrator

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
RIDOT Addendum Notification

RFP# 7606823 PROFESSIONAL SERVICES AND ITS TECHNICAL SUPPORT TO THE RI TMC
ADDENDUM #1
SUBMISSION DEADLINE: TUESDAY, AUGUST 11, 2020 at 11:30 am

Per the issuance of the Rhode Island Department of Transportation **ADDENDUM # 7606823A1** the following changes are noted:

1) Clarification: Response to Request for Documents

Attached is RIDOT's ITS Strategic Deployment Plan

APPROVED: ______________________ 8/3/20
Michael Wreh DATE
Manager, Transportation Management Center

August 3, 2020

Rhode Island Department of Transportation

2015 - 2020 ITS Strategic Deployment Plan

Technical Report Documentation Page

1. Report No. RIDOT-TMC-14-002	**2. Standards.** N/A	**3. Recipient** RIDOT
4. Title and Subtitle ITS Strategic Deployment Plan		**5. Report Date** 2015 **6. Performing Organization** Jacobs Engineering, Inc.
7. Author(s) Catherine Burns, James Ingram, William Nordstrom		**8.**
9. Performing Organization Name and Address Jacobs Engineering, Inc. 166 Valley Street Bldg. 6M Suite 101 Providence, Rhode Island 02909		**10.** **11. Contract No.** 2015-ET-004
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16. Abstract

The RIDOT ITS Strategic Deployment Plan is intended to be used as a planning guide to deploy short and long-term infrastructure to improve the performance of the transportation system throughout the state, and includes the rationale and budgetary costs associated with the deployments.

This Plan documents the existing and proposed Intelligent Transportation Systems (ITS) devices and network throughout the state including cameras, portable and permanent electronic message boards, sensors and supporting communications network to provide public services such as traveler information and to collect data for performance reporting that is required to measure the effectiveness of transportation improvements, and to comply with MAP-21 and achieve federal funding for National Highway Performance Program projects. All of the projects from Recommendations have been assigned a priority based on the ITS Needs Assessment tailored to RIDOT. This Plan assumes a budget for $5 Million per year for ITS contracts.

17. Key Words RIDOT; ITS; Strategic Plan		**18. Distribution Statement** RIDOT, RIDOT subconsultants, RI MPO, FHWA	
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Version	Date	Description
0.1	5/29/15	Draft Submittal to RIDOT Stakeholders for review
0.2	6/26/15	Reviewers comments received
1.0	7/31/15	Initial Release Revision 1.0

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Glossary of Terms

Acronym	Definition
AAA	American Automobile Association
AASHTO	American Association of State Highway & Transportation Officials
AHU	Air Handling Unit
AMS	Asset Management System (Vueworks)
BTOP	Broadband Technology Opportunities Program
CAD	Computer Aided Dispatch
CCTV	Closed-Circuit Television
CMAQ	Congestion Mitigation and Air Quality
DMS	Dynamic Message Sign
DOT	Department of Transportation
EMS	Emergency Medical Service
ESS	Environmental Sensor Station
FHWA	Federal Highway Administration
GIS	Geographic Information System
HAR	Highway Advisory Radio
HPMS	Highway Performance Monitoring System
ITS	Intelligent Transportation System
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
NHS	National Highway System
NTIMC	National Traffic Incident Management Coalition
NUG	National Unified Goal
RIAC	Rhode Island Airport Corporation
RIDOT	Rhode Island Department of Transportation
ROW	Right of Way
RWIS	Road Weather Information System
RTSMIP	Real-Time System Management Information Program
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: Legacy for Users
TAC	Technical Advisory Committee
TIM	Traffic Incident Management
TMDD	Traffic Management Data Dictionary
TMC	Transportation Management Center
TIP	Transportation Improvement Plan

USDOT	United States Department of Transportation
UPS	Uninterruptible Power Supply
V2I	Vehicle to Infrastructure
V2X	Vehicle to Everything
VBA	Visual Basic for Applications
WIM	Weigh-In-Motion
XML	eXtensible Markup Language

Executive Summary

Intelligent Transportation Systems (ITS)

Intelligent Transportation Systems (ITS) are defined by the FHWA as the application of advanced sensor, computer, electronics, and communication technologies and management strategies, in an integrated manner, to improve the safety and efficiency of the surface transportation system. ITS give the Rhode Island Department of Transportation (RIDOT, the Department) the tools to detect, verify, and respond to roadway incidents; the tools to provide public information that reduces congestion and improves safety; and provides the data gathering tools required to report on the RIDOT's system performance.

As the means to evaluate system performance, ITS is a critical piece in securing funding for Highway improvement projects. The Moving Ahead for Progress in the 21st Century Act (MAP-21 §1106; 23 USC 119(d)(1)(A)) requires that National Highway Performance Program NHPP projects support progress toward achievement of the national performance goals for infrastructure condition, safety, mobility, or freight movement on the NHS in order to be eligible for NHPP funds. Projects that do not support at least one of these four listed national goals are not eligible for NHPP funds.

ITS Baseline at RIDOT

The current RIDOT ITS infrastructure includes CCTV cameras, electronic signage including VMS, DMS, HAR equipment as well as RWIS, roadway sensors and roadway data collected by private sources. Table 1 below quantifies the current RIDOT equipment deployment.

Table 1: Field Deployment Summary 2014

Equipment	Current
Cameras (CCTV)	130
VMS	16
DMS	17
HAR Transmitters	13
HAR Beacon Signs	44
Vehicle Detectors	69

ITS in Rhode Island is managed and maintained by the TMC at RIDOT in Providence 24/7. The primary goal is incident management as well as to support autonomous traveler information systems, maintenance activities and federally mandated performance measurement programs. The TMC also serves as a host to the Rhode Island Emergency Management Agency (RIEMA) during emergency situations.

Goal of ITS Strategic Deployment Plan

The RIDOT ITS Strategic Deployment Plan provides a roadmap to deploy short and long-term infrastructure to improve performance of the transportation system throughout the state. This document is not intended to serve as a wish list but as a fundamental plan to make judicious and efficient use of infrastructure enhancements for the benefit of the RIDOT. Careful attention has been paid to evaluate and substantiate the value of deployments. To this end, the Plan has been developed with the partnership and guidance of various stakeholders within the DOT and the Department of Administration Office of Planning.

It is the intention of this ITS Strategic Deployment Plan to be used as a planning tool by various departments of the DOT and DOA Planning, including providing foundation for ITS planning in the regional TIP. The Plan should offer improved efficiencies in the deployment of ITS devices brought about by clearly defined criteria. This should eliminate repeated explanations of the value or strategy of deploying individual devices. ITS devices indicated in this Plan should be seen as components of a larger picture - building blocks to a system designed to improve safety and reduce congestion, and allow for the efficient management of the RIDOT roadway assets. A major objective of this Plan is for it to be used as an integral part of the Planning Process.

While each component of every project cannot reasonably be expected to be funded in the short term, this plan provides the blueprint from which to identify where and why the deployment of ITS provides a benefit to the RIDOT. Tables are included that identify areas of critical need, and prioritize deployments.

To form a record and baseline, this Plan also documents the existing and emerging ITS deployments and networks throughout the state including cameras, portable and permanent electronic message boards, traffic sensors and communications networks. All of the recommended projects from Recommendations have been assigned a priority based on the ITS Needs Assessment tailored to RIDOT. This Plan assumes a budget for $5 Million per year for ITS contracts.

This Plan concludes with a Vision for the Future where emerging technologies and current best practices not currently being deployed in Rode Island are presented with the aim to stimulate conversation and gain support and understanding of these productive efforts.

Current Funding and Deployment Issues

Currently there is no line item budgeting for ITS in the Metropolitan Planning Organization (MPO)'s Transportation Improvement Plan (TIP). Therefore, almost all new ITS systems are achieved through RIDOT's Mainstreaming Process.

Mainstreaming is a FHWA accepted process whereby ITS infrastructure is added to construction projects. Typically an ITS deployment is a small fraction of the cost of a construction project, and so the RIDOT is awarded efficiencies by combining the two projects without significantly affecting the budget of the construction project. The current Mainstreaming Process at RIDOT is for Roadway and Bridge Design Engineers to submit project Plan sets to the Transportation Management Center (TMC) for review. There is currently no standard policy for the point in the design stage that plans are to reach the TMC for review. The TMC reviews design Plans and responds to Engineering if there are ITS needs within the project limits. The TMC includes an Engineer's cost estimate in the response. The decision for including ITS is within the confines of the particular construction project, and not within the influence of the users/beneficiaries of the ITS equipment. Inclusion of ITS is not determined or weighted by a current strategy. Also, the current mainstreaming process is undocumented and informally conducted.

Recommendations Summary

It is the recommendation of this Strategic Plan that RIDOT establish and document a more formal Mainstreaming process that has buy-in and support from the Director and Chief Engineer and uses the strategies within this document as a basis for deployment considerations. It is also the recommendation of this Strategic Plan that the Mainstreaming processes get ITS into the construction *planning* process so that funding can be secured at the initial project development, and that the process be formally documented and distributed to all relevant staff.

Due to the size and congestion frequency in Rhode Island, the Plan recommends 100% video coverage of major interstate like Interstate 95, Interstate 195 and Interstate 295. As discussed later in the recommendations, Interstate 95 is a major freight corridor for all of the Eastern seaboard and Interstate 295 and Interstate 195 cross borders into Massachusetts and surround the Providence Metro Area. This Plan recommends leveraging all construction projects along these corridors for complete ITS coverage.

In addition, this Plan recommends deploying ITS on state routes that experience heavy freight traffic, seasonal congestion, and commuter bottlenecks such as Route 146, Route 6 and 10, Route 24, Route 78, and Route 403.

ITS deployment recommendations in this document are broken out into manageable roadway segments. The construction costs for the ITS devices and fiber optic cables for that roadway segment are then shown in a table. In the short and long term recommendations summary at the conclusion of the document, each recommended project has been assigned a priority based on the Section 7 ITS Needs Assessment.

The following table identifies the complete deployment of all recommendations. It is expected that each actual deployment strategy will be done in a phased approach using the Mainstreaming process if there are funding or construction limits placed on the contract. For example, the next consecution project may only support adding one of two cameras recommended in this Plan for a roadway segment. A follow up project may support adding the second camera. During the Mainstreaming process, available funds and a timely reassessment of requirements will be evaluated by the TMC and a recommendation for the highest needs will be made.

RIDOT ITS Strategic Plan ITS Device and Program Recommendations						
ITS Devices by Location						
Route & Segment	**Segment Length**	**No. of New CCTV**	**No. of New DMS**	**No. of New RVD**	**No. of New HAR**	**Total Cost**
Interstate 95						
I-95 Segment 1	7.1	6	1	13	2	$1,963,794
I-95 Segment 2	6.72	7	0	10	0	$1,125,354
I-95 Segment 3	7.21	4	0	5	0	$1,676,238
I-95 Segment 4	5.2	5	1	7	0	$1,262,937
I-95 Segment 5	6.45	6	1	8	0	$1,902,418
I-95 Segment 6	5.2	1	0	2	0	$958,566
I-95 Segment 7	6.9	0	0	0	0	$1,148,682
Interstate 295						
I-295 Segment 1	8.5	10	0	24	0	$2,257,594
I-295 Segment 2	5.4	3	0	9	0	$1,151,342
I-295 Segment 3	4.3	3	0	7	0	$375,780
I-295 Segment 4	5.1	5	0	12	0	$521,630
Interstate 195	3.95	1	0	2	0	$ 444,386
Route 146						
Rte. 146 Segment 1	7.5	7	0	13	0	$702,505
Rte. 146 Segment 2	6.9	4	1	4	0	$1,689,458
Route 6/10						
Rte. 6 West Segment 1	4.1	3	0	5	0	$789,159
Rte. 6/10 Segment 2	1.4	2	0	3	0	$452,981
Route 10 Segment 3	3.1	5	1	4	0	$1,047,310
Route 24	7	6	1	9	0	$ 1,238,134
Route 4	9.64	10	4	14	0	$ 3,999,590
Route 37	2.9	2	2	0	0	$ 638,037
Route 138	8.8	6	1	9	0	$ 1,214,865
Route 78	4	5	0	6	0	$ 659,058
Route 403	4	4	0	4	0	$ 516,633
Total	**131.37**	**105**	**13**	**170**	**2**	**$ 27,736,451**
Programs	2015	2016	2017	2018	2019	2020
Service Patrols			$ 270,064	$ 270,064	$ 270,064	$ 270,064
	2015	2016	2017	2018	2019	2020
ITS Costs by Year	$ 4,712,171	$ 4,991,430	$ 4,511,257	$ 4,269,654	$ 3,910,096	$ 4,008,274

Table 2: ITS Deployment Costs Executive Summary

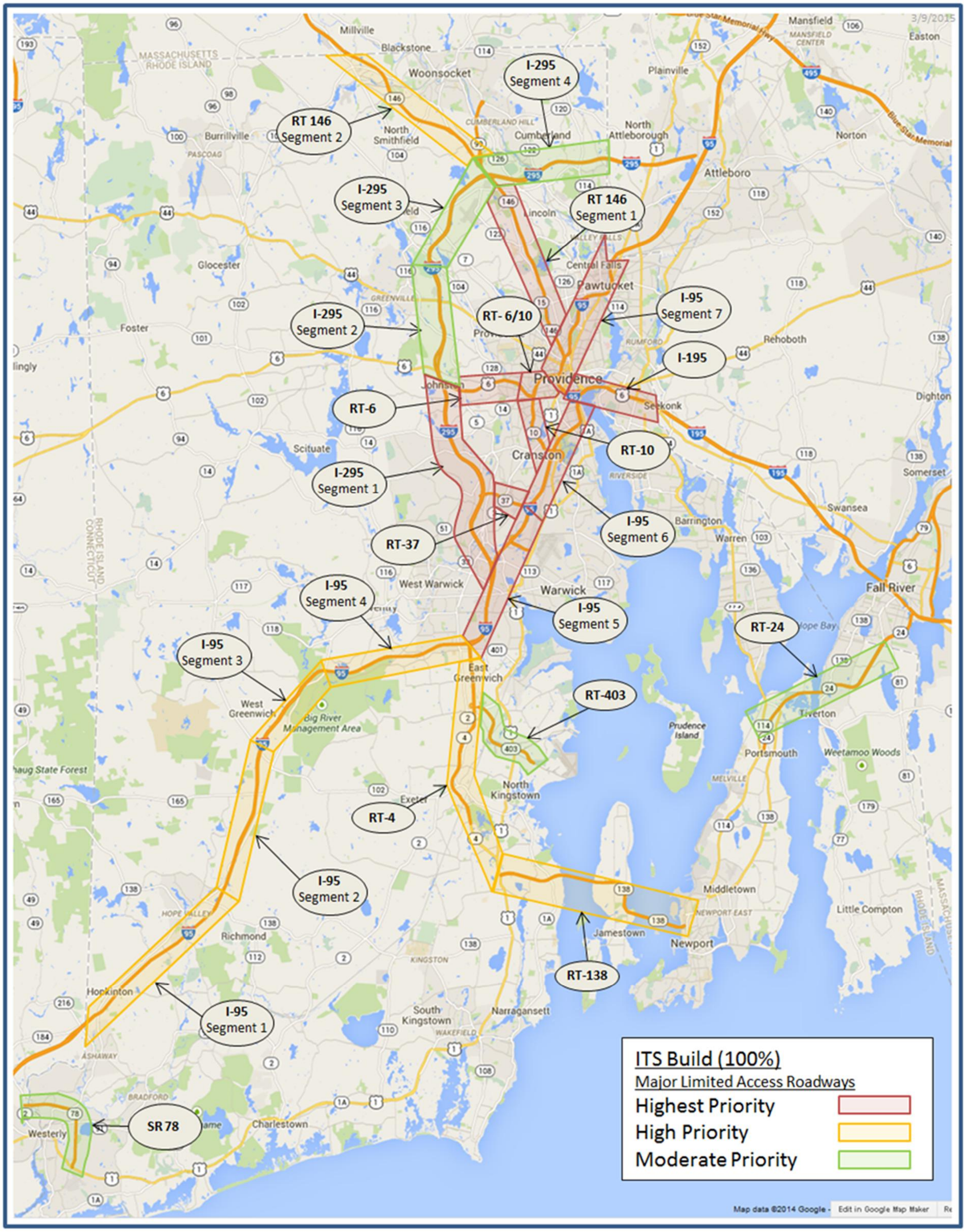

Figure 1: State-wide ITS Recommendations Map

1 Introduction and Purpose

1.1 Introduction

Intelligent Transportation Systems (ITS) are acknowledged by the FHWA to be the means to improve the safety and efficiency of the surface transportation system. ITS give the RIDOT the tools to detect, verify, and respond to roadway incidents, as well as provide public information that reduces congestion and improves safety, as well as the data gathering tools to report on the performance of these systems.

> *ITS is the means to improve safety and efficiency of the transportation system*

The RIDOT ITS Strategic Deployment Plan (the Plan or the Deployment Plan) provides a roadmap to deploy short and long-term infrastructure improving performance of the transportation system throughout the state. This document is not intended to serve as a wish list but as a plan that has been thoroughly researched, discussed with RIDOT stakeholders, and prioritized to be used as a guideline for future deployments by Department.

1.2 Purpose of the ITS Strategic Deployment Plan

The purpose of the RIDOT ITS Strategic Deployment Plan is to provide criteria for deploying ITS devices as well as recommendations for deployment locations over the next five years within a reasonably assumed budget that are proven to:

- Improve Incident Management;
- Improve Congestion Management;
- Improve Safety and Security Management; and
- Improve Operations and Maintenance Cost Effectiveness.

One of the most important transportation problems that this plan addresses is the significant increase in congestion. Americans

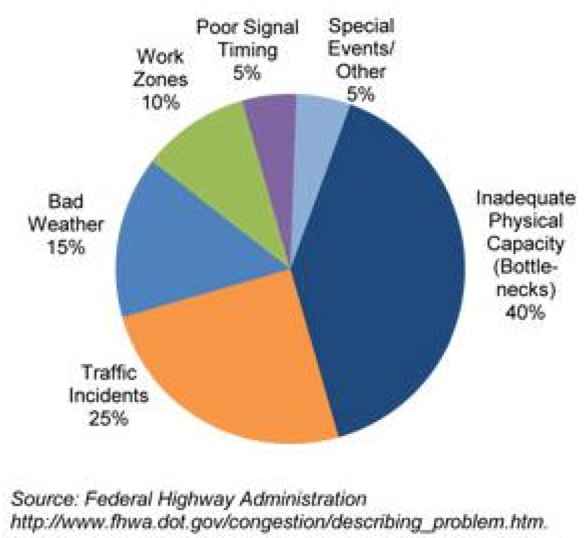

Figure 2: Sources of Congestion
Source: FHWA Final Report of Traffic Congestion and Reliability

lose 3.7 billion hours and 2.3 billion gallons of fuel sitting in traffic[1]. Studies have shown the sources of congestion in addition to capacity bottlenecks include traffic incidents, work zones, weather, traffic control devices (e.g., traffic signals) and special events. Figure 1 presents a breakdown of the sources of congestion. [2]

Federal Highway Administration (FHWA) studies indicate that the number of people killed as a result of crashes within work zones remains significant. Approximately 4,700 fatalities are recorded every year at work zones – more than two a day – and more than 200,000 were injured during the last five years.

Given the current economy, and budgetary constraints within the state, these transportation problems cannot be resolved solely through new-capacity programs. The ability to build additional capacity is not only constrained financially but also limited by existing rights-of-way and sensitive environmental resources. ITS provides a proven set of strategies for addressing the challenges of **safety, congestion and mobility** while accommodating the growth in transit ridership and freight movement. Some of the notable benefits from ITS are listed below.

Documented Benefits from Intelligent Transportation Systems (ITS)
Source: Intelligent Transportation Systems Benefits, Costs, Deployment, and Lessons Learned: 2008 Update

- ITS can improve freeway speeds 8 to 13 percent, improve travel time, reduce crash rates and improve trip time reliability with delay reductions ranging from 1 to 22 percent.
- Evaluation data show that 80 to 84 percent of motorists view weather information enhances their safety and prepares them for adverse road weather.
- ITS can improve safety at work zones by decreasing vehicle speeds by 4 to 6 mph, and reduce the number of speeding vehicles by 25 to 78 percent.
- Use of ITS in traffic incident management can significantly reduce duration of traffic incidents (and hence delays) by 30 to 40 percent.
- Studies show real-time traveler information services improve on-time reliability by 5 to 13 percent.
- ITS related to commercial vehicle operations have been found to reduce transportation costs.

[1] Intelligent Transportation Systems for Traffic Incident Management, USDOT
[2] USDOT, FHWA 2013 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance, Chapter 5, System Performance

1.3 **Strategic Goals and Objectives**

The vision of the RIDOT ITS Strategic Deployment Plan is to *optimize the use of advanced technology to create and manage a dynamic, intermodal transportation network for all users that is safe and efficient and that supports economic growth in an environmentally responsive manner.*

In support of the RIDOT vision and MAP-21 requirements as explained in Section 2, the RIDOT ITS Strategic Plan has adopted the following goals and objectives. The goals are high level ideals the RIDOT hopes to achieve in the long term. The objectives are more specific actions that help the DOT reach their goals.

Goal 1: Improve Safety

- Improve safety during incidents
- Improve safety within work zones
- Improve safety during weather, planned and unplanned events
- Reduce likelihood of wrong way driving

Objectives to Improve Safety:

- ✓ Reduce incident response and incident clearance times through improved detection and incident management training for first responders and TMC operators
- ✓ Use ITS to manage traffic approaching work zones
- ✓ Improve incident management procedures
- ✓ Integrate weather data into traveler information systems
- ✓ Improve detection and response to weather related roadway conditions
- ✓ Increase data and delivery of advisory information to the public
- ✓ Update emergency and disaster recovery plans
- ✓ Improve security of critical infrastructure
- ✓ Expand and improve wrong way driving detection on limited access exit ramps

Goal 2: Improve Efficiency / Mobility

- Reduce congestion without increasing roadway capacity (reducing emissions, improving air quality, and reducing cost of goods moved and the cost of time)
- Improve Operations and Maintenance cost effectiveness
- Include transit information to traveler information options

Objectives to Improve Efficiency / Mobility:

- ✓ Increase the amount of real-time traveler information to the public
- ✓ Increase the available means to receive real-time traveler information for the public

- ✓ Integrate arterial traffic management with freeway management
- ✓ Integrate real-time transit data into traveler information systems
- ✓ Enable real-time traffic management at special events
- ✓ Reduce secondary incident occurrences
- ✓ Enable and promote resource sharing among agencies
- ✓ Leverage private sector data and resources
- ✓ Collect and manage data to enhance operations performance management
- ✓ Review optional data sources for travel time data and reporting

Goal 3: Measure and Report System Performance

- Comply with MAP-21 requirements when they become defined
- Develop data-driven outcome based approach to transportation management

Objectives to Measure and Report System Performance:

- ✓ Improve data collection and reporting methodologies to increase efficiencies
- ✓ Perform data integration as necessary to leverage best value data sources
- ✓ Expand RIDOT's ITS traffic data infrastructure
- ✓ Measure and report roadway system and freight reliability
- ✓ Measure and report equipment maintenance effectiveness

All of the goals and objectives stated above can be addressed by the ITS and program deployments of this Strategic Plan.

1.4 **ITS Deployment Strategy**

Return on investment in ITS technologies is highest when they are deployed strategically along highway segments of prime importance to meet the goals of Rhode Island DOT. Strategic roadway segments include interstates, freeways, expressways and major arterials which serve a large portion of the annual vehicle-miles traveled within Rhode Island. The ITS investment strategy particularly focus on facilities that:

- Experience significant recurring and non-recurring congestion;
- Experience a high number of crashes;
- Serve as a major freight route within and through the state;
- Experience significant seasonal traffic; and
- Provide connections to intermodal facilities.

1.5 **Budget**

Currently there is no assigned budget for ITS device or infrastructure deployment in Rhode Island. ITS projects are only considered during the design phase of construction mainstreaming projects, and only included in the project if there is a surplus in the project budget, and only if the engineering design management approves. This has resulted in limiting RIDOT's ability to the transportation system's full potential and causes increased costs for third party data to meet federal reporting requirements of system performance.

The Fiscal Year 2013-2016 State of Rhode Island Transportation Improvement Program (TIP) does not specifically address ITS projects. However, the TIP considers "anticipated funding" and states:

> *"The TIP must be fiscally constrained, meaning the list of projects in the TIP may not exceed the anticipated funding that is reasonably expected to be available over the four-year timeframe... As a result, the TIP is not a wish list but a list of projects with anticipated, but not guaranteed, funding commitments during the timeframe."*[3]

This document follows the model of the TIP to recommend and prioritize deployments, not to serve as a wish list. Given the budgetary construction costs of the recommendations within this Strategic Plan, an annual budget of approximately $5 Million per year would be required to fulfill all the proposed ITS projects.

[3] Rhode Island Statewide Planning Program, A Guide to Rhode Island's Transportation Improvement Program (TIP) Development Process, Federal Fiscal Years 2013—2016

1.6 Stakeholder Involvement

Early identification of stakeholders for the development of the RIDOT ITS Strategic Deployment Plan was performed as part of the Systems Engineering Process. Stakeholders are those persons who greatly benefit or can provide information to the substance of the Plan. Examples include departments responsible for the deployment of ITS and traffic devices, most notably the TMC and the Traffic Engineering Departments. Also identified are those departments, agencies, and personnel who were identified as primary users of the Plan. This includes the Department of Administration (DOA) Office of Statewide Planning, RIDOT engineering disciplines, RIDOT management, and the Offices of Performance Management and Finance.

To keep the development of the Plan focused, a core group of participants were identified and met with on an as-needed and scheduled basis for input and comment. The staff identified in the following table forms a Technical Advisory Committee (TAC). Also in the TAC are the subject matter experts who contributed to developing the Plan.

The Plan was also distributed to other stakeholders at key development steps for comment and the status of the Plan was presented at the Congestion Management Task Force Meetings, where a majority of Stakeholders are participants.

Table 3: ITS Strategic Plan Technical Advisory Committee

Name	Department	Role or Focus
Joseph Baker	Maintenance and Operations	Reviewer
Joseph Bucci	TMC / Operations	Reviewer
Catherine Burns	Jacobs	Contributor
Daniel DiBiasio	Traffic Research	Contributor
Philip D'Ercole	Traffic Research	Contributor
Lori Fisette	Office Of Performance Management	Reviewer
Russell Holt	Traffic Engineering	Contributor
James Ingram	Jacobs	Contributor
Michael Moan	Office of Statewide Planning Department of Administration	Reviewer
Sudhir Murthy	TrafInfo	Contributor
William Nordstrom	Jacobs	Contributor
Sean Raymond	Traffic Engineering	Contributor

Robert Rocchio	Traffic Engineering	Reviewer
Songhap Taing	Maintenance Operations	Contributor
Daniel Waugh	Traffic Engineering	Contributor
Michael Wreh	TMC	Reviewer

1.7 Using the ITS Strategic Deployment Plan

The ITS Strategic Deployment Plan will be used as a planning tool by various departments of the DOT and DOA Planning, including for the development of the regional Transportation Improvement Plan (TIP) and the Long Range Transportation Plan. The Plan will improve efficiencies in the deployment of ITS by eliminating delays in the decision making process. Clearly establishing the criteria and rationale for a deployment ahead of time will eliminate the delays caused by explanations of the value or strategy during the construction design phase of projects. Once the strategy is approved, then the decision point for deployment should only have to be of a financial nature.

ITS devices indicated in this Plan should be seen as components of a larger picture - building blocks to a system designed to improve safety and reduce congestion, and allow for the efficient management of the RIDOT roadway assets.

A major objective of this Plan is for the information to be available globally within the RIDOT. The ITS and fiber optic cable deployment recommendations in this document will be entered into the RIGIS system to make them viewable anywhere on the DOT network, including from the RIDOT asset management system (Vueworks). During early phases of the roadway and bridge design process, engineering staff will be able to select and view the proposed ITS devices layer in any program with access to the RIGIS. This capability may be used to enhance the mainstreaming process. At a minimum it gives engineers and planners a view into the current ITS strategy.

1.8 Limited Deployment Progress to Date

The prior ITS Deployment Plan covering 2008-2013, identified a long range goal of the following quantities of ITS devices. The Table below summarizes the near term and long term goals of the previous ITS Deployment Plan.

Table 4: Field Deployment Summary 2008-2013

			Near Term			Long Range	
Equipment	Existing	In Construction	SFY 2008	SFY 2009	SFY 2010	SFY 2011-2013	Total
CCTV	88	25	24	33	28	23	221
VMS	21	0	5	1	0	15	42

DMS	15	0	6	0	0	8	29
HAR Transmitter	11	0	0	0	2	0	13
Flashing Beacon Signs	32	0	4	0	9	0	45
Vehicle Detectors	0	0	22	14	26	49	111
Service Patrols	0	0	2	2	4	4	N/A

A comparison between the long range deployment goals of the ITS Strategic Deployment Plan and the actual deployment over the five years of the plan identifies a shortfall attributed to the lack of dedicated funding and limitations in the Mainstreaming process.

Table 5: Comparison of 2008 Deployment Plan Goals and Actual Field Deployment

Equipment	2008 Plan	2015 Actual
Cameras	221	130
VMS	42	17
DMS	29	16
HAR Transmitters	13	13
HAR Beacon Signs	45	44
Vehicle Detectors	111	69
Service Patrols	4	0*

* RFP prepared, pending funding

This comparison indicates RIDOT was unable to deploy as many devices as they had intended to deploy. This may have been due to the current process of deploying ITS devices as part of other projects in the mainstreaming process, technology changes, budget cuts, unforeseen device maintenance costs or a change in the capital device cost or ongoing communication costs.

A schedule for replacement has been provided for RIDOT to optimize maintenance and repair costs but there is a lack of funding to meet the replacement needs of the Department. For example, the 2009 Operational Product Life-cycle Analysis recommended a replacement schedule for VMS, CCTV, HAR and associated network equipment at a rate of 2% of the over $10M capital value or $200,000 per year. This $200,000 a year is unavailable-not replacing new or old.

2 National and Regional ITS Goals

Section 2 provides references to applicable federal legislation including requirements and guidelines as well as historical perspective leading to this revision and development of the ITS Strategic Deployment Plan.

2.1 SAFETEA-LU

In August 9, 2005, the United States Congress passed the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)* legislation. This legislation recognized the critical role ITS plays in addressing the nation’s transportation problems. Section 5303(a) of the legislation set forth five overarching goals for the National ITS program as listed below:

1. Improve the efficiency of existing surface transportation facilities;
2. Decrease the number and severity of crashes by improving the safety of motor vehicles and by improving incident response;
3. Protect the natural environment and communities affected by surface transportation;
4. Accommodate the needs of all users of surface transportation systems; and
5. Improve the nation’s ability to respond to natural and man-made disasters.

Notably, SAFETEA-LU Section 1201 required the establishment in all states of a real-time system management information program (RTSMIP) to provide the capability to monitor the traffic and travel conditions of the nation's major highways and to share that information with State and local governments and the traveling public. The purpose of the program was to improve the security of the surface transportation system, to address congestion problems, to support improved response to weather events and surface transportation incidents and to facilitate national and regional highway traveler information.

2.2 MAP-21

MAP-21, the Moving Ahead for Progress in the 21st Century Act (P.L. 112-141), was signed into law by President Obama on July 6, 2012. Funding surface transportation programs at over $105 billion for fiscal years (FY) 2013 and 2014, MAP-21 is the first long-term highway authorization enacted since 2005. This legislation continued the ITS program, recognizing the critical role ITS plays in addressing the nation’s transportation problems.

> *MAP-21 seeks to create a streamlined, performance-based, and multimodal program to address the many challenges facing the U.S. transportation system. These challenges, or goals, include improving safety, maintaining infrastructure condition, reducing traffic*

congestion, improving efficiency of the system and freight movement, protecting the environment, and reducing delays in project delivery. [4]

The legislation plans to:

- Expand the NHS to incorporate principal arterials not previously included. Investment targets the enhanced NHS with more than half of highway funding going to the new programs devoted to preserving and improving the most important highways.
- Transform performance management for Federal highway programs and provide a means to more efficient investment of Federal transportation funds. Developing performance measures is a crucial component of this legislation that directly related to ITS activity.
- Support the Department of Transportation (DOT) safety agenda by doubling funding for infrastructure safety, strengthening the linkage among modal safety programs, and creating a positive agenda to make significant progress in reducing highway fatalities.
- Streamline Federal Highway Transportation Programs by consolidating the existing program structure into a smaller number of broader core programs.
- Accelerate project delivery and promote innovation by implementing a host of changes aimed at ensuring the timely delivery of transportation projects.

The bill stipulates that state DOTs implement the national performance measurement and management program following a forthcoming federal rulemaking. Five sections of MAP-21 contain the core provisions related to establishing and using national performance measures:

1. Section 1203 sets the overall framework for measures and targets.
2. Section 1106 deals specifically with the National Highway Performance Program and establishes asset management plans as a key element of performance-based investment decision making for the National Highway System (NHS).
3. Section 1202 addresses use of performance measures and targets within statewide long range transportation plans and transportation improvement programs.
4. Section 1112 addresses use of performance measures and targets in state highway safety planning.

[4] http://www.fhwa.dot.gov/map21/summaryinfo.cfm

5. Section 1113 addresses performance requirements for the Congestion Mitigation and Air Quality (CMAQ) improvement program.

The RIDOT ITS Strategic Plan supports MAP-21 by deploying infrastructure and programs needed to measure system performance and to address most of the core goals: improving safety, reducing traffic congestion, improving efficiency of the system and freight movement, and protecting the environment.

2.3 National Unified Goal for Traffic Incident Management

The National Unified Goal (NUG) for Traffic Incident Management (TIM) is a unified national policy developed by major national organizations representing traffic incident responders, under the leadership of the National Traffic Incident Management Coalition (NTIMC). The NUG encourages state and local transportation and public safety agencies to adopt unified, multi-disciplinary policies, procedures and practices that will dramatically improve the way traffic incidents are managed on U.S. roadways. The detailed explanation of the NUG document explains how the NTIMC is working with national, state, regional and local TIM partners to implement the 18 strategies that constitute the NUG. Improved TIM programs and practices are urgently needed to:

- Reduce traffic congestion. Traffic incidents account for approximately one-quarter of all congestion along U.S. roadways. For every minute that a freeway travel lane is blocked during a peak travel period, four minutes of travel delay results after the incident is cleared. Safer, more efficient traffic incident management will reduce congestion by decreasing incident duration as well as secondary incidents.
- Increase responder safety. One of the leading causes of death and injury for emergency responders is being struck by vehicles while working within or alongside the highway. Improved incident management reduces responder risk by improving traffic control at incident scenes and reducing incident duration and risk exposure.

The national TIM stakeholder groups include the national organizations that belong to NTIMC, and other national organizations that are interested in promoting the NUG. Sectors represented include:

- Emergency Medical Services
- Fire & Rescue
- Law Enforcement
- Public Safety Communications
- Towing and Recovery
- Transportation

2.4 National ITS Architecture

FHWA established the National ITS Architecture which defines the functions to be performed to implement a given user service, the physical interfaces/information flows between the physical subsystems and the communication requirements for the information flows (e.g., wireline or wireless). The National ITS Architecture also provides a means by which ITS standards activities can be managed and provides the framework that enables a means to detect gaps, overlaps and inconsistencies in the ITS Standards. The FHWA rule, “ITS Architecture and Standards” established that any ITS project funded by the Highway Trust Fund needs to be consistent with a Regional ITS Architecture, which is to be adapted from a national template.

2.5 Regional ITS Architecture

The Rhode Island regional ITS Architecture was last updated in September of 2014. Because of the State’s relatively small size, RIDOT has defined the Regional ITS Architecture and the Statewide ITS Architecture as congruent. The Rhode Island Statewide ITS Architecture identifies numerous public and private sector stakeholders, confirmed that the ITS Concept of Operations was in line with the Rhode Island Long Range Transportation Plan (Transportation 2035), and lists a number of interagency agreements and collaborative efforts affecting ITS implementation that have been developed within the state of Rhode Island and the bordering states. The Rhode Island Statewide ITS Architecture then uses the “Center” subsystems of the National ITS Architecture to define the ITS capabilities and needs of the statewide/regional ITS Architecture. This ITS Strategic Deployment Plan then describes specific technology that addresses those capabilities and needs.

2.6 Regional Transportation Plans

As of December 2012, the Rhode Island Long Range Transportation Plan (LRTP) has been updated in the Transportation 2035 documentation. The goals of Transportation 2035 for the state’s ITS system are to provide drivers with better traffic information and also to clear traffic incidents more quickly and reduce congestion. In the Transportation 2035 plan, the heart of the system is a Transportation Management Center (TMC) which is staffed 24 hours a day utilizing funding from the Interstate Program. For future plans for the roadway network, ITS tools are recommended to address the facts that the number of registered vehicles and the vehicle miles traveled both continue to increase and highway capacity remains relatively static. Traffic flow and safety can benefit from new technology, such as motorist information systems, centrally coordinated traffic monitoring and control, signal timing, and other ITS technologies. Transportation 2035 further recommends that mainstreaming the consideration of ITS opportunities into planned transportation projects will accelerate the potential benefits of this new technology.

3 Current ITS Programs

This section of the Plan describes the current state of programs and functions in Rhode Island that make use of ITS, including Incident/Congestion Management, Traveler Information Services, Performance Measurements, the Travel Time Information Program, Communications Planning, and support of the Incident Management Task Force (IMTF), Congestion Management Task Force (CMTF), and Transportation Incident Management Training Program.

3.1 Current State of ITS in Rhode Island

The RIDOT ITS is operated, managed and maintained by the Transportation Management Center at RIDOT in Providence 24/7. The primary goal of the TMC is incident management as well as to support autonomous traveler information systems, maintenance activities and to support federal data collection programs. The TMC also serves as a host to the Rhode Island Emergency Management Agency (RIEMA) during emergency situations. Rhode Island has made significant advancements in the planning and deployment of ITS during the past 15 years.

As ITS has grown, the TMC has become increasingly involved with other departments of RIDOT, as well as the public and media. The deployed ITS devices play a crucial role in RIDOT Planning and Mapping for normal operations and emergency operations. The ITS tools such as CCTV are available to the media during live traffic reports while performance measures and after action reporting have been used in workshops to improve safety and consistency in emergency operations with the towing associations, Rhode Island State Police and Fire Departments. Storing data on maintenance costs and procedures has led to better asset management programs and cost savings for bulk planned purchases to decrease reactionary maintenance costs.

RIDOT and FHWA are more interested than ever in performance measure data and documenting operations, maintenance and planning digitally to meet the goals of RIDOT. ITS is data driven; the roadside devices and communication network, as well as data standards, allow RIDOT to better manage the roadways due to more accurate and reliable measurements. Private company tools such as Facebook and Twitter also provide a communication tool between the public and RIDOT.

3.2 Transportation Systems Management and Operations (TSM&O)

As congestion spreads and intensifies and the level of incidents, delays, and disruptions increase, the level of service and reliability of the roadway systems in many areas continues to deteriorate. Given the constraints on the provision of significant new capacity, it is increasingly important to operate the existing network to its fullest service potential, especially “taking back” the capacity lost to congestion, incidents, construction, weather, poor signalization, etc.[5]

The intent of the Transportation Systems Management and Operations (TSM&O) is to encourage active management of the transportation system and to implement these strategies in lieu of, or strategically in conjunction with capacity expansion. Common types of TSM&O strategies include, but are not limited to:

1. Intelligent Transportation Systems (traveler information, transit signal priority, ramp metering)
2. Active Traffic Management (ATM, variable speed displays, dynamic lane assignment)
3. Incident Management (emergency service patrols)
4. Event Management

These strategies can help to increase the efficiency of the system by shifting travel demand to off-peak periods and less congested facilities, optimizing travel speeds for fuel efficiency, and utilizing existing capacity to the greatest extent possible.[6]

As shown, ITS, ATM, and the Incident and Event Management strategies of TSM&O coincide with the ITS Strategic Plan. Many DOT’s are implementing a TSM&O organizational structure. While this has not occurred in the RIDOT at this time, most of the systems already exist and the strategies are a part of this ITS Strategic Plan.

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[5] http://ops.fhwa.dot.gov/Publications/fhwahop12003/background.htm
[6] https://www.sustainablehighways.org/764/132/transportation-systems-management-and-operations.html

3.3 RIDOT Transportation Management Center (TMC)

The TMC is located in Providence and is staffed and operated on a 24/7 schedule 365 days a year. A Rhode Island State Trooper is present at the TMC during weekday commuter hours, working with the TMC staff for incident response. The trooper has access to the RISP network and the State Police two-way radio system.

3.3.1 Incident Management Functions

The primary function of the Operators at the RIDOT TMC is to detect incidents and assist in incident management functions. The TMC Operators are involved throughout the incident management timeline for the DOT including detection, verification, response and recovery. In each of these steps the TMC Operator utilizes the available ITS roadside devices and the RhodeWAYS database to increase safety for travelers and responders to provide the quick clearance of roadway incidents. The speedy clearance of incidents provides safer roads by reducing secondary crashes, reduces congestion and the accompanying vehicle emissions, and reduces the cost of business and the cost to transport goods by reducing traffic delays.

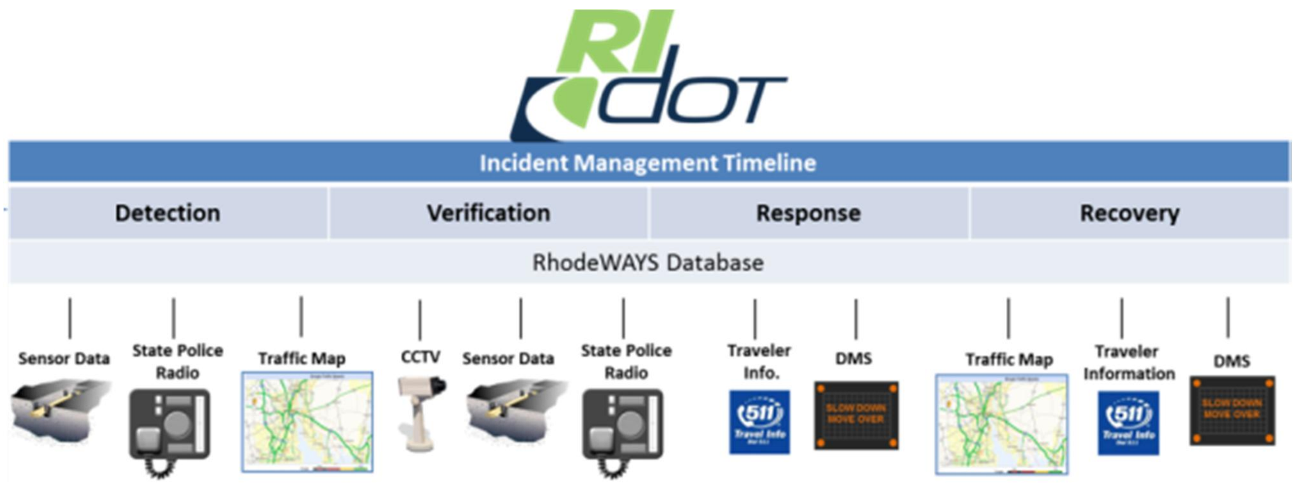


Figure 3: RIDOT Incident Management Timeline

1. Peak Period Incident Statistics*

	AM Peak	PM Peak	Off-Peak	Total
Number of Incidents	863	1396	1770	4029
Avg. Incident Clearance Time (min)	44	47	39	43
Avg. Roadway Clearance Time (min)	29	33	26	29
# Detected by TMC Operators	541	337	657	1535
# Detected by State Police (RISP)	300	1033	1061	2394
# Notified by RhodeWatchers	0	1	1	2
# Utilizing VMS	46	117	226	389
# Utilizing DMS	214	424	622	1260
# Utilizing HAR	172	165	351	688
# Posted to Web	813	1351	1605	3769
Avg. Delay Cost**	$185,296	$197,468	$163,469	$179,925
Total Delay Cost	$159,910,846	$275,664,753	$289,340,314	$724,915,913

* AM Peak: 6:00AM to 10:00 AM, PM Peak: 3:00PM to 7:00PM, Monday - Friday

** Delay Cost is a function of incident duration, volume on the roadway, delay per person, and cost per hour of delay for both commercial and personal vehicles. Average delay cost includes only incidents with a lane blockage and represents average cost per incident.

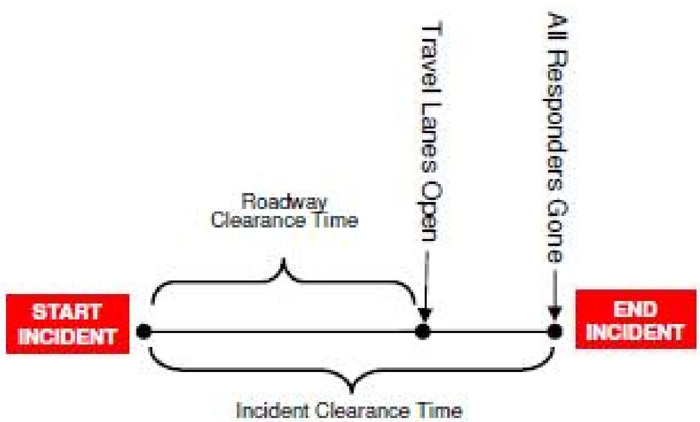


Figure 4: 2012 Annual RIDOT TMC Incident Statistics Report

The data the TMC Operators enter into the TMC RhodeWAYS database regarding Incident Management is used to determine Performance Measures such as Incident Clearance time as well.

3.3.2 Maintenance Dispatch Functions

The secondary function of the TMC is Maintenance Dispatch. TMC Operators log maintenance issues and dispatch/track the maintenance personnel required to resolve the issue. Examples of maintenance issues include hazards in the roadway such as debris or potholes, damage to traffic protection devices such as signals, guardrails and light poles, and weather-related events such as flooding, snow, and ice. The operators triage calls based on the severity and current work load. During working hours, less urgent issues may be referred to Customer Service. After working hours, the TMC handles all calls and has the authority to call in an off-duty worker if warranted by the severity of the issue.

Prior to August 2014, these issues were tracked by the TMC using RhodeWAYS (using a different form than the one used for incidents), while Customer Service used a separate system. Since August of 2014, these issues have been tracked in Vueworks, which is used by both Customer Service and the TMC, eliminating potential duplication or miscommunication of work.

3.4 Traveler Information

3.4.1 CARS 511

In 2005, the Rhode Island Department of Transportation (RIDOT) joined the Condition Acquisition and Reporting System (CARS) coalition and is currently operating Version 3 of CARS-511. The RIDOT website (www.dot.ri.gov) provides basic traveler information on bridges, traffic, rail, transit, bicycling, tolls and air. The RIDOT Transportation Management Center (RIDOT/ TMC) website receives approximately 15,000 visits a month with 75% of the traffic directed to the cameras. The RIDOT website links to the CARS 511 website that is operated by CARS and hosted outside the TMC. Less than 5% of the RIDOT TMC website visitors link to the 511 website. The 511 telephone number receives around 4,000 to 5,000 calls per month.

The CARS-511 system is primarily used for dissemination of road and traffic information as well as e-mail notification of high priority incidents to a select group of RIDOT officials and employees. The system provides 511coverage across the State. Data is entered into CARS-511 by RIDOT'S TMC operators. Typical data input includes traffic, incidents, construction and roadway information. There is no physical hardware or specialized software for CARS-511 at RIDOT'S TMC facility in Providence. The CARS server processes the information and makes it available telephonically to callers from within Rhode Island who call 5-1-1 and to callers to an 888 number from outside Rhode Island through an Interactive Voice Response (IVR) system.

3.4.2 Travel Time Program

The RIDOT Travel Time Program is intended to present information to the public that will allow them to make informed decisions that will reduce congestion by allowing travelers to recognize areas of congestion before (pre-trip planning) and during travel. The RIDOT Travel Time Program was made possible as a direct result of leveraging the travel time data collected from the traffic sensors that are used for Performance Measures. The data is made available to the public via travel time messages on electronic message signs and on the RIDOT web site. The raw data will be made available to the public in 2015 via the RIDOT website that will support and encourage third party vendors who make traveler information applications for smart devices that also enable the public to make informed traveling decisions that reduce congestion.

3.5 Performance Measures

MAP-21 requires measurable performance targets for transportation plans, transportation improvement programs, and in state highway safety planning. Performance targets rely on measurable criteria.

For many years, RIDOT has deployed traffic monitoring tools such as imbedded roadway loops and wireless vehicle sensors that can count vehicles, identify vehicle class, as well as detect vehicle speed. These devices can be used to calculate useful criteria such as:

- Roadway Segment Travel Times;
- Travel Time Reliability (detecting the amount of variation of travel between uncongested and congested times as well as comparing travel times over similar periods of time);
- Annual Hours of Truck Delay; and
- Truck Reliability Index.

This data has been used by Traffic Engineering and the state Planning Sections to identify and assist in roadway improvement and safety projects and to comply with such federally-mandated programs such as the Highway Performance Monitoring System (HPMS), which is one of the primary tools used by the Federal Highway Authority to apportion funds to the States. Already experienced in the use of radar traffic sensor technology, the RIDOT began deploying additional radar traffic sensors in 2009 that allow the measuring of congestion, travel speeds, delays, and queues for the TMC. Newer sensors can also perform vehicle classification.

The RIDOT TMC began publishing monthly Performance Measure Reports in 2012, distributing throughout the RIDOT Engineering and the MPO. The data summarized in the Performance Measure Reports assist the planning process by identifying areas of bottlenecks, congestion, and changing congestion patterns over time. This not only assists in identifying *where* transportation improvements are beneficial, but they can also identify the *severity*, assisting in prioritizing future projects.

Understanding the importance of the ability to measure criteria that assists in the recognition of current conditions, and the ability to measure the effects of remediation activities, the RIDOT continuously assesses the level of deployment of traffic monitoring sensors (as well as seeking alternative means as discussed later), and identifies areas of need to deploy additional sensors.

3.6 **Communications Study Program**

In 2011 a Communications Study was developed to identify capital cost savings in the form of reduced leased data line fees, while simultaneously improving the quality of network services such as improving video quality. This study identified the benefit of and triggered the implementation of consolidating multiple private leased point to point copper wire communication lines with larger bandwidth fiber optic and coaxial lines. In some locations, wireless transport was used to consolidate communications lines or multiple ITS devices into one coaxial or fiber optic cable service drop. The end result is to realize an economy of scale.

A major savings and benefit of the communication study was the changing of service providers and the medium that is being used. The fees for the existing point to point copper connections are based on service distance, and the bandwidth is very restricted. Lower cost fiber optic and coaxial cable connections by a different service provider proved to be less costly with greater communications throughput, allowing more devices to be placed on a single line and allowing for higher data rates for the transfer of video signals, which greatly improved the quality of video seen at the TMC.

The cost savings resulting from the Communications Study proved successful enough for the opportunities and techniques for efficiencies, to be continuously monitored and implemented over time, establishing the Communications Study into a continuous improvement program. The cost savings realized from this program are over $16,000 per month in reduced leased line costs for the DOT as of January 2015.

3.7 **Incident Management Task Force**

The TMC has been chairing the state Incident Management Task Force (IMTF) since 2003. The program has evolved into a standing task force representing key state agencies, the 39 cities and towns, and other stakeholders who evaluate incident management techniques and encourage sharing of resources in an effort to continue to improve incident management safety and efficiency.

The IMTF is an action-oriented work group comprised of representatives from:

- RIDOT
- FHWA
- State and local emergency management agencies
- State Police
- Department of Administration
- Fire Marshal’s Office
- Rhode Island Association of Chiefs of Police
- Rhode Island Association of Fire Chiefs
- E911
- Rhode Island Public Towing Association

- AAA
- The CVS Samaritan program

Continued participation by these key stakeholder agencies has led to improved communication and more effective interagency coordination.

The Rhode Island IMTF has effectively implemented several initiatives that contribute to the safer operation of the State's roadways, including:

- Developed and promoted video sharing initiatives to improve interagency situational awareness
- Developed procedures and protocols to improve coordination for planned special events
- Sponsored courses and training for IMTF members to improve planning capacity and improve the safety of responders and motorists
- Developed a process for Post-Incident Response Evaluation/After Action
- Reviews to capture lessons learned from events and incidents in an organized manner
- Developed Quick Clearance/Move-It policies and supported the passing of the state Move-Over law
- Developed and implemented policies and procedures to support the RIEMA Winter Storm Response Plan

Through monthly RIDOT Traffic Incident Management Task Force meetings, the RIDOT's Traffic Incident Unified Response Manual was revised and updated with stakeholder input. The Traffic Incident Unified Response Manual is a response plan which consists of implementation guidance and procedures outlining the actions of all Rhode Island public safety and transportation agencies in response to traffic incidents.

3.8 Congestion Management Task Force

The Congestion Management Task Force (CMTF) oversees the implementation of Rhode Island's Congestion Management Process (CMP), which monitors both recurring and non-recurring congestion. Supplemental data for this monitoring is drawn from the partners and collaborators of the CMTF: RIDOT Maintenance and Design Divisions, Rhode Island Public Transit Authority (RIPTA), and the Statewide Planning Program. The CMTF includes multi-disciplinary membership and draws officials from federal, state, and local levels. Additionally, the Access Management Task Force (AMTF) is a subcommittee of the CMTF. The goals of the AMTF are to balance RIDOT and property owner needs while also respecting the local role in development permitting development. The AMTF is currently working with RIDOT, the Rhode Island Builders Association (RIBA) the Office of Regulatory Reform and the Rhode Island Chapter of the American Planning Association to assess the Physical Alteration Permit (PAP) process and to identify any disconnects that may exist between the local and state approval processes. The CMTF and CMP received a commendation mention in the most recent update of the Rhode Island LRTP (Transportation 2035) that they provide a structured and comprehensive means of evaluating causes of congestions and planning for access management.

The TMC co-chairs the Congestion Management Task Force (CMTF) with the Office of Statewide Planning, in the Department of Administration. CMTF support includes identifying data sources and presenting studies for roadway system performance measures such as identifying and ranking bottlenecks, and identifying areas of recurring congestion. These data sources will be evaluated in 2015 for their usefulness in providing data for gaps in the DOA/DOT performance monitoring programs.

Ongoing contributions include research and presentations on AASHTO proposed recommendations for freight reliability measurements that will be required of DOT's. In 2015 the TMC will continue to support the CMTF with updates to freight measurement requirements.

Additional work in 2015 includes constructing Work Zone performance measures. A study of work zone operations was proposed by FHWA. Work zones can be considered as possible cause of non –recurring congestion and as such should be managed as efficiently as possible while staying within the recommended parameters of safety for work crews and the motoring public. These measurements will be conducted before, during, and after implementation of a work zone to determine the impact on the system and the effectiveness of traffic management plans for the project.

3.9 Transportation Incident Management (TIM) Training

Since 2013, the RIDOT has been facilitating the SHRP-2 state wide and interdisciplinary first responder training program. SHRP2 is the Strategic Highway Research Program authorized by Congress to address some of the most pressing needs related to the nation's highway system including safety, renewal, reliability and capacity. SHRP-2 is administered by the Transportation Research Board (TRB), with assistance from FHWA and The American Association of State Highway and Transportation Officials (AASHTO). FHWA leads the implementation effort.

The objectives of TIM training are to:

- Improve responder safety

- Improve reliability (reduced incident duration)
- Improve motorist safety (reduced secondary crashes)

The approach of the TIM training is to conduct a multi-disciplinary training program for all responder stakeholders. Multiple agencies participating in joint training sessions produces a greater understanding of roles and builds relationships that assist in the goals of providing quick clearance and improved safety.

The TMC organized a TIM Training Implementation Committee that meets quarterly to re-focus goals and facilitate new training sessions. The TMC leads the effort of stakeholder outreach to solicit training facilities, trainers, and scheduling.

In March of 2013 a Train the Trainer session was held at the Municipal Police Academy in Lincoln, RI where thirty-six first responders and other personnel were accredited to conduct training sessions. The TIM training program is intended to be a five year program with the goal of reaching a minimum of 10% of the boots on the ground first responders of the state.

The TIM training materials have been incorporated into the State Fire Academy, the State Police Training Academy, and the Municipal Police Training Academy's training programs. This assures that all new responders will be introduced to the methods and principles of the TIM training program.

As of the end of 2014, RIDOT has facilitated the training of 664 first responders. Including:

- 362 Fire and Rescue
- 188 Law Enforcement
- 77 Transportation
- 10 Towing and Recovery
- 7 EMS
- 20 Other disciplines

4 Mainstreaming and Deploying ITS

Currently there is no budgeting in the TIP for ITS Deployment. Therefore almost all new ITS systems are deployed through the mainstreaming process. Mainstreaming is a FHWA accepted method for deploying ITS for reasons of efficiencies and cost savings.

The current mainstreaming process at RIDOT is for roadway and bridge design engineers to submit project Plan sets to the TMC for review. The TMC reviews the Plans and responds to Engineering on whether there is ITS needed within the project limits and the TMC includes an Engineer's estimate of the cost in the response.

Unfortunately, there are weaknesses of the current process. One, the TMC does not always get the project plans at an early enough stage to get the ITS into the project. This may be due to a project that was designed to 90% at a previous time, but could not be advertised because funding was not available. When funding is released the project is expedited, and there is little time to add ITS. A remedy to this is for the TMC to review all on-the-shelf projects ahead of time. This goal is part of the ITS Strategic Plan.

The second weakness is that funding for the ITS components of a project are not guaranteed. Funds are typically only available if the ITS portion added to the construction estimates do not exceed the original funding allocation. A remedy for this is to modify the mainstreaming process to involve the TMC in the planning stage of the project. In this way, the ITS components can be budgeted in at the beginning and achieve FHWA approval along with the rest of the project.

Another weakness is that after ITS recommendations that have been duly researched and validated leave the TMC, the ultimate decisions to include or not include the recommendations are done at a civil engineering level that does not include the TMC. In other words, after all the research and validation has been done, the deployment can be denied by persons with no understanding or interest in the ITS program. This not only causes the DOT to lose the benefits of the deployment, but also wastes valuable resources in the process. The remedy is to formalize the process so that the ITS recommendations have weight as long as funding is available. If the ITS is formalized into the project early as recommended, then the ITS design becomes an integral part of the project and is more likely to come to fruition.

The current mainstreaming process at RIDOT is undocumented and not formally conducted. It is the recommendation of this Strategic Plan that the RIDOT more formally establish processes to get ITS into the construction design process sooner so that funding can be secured at the initial project development, and that the process be formally dispatched to all relevant staff.

5 Current ITS Deployments

This section describes the current RIDOT ITS infrastructure including CCTV cameras, electronic signage including VMS, DMS, HAR equipment as well as RWIS, roadway sensors, service patrols and roadway data collected by private sources.

Table 6: Field Deployment Summary 2014

Equipment	Current
Cameras (CCTV)	130
VMS	16
DMS	17
HAR Transmitters	13
HAR Beacon Signs	44
Vehicle Detectors	69
Service Patrols	0*
Roadway Weather Information System (RWIS)	

*Existing RFP

5.1 Roadway Camera System

The RIDOT TMC has 130 Cameras deployed statewide primarily on interstates and highways. These cameras are used by the TMC for incident detection, verification, and monitoring. By verifying an incident's specific location and the details of that incident, such as lane closures, updated travel information is then distributed to agencies and motorists. Traffic video from the TMC cameras is shared directly with the State Police, Providence Public Service and E-911.

Areas with heavier congestion typically have more frequent vehicle accidents and other vehicle bottlenecks, which increases the need for camera coverage. For the existing CCTV deployment, I-95 within Providence has the highest density of camera coverage. Congestion mapping can help locate additional locations where denser camera coverage can be beneficial.

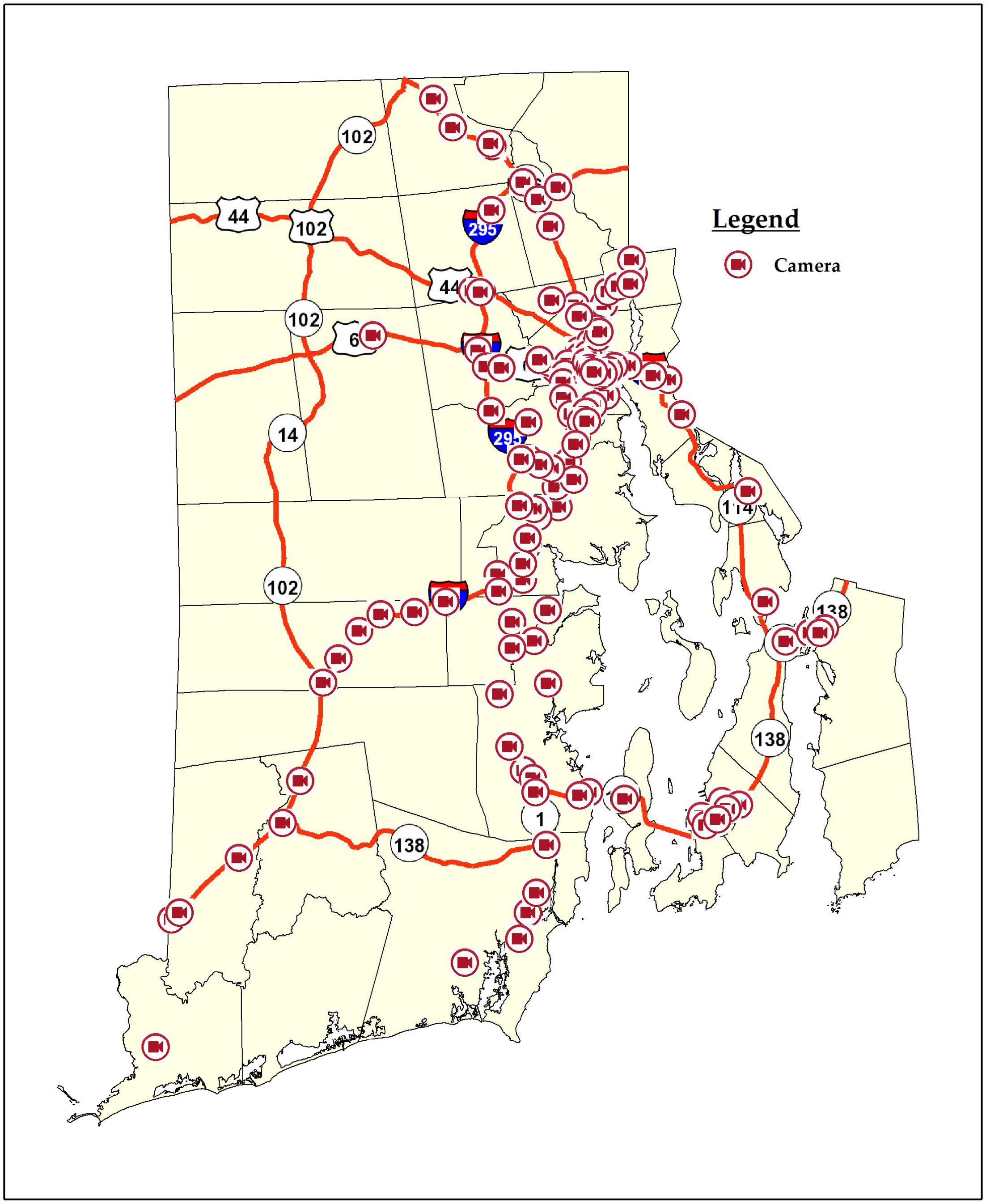


Figure 5: Existing RIDOT CCTV Locations

5.2 Dynamic Message Signs (DMS)

Dynamic Message Signs (DMS) are the large, electronic signs which appear along major highways in Rhode Island. The signs are typically used to display information about traffic conditions, travel times, construction, and road incidents. Travel time information is the default message that appears on a DMS daily from 5:00 A.M. to 9:00 P.M. Travel times have been approved by the FHWA as a means to reduce congestion by providing travelers information which can help them avoid existing congestion.

Figure 6: DMS Travel Time Message Example

5.3 Portable Variable Message Signs (PVMS)

A Variable Message Sign (VMS) is a portable electronic traffic sign often used on roadways to give travelers information about special events, work zones or incidents. Such signs warn of traffic congestion, accidents, incidents, roadwork zones, or speed limits on a specific highway segment. In urban areas, VMS are used within parking guidance and information systems to guide drivers to available car parking spaces. They may also ask vehicles to take alternative routes, limit travel speed, warn of duration and location of the incidents or just inform of the traffic conditions. As shown on the following Figure, a few portables are installed in Massachusetts on Interstates approaching RIDOT. This give motorists the ability to avoid congestion, work zones, or incidents by traveling an alternate route, such as I-295 instead of I-95 to points south.

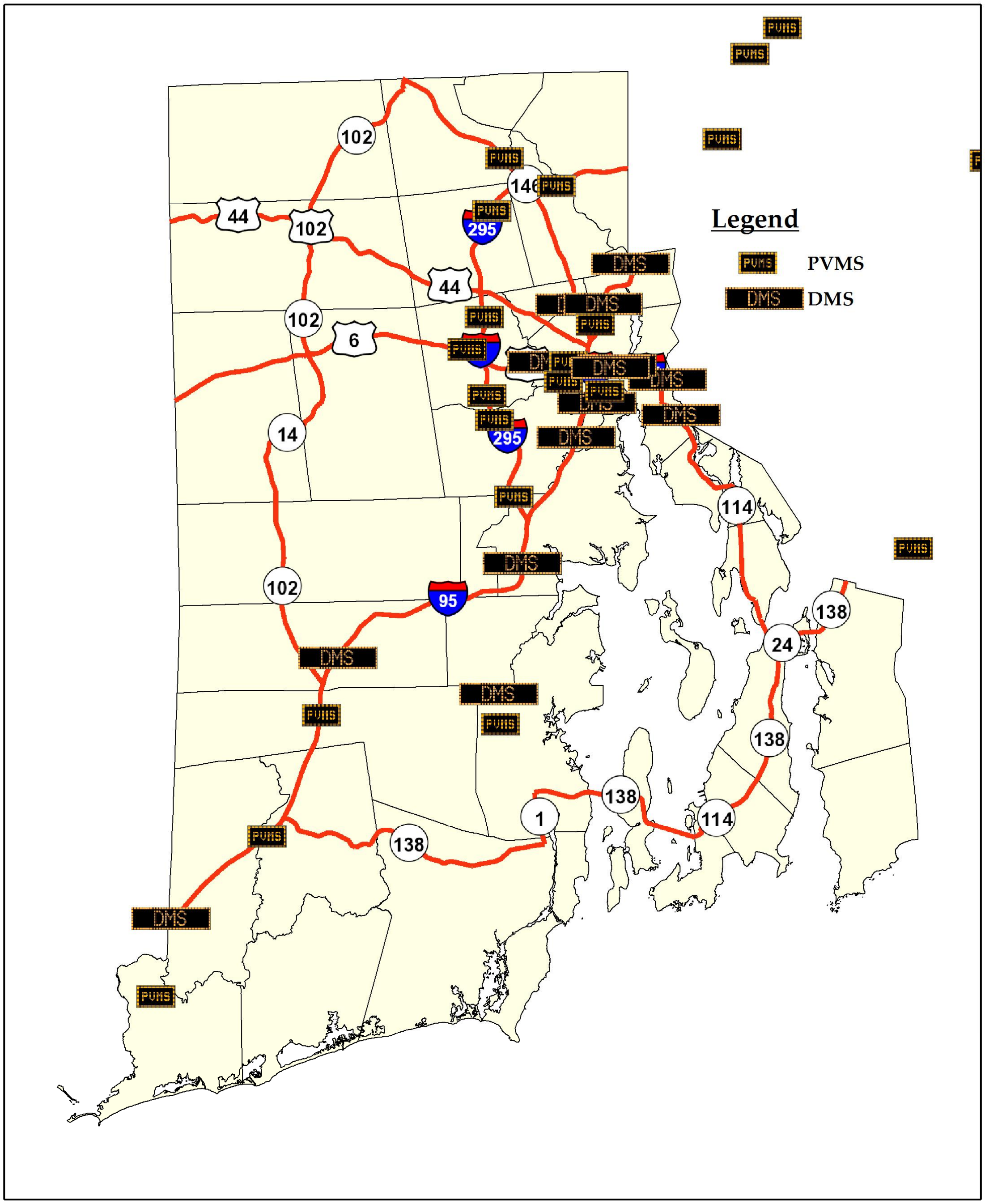


Figure 7: Existing RIDOT DMS and PVMS Deployments

5.4 Highway Advisory Radio (HAR)

Highway Advisory Radio (HAR) is non–commercial voice information AM station primarily providing traffic and road conditions, as well as traffic hazard and travel advisories. RIDOT currently has 13 highway advisory radio transmitters throughout the Rhode Island State Route and interstate network, with 42 associated Beacon Signs. Through a roadside sign and beacon system, RIDOT informs motorists of the HAR channel and whether an active traffic or weather advisory is being broadcast. When the sign beacons are not active, the radio channel broadcasts the latest construction and maintenance information. Motorists are advised that a traffic, weather, or other special advisory that may affect traffic conditions is being broadcast on the HAR station when the beacons are flashing. See Figure 8: Current HAR Deployments.

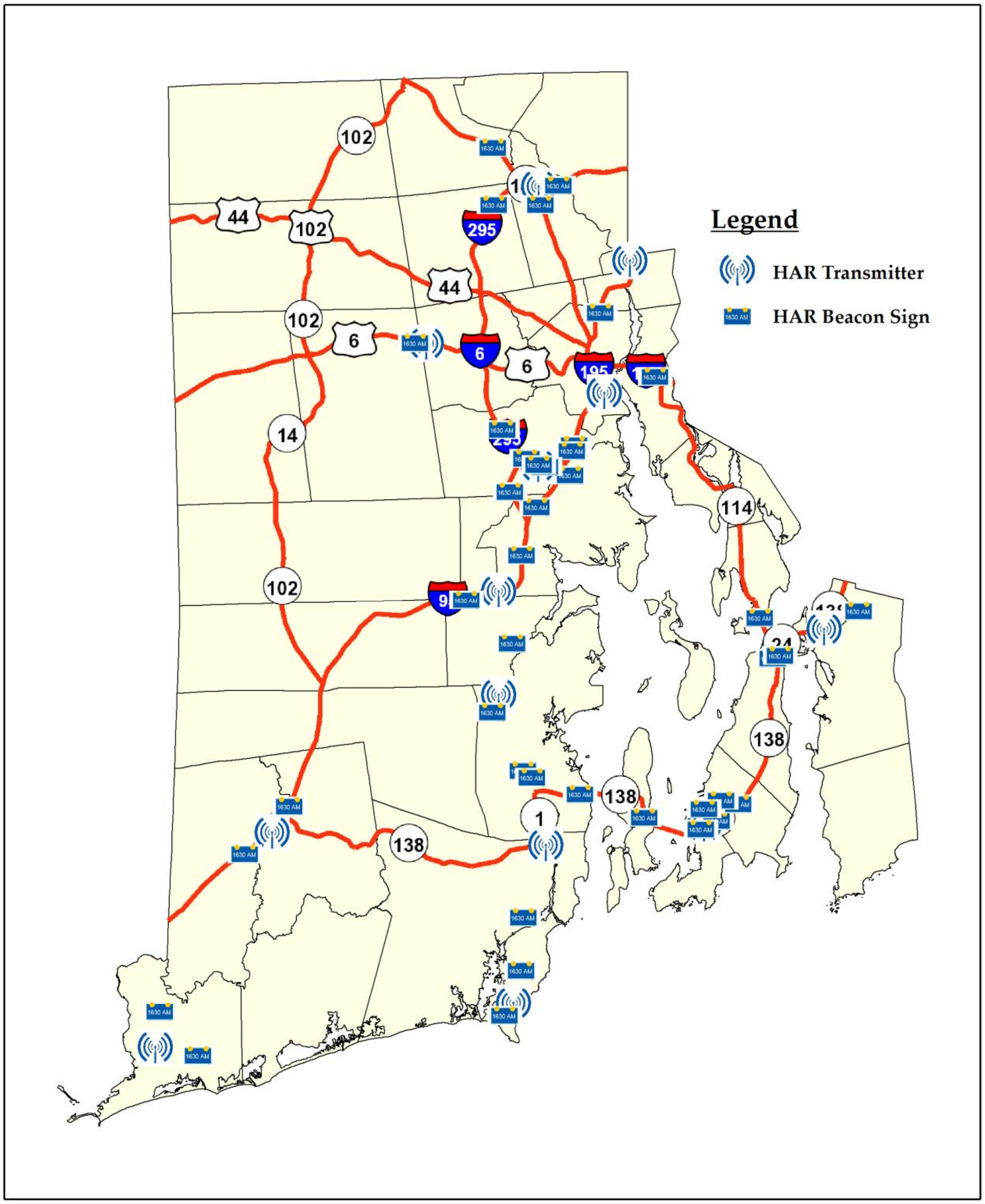


Figure 8: Current HAR Deployments

5.5 Roadway Data Collection Systems

Radar Vehicle Detectors	Current
TMC	71
Traffic Research Center	170
HERE/Navteq RVDs	63
Total	304

5.5.1 TMC Radar Vehicle Detectors (RVD)

Roadside-mounted radar vehicle detectors use overhead antenna to transmit microwave energy toward an area of the roadway. When a vehicle passes through the antenna beam, some of the energy is reflected back to a receiver, which allows software to determine vehicle data such as volume, speed, occupancy, and length (classification). The vehicle speed and subsequent traffic flow information is a critical part of RIDOT TMC's traffic management program, as this information is the primary source for the DOT's traffic related Performance Measures as well as travel time notifications on electronic signs and the DOT's web site. RIDOT has deployed approximately **71 RVD** on primary and secondary roads throughout the state. The traffic information sent back from the RVDs can also be used for early detection of incidents or congestion, through real-time analysis to track historical trends or user defined thresholds base on speed, volume, or occupancy.

5.5.2 Traffic Research RVD Sensors

The Traffic Research Section of RIDOT has **170** RVDs whose data is transmitted wirelessly to private contractor TrafInfo, who collects and packages the data into a format used by the Section's database. The radar data is used to measure vehicular counts and classifications.

In addition, in July of 2014, the RIDOT took ownership of **63** additional RVD sensors at **44** different locations from an agreement with HERE (formerly Navteq/Nokia who is the former Mobility Technology and the data source for Traffic.com). Under the terms of a MOU, HERE will continue to collect the data to their facility through July 31, 2016, by which time the DOT will need to have in place a method to bring the data into the DOT facility as discussed in the Deployment Recommendations section of this document.

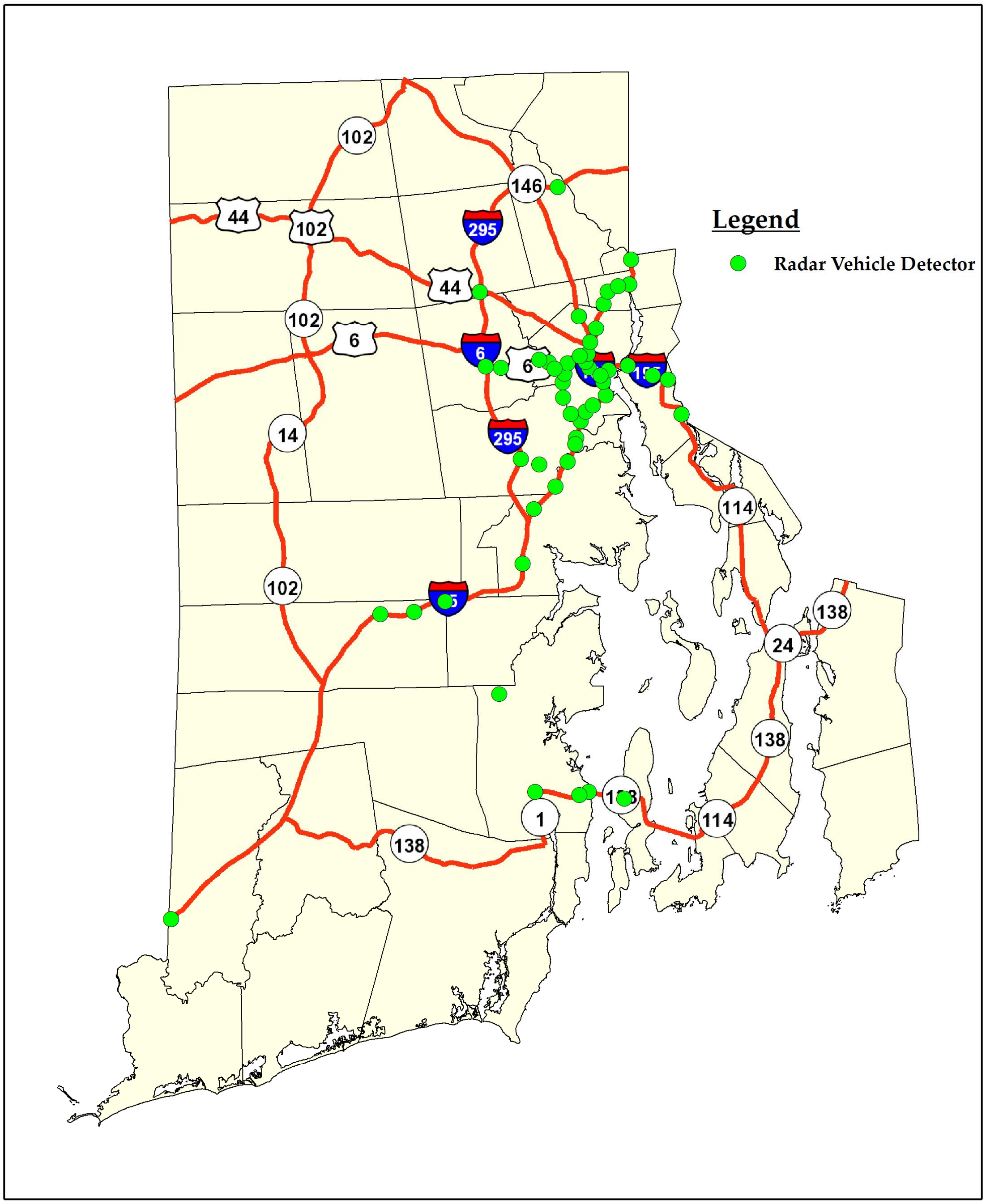


Figure 9: Current RVD Deployments

5.5.3 Conventional Count Stations and Sensors

Loop detectors are the most widely used technology for vehicle detection in the United States. A loop detector consists of one or more loops of wire embedded in the pavement which forms an inductive element in combination with a control box. When a vehicle passes over or rests on the loop, the inductance of the loop is reduced, causing vehicle detection. The technology of inductive loop detectors is well-established, and they generally have a well-defined and reliable zone of detection. However, loop detectors are very sensitive to the installation process and to any subsequent roadwork and they can only be installed in good pavement. RIDOT has maintained approximately **19 loop counters** on its primary roadways for vehicle volume recording.

5.5.4 Short Term Counters

RIDOT contracts out for short term counting to develop localized AADT for the Highway Performance Monitoring System (HPMS) at 500 to 1,000 locations per year. This is done to satisfy FHWA segment requests.

5.5.5 Road Weather Information System (RWIS)

A Road Weather Information System (RWIS) is comprised of Environmental Sensor Stations (ESS) in the field, a communication system for data transfer, and central systems to collect field data from numerous ESS. At RIDOT, each RWIS location is equipped with temperature sensor, precipitation sensor, atmospheric sensor, wind gauge and a camera. The data is collected at each station and transmitted to RIDOT vendor Vaisala via cell modem. RIDOT has access to the data through Vaisala's Navigator software. The system provides real time data and is part of RIDOT decision making toolkit for operation; especially winter operation.

There are **12 RWIS** locations statewide; RIDOT owns 10 RWIS devices and 2 are owned by the Rhode Island Turnpike and Bridge Authority (RITBA).

5.5.6 Weigh-in-Motion (WIM) Devices

In addition to capturing the same data as typical traffic data sensors (volume, classification, speed), weigh-in-motion (WIM) devices collect axle loadings, vehicle and axle configuration, and truck volume characteristics. When a vehicle passes over a WIM site, a sensor emits an analog signal whose strength is directly proportional to the axle weight of the vehicle, and the approximate weight of the vehicle is then recorded. Analysis of annual trends in the data can lead to a better understanding of truck fleet characteristics and truck weights as they change over time. Gross vehicle and axle weight monitoring is useful for a wide range of reasons, including pavement and bridge design/monitoring, size and weight enforcement, legislation requirements and future planning. RIDOT uses this information in producing the annual Traffic and Truck Flow Maps, as well as federally mandated annual reports such as the Truck Size and Weight Enforcement Plan and The Truck Size and Weight Certification. RIDOT has installed **15 WIM** devices.

5.5.7 Inrix and I-95 Corridor Coalition / VPP

The I-95 Corridor Coalition’s Vehicle Probe Project (VPP) enables member agencies to monitor and manage their transportation network, provide accurate traffic information to their users, and assess network performance. Ongoing since 2008, the project’s objective is to develop and maintain a corridor-wide traffic monitoring system to deliver travel times and speeds on freeways and arterials. The data is probe data that draws on a variety of sources such as mobile phone apps, truck and auto fleet data, GPSs, and other in-car computer systems. The VPP is committed to supporting all MAP-21 requirements once they are finalized by the federal government. Initially, the Coalition contracted solely with Inrix to provide the probe data, but they now provide a data marketplace where the DOT can select the probe data from one of three sources: Inrix, HERE, or TomTom. The VPP Suite of analysis tools can be used with any of the probe data sources.

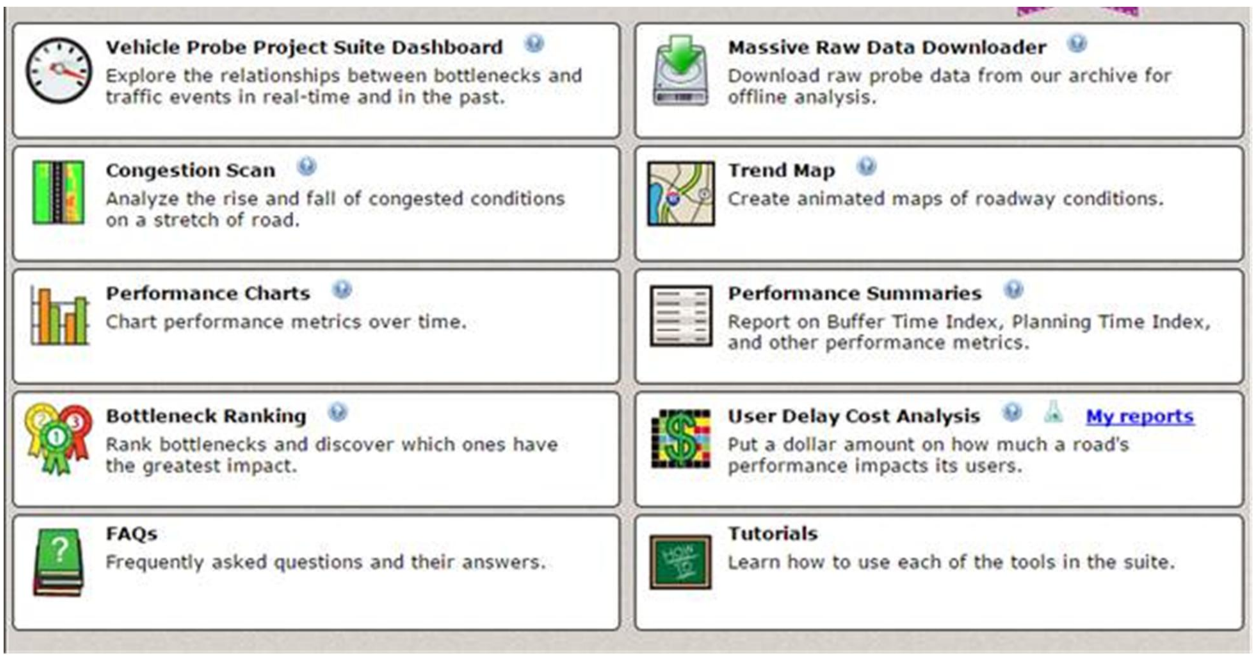


Figure 10: Inrix Suite Interface

The Suite is designed to be easily used by people of all skill levels. It is not just a tool for those with advanced knowledge and experience analyzing data. It’s made for ops personnel, planners, system administrators, managers, directors, and anyone else who has an interest in congestion data, both live and historical.

Funding

RIDOT originally gained access to Inrix data in July 2011 by virtue of its participation in the I-95 Corridor Coalition’s pooled fund study TPF-5(252), also known as the Vehicle Probe Project (VPP). Through this study, Inrix provides travel time information to the participating agencies. Funding is allocated yearly with approval from FHWA and submitted to the lead agency for the pooled fund study, the Maryland State Highway Administration.

The initial coverage area for RIDOT in the VPP was for 78 highway miles (encompassing the interstates and a few additional limited access highways). The fee paid to Inrix for this data was $58,500/year, of which the cost to RIDOT was 50%, or $29,250 per year.

In July of 2012, the VPP applied and received funding from the Multistate Corridor Operations and Management Program grant from the FHWA. With this grant funding, the VPP purchased the remaining 84 freeway miles and all arterials on RIDOT's behalf at a yearly rate of $93,375/year, with no increased cost to RIDOT. This arrangement continued through June 2014 with the help of additional grants.

Beginning in July 2014, the grant money was no longer available, so RIDOT took on the responsibility of continuing to fund access to its Inrix data. Beginning in January 2015, the University of Maryland began charging the VPP member states for access to its VPP suite of tools and RIDOT partnered with DOA Statewide Planning to fund its access to the VPP suite at a cost of approximately $146,000/year. The Inrix Data is an additional $117,023.50 per year, for a total cost of $263,023.50 per year. Both of these contracts are facilitated by the University of Maryland.

The Inrix/VPP agreement gives RIDOT the benefit of utilizing Inrix data on all covered roads for performance metric reporting, a dashboard for live and historical situation analysis, and travel times to display on DMS. Typically this data can supplement routes with low sensor density to improve travel time calculations or even provide full coverage to report travel times on segments that do not have any RIDOT-owned sensors. In addition to live traffic analysis and reporting, the VPP Suite has been very useful in analyzing congestion trends around the state. The VPP Suite's Bottleneck Ranking, Congestion Scan (heat map), and User Delay Cost tools could help with planning future transportation projects

To summarize Inrix and VPP costs as of 2015:

- VPP suite $146,000 per year
- Inrix Data $117,023.50 per year
- Total cost of $263,023.50 per year

Because of the magnitude of the costs for this service, the DOT has periodically revisited the need for this data. A separate cost / benefit analysis is being prepared just for this purpose that looks at the data requirements, the performance measurement requirements, the coverage area requirements, and the optional data sources. In summary, The RIDOT does not have the ITS infrastructure installed at this time to produce all the performance measures for all the roadways in the NHS that is expected to be in the FHWA rulemaking under MAP-21.

The DOT also does not have all the software tools required to create all of the performance measures that have been created to date without the VPP suite of tools. Should the final FHWA requirements be less than expected the data sources and coverage areas can be re-visited. Meanwhile, the ITS mainstreaming program strives to supplement the existing sensor infrastructure with the aim of reducing the DOT's reliance on external probe data. Also, the Office of Performance Management is working closely with AASHTO on Performance Measures recommendations to FHWA.

A survey in 2015 identified that the responding states use varying combinations of sensor, probe data, and Bluetooth data for travel time programs. The singular commonality to all those responding to the survey is that they all seek data for select roadways defined as significant corridors, major roadways, or metropolitan areas. The DOTs for OH, KY, FL, NH, ME, MA, MO and VT, and the PA Turnpike do not use probe data for state wide or NHS coverage at this time.

5.5.8 National Performance Management Research Data Set (NPMDRS)

FHWA has acquired a national data set of average travel times for use in performance measurement. This data set is being made available to States and Metropolitan Planning Organizations (MPOs) as a tool for performance measurement. The FHWA has contracted with HERE North America, LLC (formerly known as Nokia/NAVTEQ) to provide the National Performance Measure Research Data Set (NPMRDS).

Freight performance measures are a requirement of MAP-21. While not completely defined at this time, it is widely expected that the Federal Highway Administration (FHWA) will require the following two freight-related performance measures that were recommended by the AASHTO Annual Hours of Truck Delay, and Truck Reliability Index (RI80). The main data inputs to compute these two performance measures are truck travel times by time of day, and truck volumes.

At RIDOT, NPMRDS is used as the data source for truck travel times. The source for truck volumes is the RIDOT RVDs, WIM and continuous count stations appropriately configured to collect truck data.

The NPMRDS data set covers the National Highway System (NHS), which includes the interstates. The data set includes travel time for all vehicles, passenger vehicles and trucks on each segment for each 5-minute interval. This data set is typically packaged monthly.

In 2014 a review of the NPMRDS data by TrafInfo indicated significant limitations or gaps in the data set. The review found that more than 95% of the segments have data for only about 9 days in a month. The review also found that for each 5-minute interval, travel times will be missing in about 30-50% of the segments. Due to significant missing data, the processing of the NPMRDS requires estimation of travel times on several segments for several 5-minute time intervals.

The truck travel times extracted from the NPMRDS is generated for each of the following interstate segments:

- I-95 from CT State Line to Route 4
- I-95 from Route 4 to Providence (Exit 22)
- I-95 Providence (Exit 22) to Mass State Line
- I-195 from I-95 to Mass State Line
- I-295 from I-95 to Route 6
- I-295 from Route 6 to Mass State Line

5.6 Wrong Way Driver Detection System

A Wrong-Way Mitigation Project has been developed within RIDOT with the goal of upgrading the signing and striping at limited access off-ramps in the state of Rhode Island. As part of this effort, The RI Department of Transportation and the RI State Police identified 24 urban locations with a history of wrong-way drivers and/or geometry conducive to wrong-way driving. At these locations RIDOT installed flashing Wrong-Way warning signs triggered by a combination dual direction radar and video camera to detect and verify that a vehicle is travelling in the wrong direction. Once triggered, the camera sends a photo confirmation of the wrong-way driver to all persons on the pre-determined e-mail notification list for that particular site. Also included in the system is access to a web-based traffic device monitor and control site, which can be accessed from any web-enabled computer. This website allows remote monitoring of the battery, cellular status, and detection triggers as well as control of the flashing LEDs, event programming, and alerts for those with administration privileges.

5.7 Adaptive Signal Control (ASC)

Poor traffic signal timing contributes to traffic congestion and delay. Conventional signal systems use pre–programmed, daily signal timing schedules. Adaptive signal control technology adjusts the timing of red, yellow and green lights to accommodate changing traffic patterns and ease traffic congestion. The main benefits of adaptive signal control technology over conventional signal systems are that it can:

- Continuously distribute green light time equitably for all traffic movements.
- Improve travel time reliability by progressively moving vehicles through green lights.
- Reduce congestion by creating smoother flow.

- Prolong the effectiveness of traffic signal timing[7]

The opportunity to try an Adaptive Signal Control (ASC) system was identified by FHWA-RI during a recent Roadway Safety Assessment along Airport Road, a corridor that is currently congested during peak travel periods, which contributes to vehicular crashes. An ASC system, which uses an advanced algorithm to adjust traffic signal timings in near-real time, may help reduce the congestion and resulting crashes. RIDOT's role has been and will continue to be to oversee and approve of the RIAC's Designer's selection of a qualified ASC system Vendor as well as the Vendor's subsequent design, implementation, operation, management, and maintenance of the ASC system for the trial (Pilot) period of 3 years. After that time, RIDOT will be fully responsible for the operations and maintenance of the ASC system, should it be successful and deemed worthy of continued operation (i.e., the performance of the ASC system is shown to provide cost-effective benefits, as hoped at the outset).

While the primary goals of the ASC project at Airport Road are to reduce congestion and resulting crashes, a secondary goal is for RIDOT to learn from the performance metrics/data acquired and reported by the pilot ASC system - both to help us see how we can better monitor all of our traffic signals' performance, and also to help us decide which 'System Reliability' PM's are best suited for our own use in RI, for MAP-21 compliance.

5.8 Closed Loop Traffic Control Systems

New technology, such as traffic-responsive closed-loop systems or adaptive traffic signal systems using advanced surveillance and traffic management centers, will become increasingly critical for city, county, and state organizations to meet transportation needs. Closed loop systems are becoming the preferred method of operating coordinated traffic signal systems. Some of the benefits of a closed loop system include remote controller access, synchronization of controller time clocks, and orderly transition between coordination plans. With ensured time clock synchronization, the coordination of traffic signals becomes more reliable, which leads to optimal vehicle progression through the system.

Such systems depend heavily on field infrastructures such as vehicle detection, distributed microprocessor-based control systems, and near real-time interaction over diverse communication media.

[7] FHWA website: http://www.fhwa.dot.gov/everydaycounts/technology/adsc/

6 Current ITS Supporting Systems

This section describes the current systems in place to support existing ITS devices in the field and the goals of RIDOT including the RhodeWAYS Database, communication systems such as fiber and wireless as well as asset management.

6.1 RhodeWAYS Database

The RhodeWAYS database is the central repository for recording incident and equipment data. The TMC Operators enter information into the RhodeWAYS database through a custom designed, user-friendly, web-based application. This data is then shared with other systems.

6.1.1 Data Integration and Management

The data that is collected and stored in the RhodeWAYS database is being utilized by other systems, such as CARS 511, the RIDOT legal department, and the RIDOT website. Using an XML feed, the RhodeWAYS data is being provided to the CARS 511 system. Also, an XML feed to provide data to the I-95 Corridor Coalition is currently under development. The RhodeWAYS data is shared with the RIDOT legal department via SQL "views," which allow the legal department to query the database as necessary. Furthermore, the RhodeWAYS data has been integrated into the RIDOT website. The data from RhodeWAYS provides the current incident information and the HAR data to the website.

Conversely, the RIDOT GIS data has been integrated into the RhodeWAYS. This allows the operators to select location information from a list of roadways, exits and cross streets that have been standardized by the RIDOT GIS department. Also, this GIS information has been used to develop the RhodeWAYS map. Integrating the RIDOT GIS data allows the TMC operators to use the same location information for various platforms, including Vueworks.

6.1.2 Current Data Management

Currently the RhodeWAYS application is used to manage data for incidents, equipment, trouble tickets, contacts, and vendors. A user with the appropriate login privileges can search the data or access data through reports, such as the SQL reports that are in RhodeWAYS. SQL Server 2008 R2 serves as the back-end to the central RhodeWAYS database. The other development tools used for the RhodeWAYS application include ESRI ArcGIS Server 10.1 and Microsoft .NET and web development technology.

6.1.3 Data Archival & Retrieval Standards

All incident and event information from the original Access VBA project was imported into the current RhodeWAYS system; therefore, the RhodeWAYS database contains all recorded incident and event information from 1999 to the present. Additionally, in 2009 the dispatch calls were incorporated into the RhodeWAYS, so the database contains dispatch calls from 2009 until 2013.

The RhodeWAYS data archival and retrieval is currently managed by RIDOT DoIT; therefore the procedure should adhere to RIDOT standards. A full database backup is performed on a daily basis. Also, every six (6) hours a transactional backup is provided to ensure that no more than three (3) hours of data would be lost in the event of a catastrophe.

6.1.4 Data Standards

The RhodeWAYS system has evolved from RIDOT's legacy incident and dispatch databases. Through enhancements, the data collected in the RhodeWAYS has started to more closely comply with the Traffic Management Data Dictionary (TMDD) standards. Although TMDD was used as a reference, the standard was not strictly followed because the RIDOT TMC dictated how the data should be recorded and stored.

The TMDD is a guideline for incident data collection and reporting. It also outlines several schemas for the creation of XML feeds. In order to share data with different entities required that the data from the RhodeWAYS database was mapped to specific TMDD standards as closely as possible. For the CARS 511 data integration, the RhodeWAYS data had to comply with a modified version of TMDD v.2.0. Also, for the I-95 Corridor Coalition XML, the RhodeWAYS data needs to comply with TMDD v.3.0.

6.2 Communications Systems

6.2.1 Fiber Optic Network

The State currently utilizes fiber optic cable to create closed loop systems to connect traffic signal systems that then come back to the DOT over leased lines provided by COX or Verizon. The State owns 24 strands of fiber optic cable that is on Rte. 146 and I-295 and connect directly back to the TMC. This has considerable potential to bring back additional existing ITS equipment and support future ITS equipment. The following describes the physical topology of the current fiber optic cable network:

- Level 3 Fiber: Rte. 14/I-295/Rte. 44 – 24 strands of fiber that run from the TMC up Rte. 146 to I-295. The fiber continues to run north up I-295 to the Massachusetts Stateline and south to Rte. 44. At Rte. 44 it run south back to the TMC and west to the Connecticut Stateline.
    - This fiber currently supports 2 CCTV Traffic Cameras.
- I-Way Fiber Optic Ring – 72 strands of fiber that run from I-95 at Broadways St to I-95 at Public, and across I-195 to the beginning of the Washington Bridge.
    - Currently support 8 CCTV Traffic Cameras, 2 Dynamic Message Signs, and 11 Radar Vehicle Detectors.
    - Connects back to the TMC at 2 Capitol Hill via a 20 Meg COX circuit.

    - Current projects will support the expansion of this fiber optic network which shall bring the fiber back to 2 Capitol Hill.
        - The Viaduct project shall extend the fiber from the I-95 Broadway location up I-95 to Orms Street.
        - The South Main Street project shall extend the fiber optic cable from the I-195 India St location up South Main Street to Smith Street.
- North Main St Arterial Improvements – 72 strands of fiber that runs from Orms Street to Charles Street, across the Randall Street Bridge then up North Main Street to White Street.
    - Currently supports 2 CCTV Traffic Cameras, and 11 traffic controllers.
    - Fiber connects all the way back to DOA building where the strands 1-24 connects to strands 1-24 of 120 strands fiber optic cable that runs all the way to the TMC.
- Elmwood Ave Fiber Optic Ring – 72 Strand fiber optic cable that runs from Park Avenue north to W. Franklin Street.
    - Currently brings back 2 CCTV Traffic Cameras and multiple traffic controllers.
    - Current contract 3 will tie the fiber optic cable into the I-Way and bring all ITS equipment back over the existing 20 Meg COX circuit.
- Middletown/Portsmouth Fiber Optic Ring - 72 Strand fiber optic cable that runs from Oakwood Road on Rte. 114 north to the Rte. 24 split.
    - Currently brings back 1 CCTV Traffic Cameras and multiple traffic controllers.
    - Future contract (Two Mile Corner) will install on E. Main Road and connect to this existing fiber on Rte. 114.

6.2.2 Wireless Communications

Currently RIDOT utilizes commercial wireless communications to reach ITS devices to which fiber optic or copper cable facilities are not available. There are monthly fees associated with these connections commensurate with the amount of data usage such as is incurred with private mobile phone usage. This type of service is typically only used where the bandwidth requirements are low so that the service costs are low, or when there are no other options.

Currently RIDOT leases the majority of wireless 3G/4G services from Verizon Wireless.

- 6 HAR Transmitter locations

- 1 DMS location
- The Smart LED Lighting test project
- And all portable variable message signs

The TMC has also deployed several point-to-point wireless connections to consolidate the communications services for multiple devices to a single leased line service, rather than one lease line for each device as was done previously. An example of this is the Tiverton HAR and camera located on Rte. 24.

6.2.3 Internal TMC Network

The TMC has its own internal network that supports direct connections to various ITS equipment through a combination of owned and leased lines with Verizon and COX Communication. For State resources the TMC connects to the DOT router on the 3rd floor that allows the TMC access to resources such as e-mail, files services, and access to the internet.

TMC Core Network Equipment

- Two Cisco 7507 routers – Support all the leased serial connections through Verizon that connect to all the field sites brought back of T-1
- Two Cisco 3750x layer 3 switches – Provide the core networking for all TMC servers and workstations. Considered the edge equipment that tie to the DOT/State network and resources.
    - Utilizes 1 Gigabit and 10 Gigabit speeds.
- Cisco ASA 5520
    - Utilized to allow public sharing partners to connect to the TMC and connect to the Video Management System to stream live traffic cameras.

Network Field Equipment

- A combination of Cisco 1841/2610 routers and various Ethernet switches.

6.2.4 State Beacon 2.0 Network

OSHEAN, Inc. is an Internet service provider. OSHEAN stands for “Ocean State Higher Education Economic Development and Administrative Network”. Since 1999, OSHEAN has installed more than 500 fiber-optic miles in the region and has enabled more than 125 local institutions to provide research, improved health care services, classroom instruction and life-safety upgrades. OSHEAN manages and maintains a nonprofit network called Beacon 2.0.

The Beacon 2.0 project installed over 450 miles of fiber optic cable to provide Rhode Island's medical, educational, and other important institutions with a high-capacity broadband network. Beacon 2.0 was funded with a $21.7 million federal stimulus grant and $10.7 million in private funds. This was accomplished by a Rhode Island congressional delegation that spearheaded the 3-year federal initiative under a program entitled the Broadband Technology Opportunities Program (BTOP). The Rhode Island Division of Information Technology (DoIT) is a member of the OSHEAN consortium.

While the DOT does not use the Beacon 2.0 network directly for ITS purposes, it is mentioned in this strategic plan as a potential opportunity in the future. While the Beacon 2.0 network has fiber optic cable assets in areas that could be utilized by the RIDOT, there is a cost associated with it. As of this date, the RIDOT has sought to reduce leased services and will seek to deploy ITS devices on RIDOT owned resources.

6.3 Asset Management System (Vueworks)

Vueworks software is the RIDOT's asset management and work order tracking system. In the past few years, RIDOT has faced increasing pressure to reliably and accurately track its performance. It is anticipated that future federal and state funding allocations will be based on the productivity, work load, and relative value of the various DOT sections. Faced with the need to more accurately track its work, and produce reports more frequently and on shorter notice, the DOT sought to unify its efforts under a new common work order system. After an extensive evaluation, Vueworks was chosen based on its compatibility and support of GIS architecture.

Over the past few years, representatives from several RIDOT sections have worked to purchase, configure, and deploy the Vueworks software department-wide, with many more enhancements planned in the future. The first step was to inventory the many data sources available (such as RhodeWAYS, the Bridge Management system, the Project Management System, E-911's address database, Human Resources' Oracle system, etc.) and build interfaces between those sources and GIS. Many data sources such as the traffic signal and sign inventories were stored in Excel and Access databases and needed to be converted to a more reliable SQL database. Some of this work is ongoing, and RhodeWAYS has been identified as a robust database that can be used for storing additional traffic devices beyond those used by the TMC.

Once the data is in GIS, the Vueworks system overlays GIS and can assign and track service requests and work orders related to any asset contained in the GIS. The Vueworks committee then worked with individual sections to diagram their workflows and see how they could best utilize the Vueworks system. A great deal of effort has been expended to simplify and streamline these processes to eliminate duplication of effort, reduce paperwork, and refine communication procedures. For instance, the Vueworks system allows for customized auto-notification based on the type and severity of the issue to reduce the need for phone calls or separate emails. Work order lists are now automatically generated for employees instead of a clerk needing to manually gather the requests and assign them to workers.

While much work has been done, much more remains. Planned deployment of ESRI's Roads & Highways will allow for more accurate cataloging of assets and work on the highways. Planned improvements of Vueworks include mobile device support and field access so that work orders can be assigned and updated in the field, where the majority of work is done. So far the users of the system have been mainly customer service, the TMC, and the highway maintenance workers, but there are plans to bring the Construction and Design sections onboard so that their operations can be more closely tied to the maintenance condition of the roadways.

7 RIDOT ITS Needs Assessment

While the challenges and requirements mentioned previously warrant deployment of ITS devices, RIDOT takes a methodical approach to identifying areas of need for the proposed ITS Strategic Network. In addition, any TIP and Project Guide criteria may be considered a guide for ITS Needs Assessment.

The contributors and stakeholders of the Strategic Plan have identified the following needs from which the basis of deployment recommendations and criteria cited later were derived:

- **RIDOT's and the TMC's Mission Statement** - ITS equipment deployments shall support RIDOT and the TMC's goals, which are to improve safety, operations, maintenance and cost effectiveness as well as incident and congestion management while meeting FHWA mandates and data requirements.
- **Operational requirements of the TMC -** ITS deployments must support the ability of TMC operators to carry out their daily activities as effectively as possible. The camera type must be selected and its installed location must be deployed strategically to identify and manage incidents day or night. Similarly, communications device and methods, as well as ITS management software must be carefully selected to offer reliable and capable performance.
- **Adherence to Design and Protocol Standards -** The TMC has developed an ITS Design Guide which describes RIDOT CAD standards for ITS, and contains a library of Standard Specifications and Detail Plan sheets for ITS devices, cabinets, and structures. New ITS Deployments shall refer to these standards or update them as required. All ITS deployments must consider compatibility with existing software and communications protocols. For this reason standard protocols are used and Commercial off the Shelf (COTS) software is used whenever possible.
- **Safety and Accessibility** - The equipment recommendation locations shall take into account the topography, traffic engineering and physical attributes of the road such as the height and slope, as well as road access to allow for safe access to the ITS devices and associated cabinet, communications and power utilities.
- **Minimize Impacts upon Traffic Flow** - The recommendation locations for devices shall minimize the impact upon traffic flow during operations such as a DMS placement in clear view of a driver and the DMS cabinet in clear view of the sign for maintenance testing. The devices were also located in a place to decrease lane closures during construction and maintenance.
- **Leverage Existing Power and Communications Networks** - Recommendations shall leverage existing power and communications networks when proposing equipment locations and communications designs. Locating closer to existing

utilities decreases the cost and need to install new equipment. Consolidating communications of several devices is often the most economical method.

- **Employ Economies of Scale** - Recommendations shall strive to co-locate ITS devices where possible to reduce construction and maintenance costs. Co-location helps consolidate power and communication need for devices at the time of deployment as well as during maintenance activities.
- **Provide Communications Resiliency** - Fiber optic cable networks are commonly deployed so as to allow for diverse paths of communications to critical facilities and instrumentation. The network equipment attached to the fiber cable can detect failures such as an unplugged patch chord, or a damaged cable, and automatically fail over to the backup fiber cable path. This ensures system resiliency and higher equipment availability to the TMC and operations.
- **Reduce Energy Consumption –** Some devices have the option of using utility company power or using a solar power and battery solution if the device power requirements are low enough and the solar panels can be arranged with a clear view of the southern sky. Currently manufacturers are working to decrease the power requirements of large devices such as message boards which allows for more solar supported projects. The location of the device for should take into account the seasonal location of the sun, trees and battery types, as well as potential security such as a fence or anti-theft device for solar batteries.
- **Consistency** - Consistent designs, cabinet layout, approach to purchasing upgrades and replacements can allow for easier upfront purchases and later for maintenance and troubleshooting. The Deployment Plan device type and placement is consistent with current deployment practices as well as throughout the recommendations for ease of maintenance and for economy of scales when RIDOT purchases large orders of equipment.

7.1 Traffic Congestion

New ITS deployments shall seek to support congestion identification and management.

Modern research has identified that commuters come to expect congestion on certain roads at certain times. Commuters can plan on their travel times based on their commuting experiences even with recurring congestion. Non-recurring, unexpected congestion causes more hardship for commuters because it cannot be planned for and avoided. RIDOT uses roadway sensors and third party data to identify road segments with both high recurring and non-recurring congestion. See Figure 11 Sample Congestion Map for RI for a representative map of the monthly average congestion on RIDOT roadways at 4:00PM during a weekday.

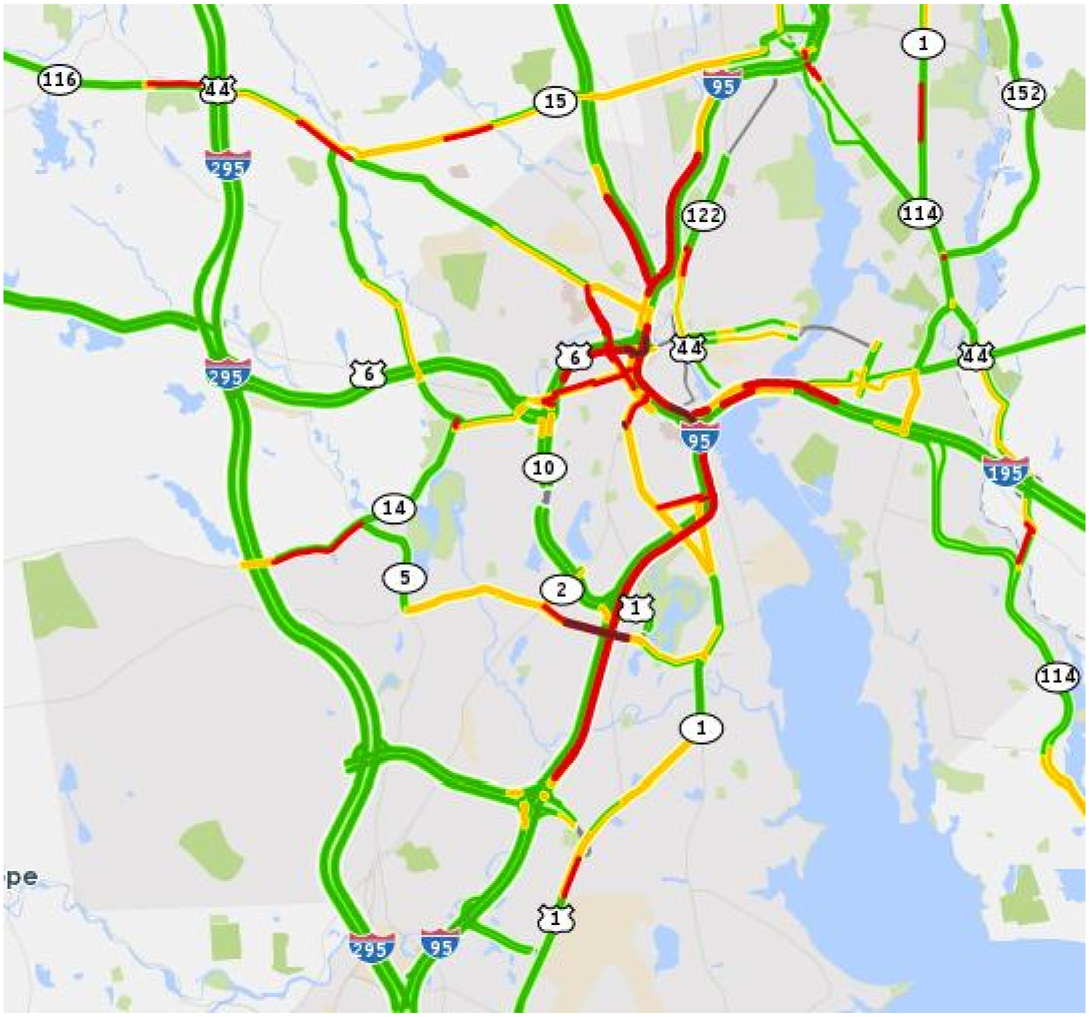


Figure 11 Sample Congestion Map for RI

Recurring congestion is a limitation of capacity and so FHWA has determined *non-recurring* congestion needs to be the focus of DOT's attention. Non-recurring congestion is measured and defined as **Travel Time Reliability**.

Non-reliable segments are focus areas for ITS devices which can define the causes and can assist in reducing congestion. ITS can also measure the effectiveness of remediation efforts. As an example, increased travel time signs prior to the areas of congestion can alert motorists to take alternate routes. Note that ITS may be best deployed on an entirely different road than the problem area, such as prior to areas of congestion.

7.2 Bottlenecks

New ITS deployments shall seek to support incident response and congestion management at recurring bottleneck locations.

Bottlenecks can be determined using the same devices and methods used to detect and measure congestion. The MPO uses bottleneck rankings as a key component to the statewide planning program. Bottlenecks are ranked by considering the length, duration, and frequency of the queue and can be normalized with traffic volume data.

7.3 High Crash Locations

New ITS deployments shall seek to support incident response and congestion management at high crash locations.

The TMC receives crash reports from the state police. The TMC records incidents, which may include a crash. In early 2014, the TMC began to assign latitude and longitude to incidents, where previously operators had to select a roadway and the nearest cross street. This new development, which highlights the importance of advancing the computer systems and software tools for the TMC Operations, allows the RIDOT to more accurately locate crashes, which will greatly assist in traffic safety designs.

7.4 Traveler Information

New ITS deployments shall supplement the current Travel Time Device Network to reach a large audience, provide drivers with alternative routes, promote use of transit systems, as well as travel times that assist in reduced congestion through trip planning. Electronic signs such as DMS and VMS are deployed to provide traveler information such as notification of incidents ahead, planned events. There is an active Travel Time Program managed by RIDOT.

7.5 Federal Data Collection Requirements

New ITS deployments shall ensure that data collection devices such as traffic sensors, WIM, and RWIS shall meet the federal data collection requirements of the USDOT.

7.6 TMC Integration Requirements

New ITS devices shall meet TMC network security requirements as well as operate with the existing software if possible.

8 ITS Deployment Methodology & Criteria

This section describes the general design deployment criteria when deploying new ITS. The design criteria act as a starting point to meet the needs assessment for Rhode Island. From the initial design criteria, each design is tailored to the location, type of device, budgetary constraints, and available technologies in the market and then a back check to ensure the deployment helps meet the goals of RIDOT and USDOT.

Due to the RIDOT/TMC mission, areas of congestion, bottlenecks, and crashes, and travel time program as summarized in the Needs Assessment, the Plan recommends 100% video, traffic sensor and DMS coverage for Interstates 95, 195, and 295. Interstate 95 is a major freight corridor for all of the Eastern seaboard. Interstates 295 and 195 surround the Providence Metro Area providing primary and alternate freight and public routes. In addition, this plan recommends deploying ITS on other state routes that experience heavy freight traffic, seasonal congestion and commuter bottlenecks such as Route 146, Route 6 and 10, Route 24, Route 78, and Route 403.

The deployment strategy considers that devices will be deployed within the context of a typical high speed, limited access highway. Routes that are covered under this strategy include: I-95, I-295, I-195, RT 146, RT 78, RT 37, RT 24, RT 4, RT 6 and 10, RT 403.

The Rhode Island travel time program requires increased RVD locations to fill in gaps and to comply with Section 1201 - Real Time System Management Information Program (RTSMIP). Increasing RVD coverage also reduces the RIDOT's dependence on costly third party data for compliance with system performance measures.

8.1 Roadway Cameras

Roadway cameras (cameras) provide the greatest benefit to the TMC Operations because of their ability to provide a visual confirmation of incidents and conditions that could lead to incidents, thus being the greatest tool in engaging response plans, and providing information that alleviates congestion and secondary incidents. With this knowledge, the goal for deploying roadway cameras is to have 100% coverage for all major Interstates and other freeways, and to cover areas of recurring bottlenecks, congestion and crashes. Design/deployment criteria include:

- Cameras will be located at approximately a 3-6,000 foot separation, depending on the geographic layout of the roadway
- The standard Camera installation shall be on a 40'-80' camera pole (Steel w/ foundation or Concrete/ direct buried) depending on location and elevation.
- Each Camera location shall have an ITS equipment independent power connection.

8.2 Radar Vehicle Detection (RVD)

The primary strategy of deploying RVD is to alleviate dependency on third party leased data services for traveler information to satisfy the DOT's Performance Measures and traveler information requirements. RVD's shall be located to fill in missing data gaps in a judicious manner to reach a minimum coverage. In addition, an integration strategy should be planned to integrate the existing sensors used by the Traffic Research department into the TMC's travel time database. Some of these sites would need upgrades to the latest generation RVD to provide the required data.

The criteria for Radar Vehicle Detection (RVD) Units shall consist of installing at approximately a 1,500 foot separation. Also:

- o RVD's may be stand-alone installations or co-located with Cameras or other ITS devices
- o Each RVD stand-along installation shall be on a 30'-40' pole (Steel w/ foundation or Concrete/ direct buried)
- o Each RVD location shall have an ITS equipment independent power connection.

8.3 Dynamic Message Signs (DMS)

Dynamic Message Signs (DMS) are deployed to provide traveler information to the motoring public in the form of traffic condition notifications, alternate travel routes, emergency notifications and travel times to a destination. Design considerations for DMS include:

- Deployment locations shall consider the geographic road constraints and visibility.
- DMS structures may be of various sizes and construction styles to best suit the application, the need for sign visibility, the sign size, and the application. Sign structures may span the roadway to allow DMS deployments for both directions of traffic flow, or may be positioned for a roadside mounted DMS.
- Each DMS location shall have its own separate power connection.
- For limited access roadways, signs should ideally be installed with a minimum of 4,500 hundred feet line of sight so that messages can be seen and read in a reasonable amount of time.

While understanding the benefits of Dynamic Message Signs, the RIDOT recognizes that signs must be deployed with a consciousness of the environment and to minimize visual clutter or obstruction. To help offset these concerns, several approaches can be taken when considering new DMS installations. The primary consideration of locating a DMS is visibility**,** it is not recommended to locate a new DMS in close proximity to an existing overpass or overhead sign structure. The design shall allow for a minimum of 4,500 hundred feet approach so message can be seen and read in a reasonable amount of time. This requirement is especially important for a structure that would have a full span of the highway.

The introduction of the LED DMS has made the LED pixel spacing smaller (pixels closer together), reducing the size of the sign for the same number of characters. This allows for alternatives to traditional road spanning overhead sign structures, such as cantilevered monopole, center mount monopole, and butterfly installations. Some of these structures allow for a similar size sign to place at roadside, decreasing the visual space occupied. An added benefit of these alternatives is that it is easier to determine a suitable location due to utilizing only one side of the roadway.

Additionally, as sign controller electronics and communications equipment get smaller the need for large ground mounted cabinets are no longer necessary. The smaller cabinets can be mounted to the DMS structure itself which will lessen the systems overall footprint.

8.4 **Fiber Optic Communications Network**

RIDOT currently relies on DOT installed fiber optic cable as well as leased wireless services from private providers. For communication deployments, each device location shall compare the benefits of RIDOT owned fiber optic cable (such as security and lower long-term operating costs), to the benefits of leased lines (such as flexibility and low deployment cost). This report recommends utilizing existing fiber optic cable when possible. For example, the fiber optic cable between TMC and DOA may be used to create a dedicated high bandwidth connection. This connection will reduce/eliminate reliance on DOT network to access Vueworks and cloud based applications such as CARS 511.

The final installation that will complete the “System” shall be the installation of a primary Conduit Duct System with a designated Backbone Fiber which will connect all ITS devices.

- The backbone Fiber shall be “Outside Plant, 72 strand Single Mode (SM)” (unless otherwise specified) of various fiber stand designations.
- All devices will be connected to the Backbone Fiber by a SM fiber Drop Cable spliced into the Backbone Cable.
- Each location to be spliced into the Backbone Cable will require an additional hand hole, splice closure and fusion splicing.
- The installation of the “System” may be accomplished by applying construction Phases or Levels of construction.
    - These Phases or Levels may be implemented at varying times over a period of time so a Complete System Installation may be accomplished.

- o Installing a Complete System this will eliminate reoccurring communication costs but a level of Maintenance must be maintained by the DOT or Agency

8.5 Bluetooth and Cellular

Bluetooth is a standard short range radio link intended to replace the cable connecting portable and/or fixed electronic devices. This approach involves the installation of Bluetooth receivers and antennae at various locations along an interstate to detect various mobile devices as they are traveling on the interstate. This is accomplished by the Bluetooth readers' ability to read the MAC address of a device that is turned on. Media Access Control (MAC) addresses are unique 48-bit addresses that are assigned by manufacturers of consumer electronic wireless devices such as cell/smart phones, hands-free headsets, MP3 players, and in-vehicle navigation/entertainment systems.

An important element of this type technology is the use of GPS to ensure accurate measurement of distances between successive collection points. Another important consideration is that of privacy – unlike toll tags, there is no traceable relationship between the device's MAC address and the owner/user of the device. Bluetooth receivers and central processing software are available from a number of vendors. Bluetooth based travel time measurements are being used as the baselines by the I-95 Corridor Coalition for the ongoing evaluation of INRIX data along both freeways and arterials. There are now devices that are sold off the shelf with Bluetooth and cellular signal capabilities to increase penetration and accuracy of the resulting travel time calculations.

8.6 Variable Message Signs (VMS)

The intended use of VMS are for temporary portable deployment such as for construction zones, long term incident response, and for special events. VMS are installed on trailers with wheels and typically have solar panels and mobile communications, so that they can act as stand-alone devices. They also have a controller that can be programmed locally (as an option).

In the past, the RIDOT had deployed some VMS in a semi-permanent manner, placing them on concrete slabs. However, each winter, the shortened daylight and cold weather causes extreme duress on the solar charging systems and constant maintenance has been needed. For this reason, the semi-permanent units are being replaced with utility company powered ground mounted DMS.

In the future, there will still be a need for portable units, in particular for construction work zones. The portables are stored at the local maintenance deport when not needed and deployed as required.

8.7 Highway Advisory Radio (HAR)

The Highway Advisory is one component of RIDOT's Traveler Information System. It is used to alert drivers of critical traffic and roadway conditions, incidents, and emergency and evacuation information.

While emerging technologies are supplementing the traveler information area, such as mobile applications and the potential of connected vehicles is on the horizon, these technologies are not pervasive as yet and the HAR still provides a major component to disseminate traveler information. For this reason RIDOT's short and long term strategies for HAR are different and are expected to change over time.

For the near term, the HAR is seen as a viable and valuable system. For the long term planning it is expected that the HAR will slowly lose this value over time to the point where it may be obsolete in the 10 to 20 year time frame. With this consideration, the ITS strategy is to maintain the existing HAR equipment, but not to invest in an increased deployment strategy with the exception of one critical location. Instead, the near term strategy is to repair and or replace critical locations and to remove non-critical locations.

For example, the HAR transmitters have greater value where DMS and other means are not available, before critical decision points, and at coastal locations. The first two coincidentally occur in the same locations – that being at entry points into the state via I-95 from Connecticut, and Rt 146 / I 295 from Massachusetts. Coastal locations have a unique priority in their use as evacuation routes and congestion diversion instructions.

There is one recommended new location on I-95 North near the Connecticut State Line, and a replacement recommended and I-95 South at Exit 5.

Conversely, the HAR in downtown Providence is seen as having a decreased effectiveness due to the proximity of quantity of DMS. For this reason, our recommendation is to surplus this transmitter and the four associated beacon signs, and use the surplus to maintain more critical locations.

8.8 Road Weather Information Stations (RWIS) Recommendations

The RWIS recommendations described in this report were written as a result of conversations with RIDOT Operations. The RWIS devices are not included in the ITS Deployment Recommendations, as they will not come from the assumed $5M annual budget. However, in the future the TMC and multistate weather information sharing should be considered to improve operations and increase safety.

RIDOT Operations is continually looking to incorporate additional RWIS sites throughout the State. Operations are planning to update the stations with new technology as existing equipment are obsolete or malfunction. RIDOT is currently replacing existing pavement sensors with non-invasive laser sensors. The data can be shared with neighboring states.

RIDOT Operations recommends increasing RWIS coverage by deploying additional RWIS on southern I-95, central I-295 and near the Charlestown or Narragansett area. Each new device is approximately $50,000 to deploy. RIDOT Operations try to incorporate new device deployment with existing construction contracts, like the ITS Mainstreaming Process.

In addition, RIDOT Operations are looking into thermal mapping through their existing RWIS vendor Vaisala. The vendor would provide cars to drive the road to get a baseline to help improve forecast models. RIDOT Operations is interested in using this for the Providence metro area. Currently Connecticut, Massachusetts and New Hampshire utilize the Vaisala system and share data. There is no formal sharing agreement between the states but there is an aspiration to develop an agreement RIDOT Operations can utilize their Navigator map tool to zoom out and visit the other state RWIS devices and information.

9 ITS Deployment Recommendations

This section describes the recommended ITS deployments for the Rhode Island DOT. Interstates, other freeways and major arterials were assessed individually based on the ITS Needs Assessment presented earlier in this report. Each roadway corridor was broken into segments that could relate to manageable construction projects.

Each sub-section begins with an overview and graphic to illustrate the proposed devices and communications of the entire corridor and total cost for all segments along the corridor. This is followed by a segment by segment description, device location graphic, and cost table for each segment.

Cost estimates for each device are site specific. All costs are budgetary installed costs and include structures, associated control cabinets, and electrical and communications connectivity. All conduits and cables are budgetary installed costs and include hand holes, splice points and enclosures as necessary. For existing equipment such as CCTV, a cost may be shown for upgrading existing devices to the proposed communications network. For new equipment like a CCTV, the cost represents the capital cost of the CCTV, CCTV cameras, poles, lowering devices, lighting dissipaters and shared power with new RVD's; the cost that is shown on the recommendations cost table is for power that is shared 50/50 with the RVD's.

Table 7: Summary of ITS Deployment Recommendations

Equipment	Current	Proposed	Total
Cameras (CCTV)	130	105	235
VMS	16	0	16
DMS	17	13	30
HAR Transmitters	13	2	15
HAR Beacon Signs	44	2	46
Vehicle Detectors (RVDs)	69	168	237
Service Patrols	0*	1	1
RWIS			

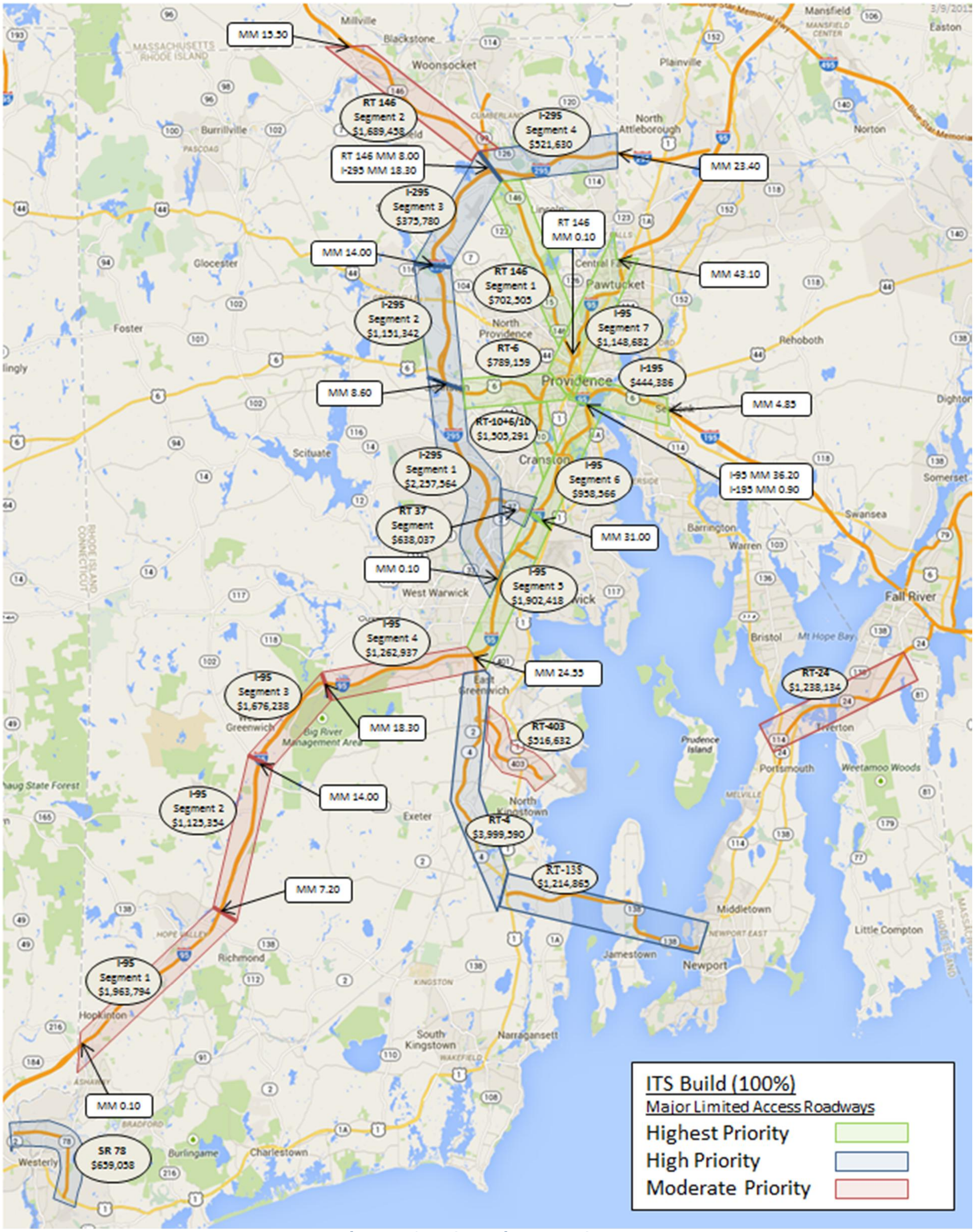


Figure 12: ITS Deployment Summary

9.1 Interstate 95 Summary

Interstate 95 was divided into seven segments for recommendations. As the most important freight route and corridor on the Northeast, this report recommends 100% coverage from the Connecticut State line to the Massachusetts State line all along Interstate 95. Obviously recurring congestion is greatest in the metropolitan area and Segments 6 and 7 face the greatest need and are given the highest priority weighting.

Although many parts of Interstate 95 around the Providence Metro Area and Massachusetts State line have a number of ITS devices, communication infrastructure (conduit, fiber optic cabling, network switches etc.) are lacking forcing the RIDOT to rely on leased lines.

As illustrated in Figure 11, I-95 Segments increase numerically from the Connecticut State line to the Massachusetts State line beginning in one and ending in seven.

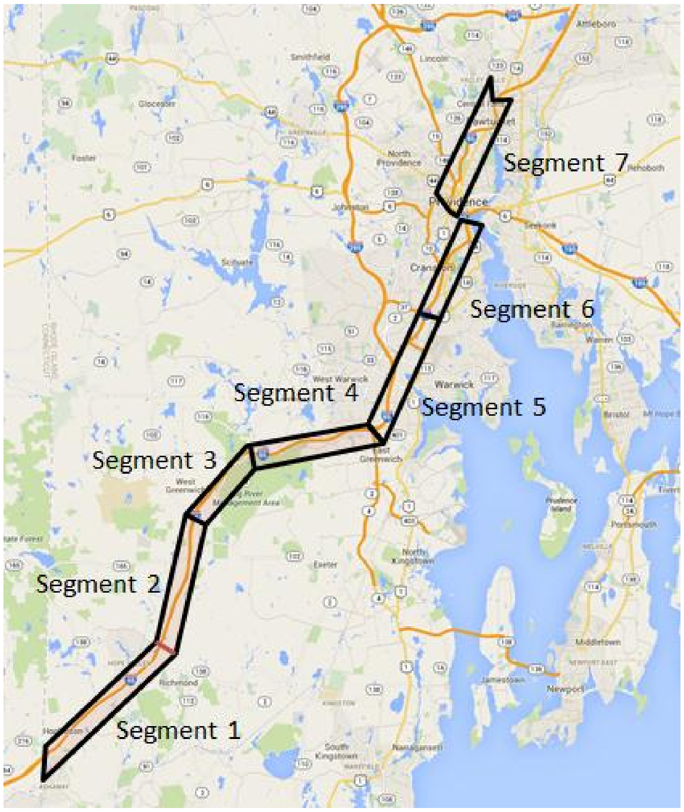


Figure 13: Interstate 95 Segments

Table 8: Interstate 95 Segments Recommended ITS Summary

Route & Segment	Segment Length (mi)	No. of New CCTV	No. of New DMS	No. of New RVD	No. of New HAR	Total Cost
I-95 Segment 1	7.10	6	1	13	2	$1,963,794
I-95 Segment 2	6.72	7	0	10	0	$1,125,354
I-95 Segment 3	7.21	4	0	5	0	$1,676,238
I-95 Segment 4	5.20	5	1	7	0	$1,262,937
I-95 Segment 5	6.45	6	1	8	0	$1,902,418
I-95 Segment 6	5.2	1	0	2	0	$958,566
I-95 Segment 7	6.9	0	0	0	0	$1,148,682
Total	**44.78**	**29**	**3**	**45**	**2**	**$10,037,989**

9.1.1 Segment 1 I-95: Connecticut State Line to Exit 3A

Interstate 95 Segment 1 begins at the Connecticut State line at Mile Marker (MM) 0.10 and ends at Exit 3A MM 7.20.

This portion of I-95 from the Connecticut State line has limited access to power off the ROW, except at the existing exits and a few overpass crossings. This may limit or lengthen distances between ITS installations.

The Highway ROW is somewhat open but does have some dense trees on the outside of the ROW fence. The Highway travel lanes are separated by a Jersey type barrier wall that begins just south of Exit 1 for this entire segment. A 72 Fiber Backbone Cable Duel 2 inch HDPE Duct System is being installed for the entire segment and has a few potential splice points into the State Fiber cable at these crossovers.

Currently there is 1 RVD installation co-located with the existing CCTV and DMS on the Rhode Island state line. Every camera location provides an opportunity to co-late an RVD to leverage the pole, power and communications which can be shared.

Figure 12 below pinpoints the location of the proposed ITS devices for Segment 1. The total cost of the ITS and communications deployment for this segment are $1,963,794.

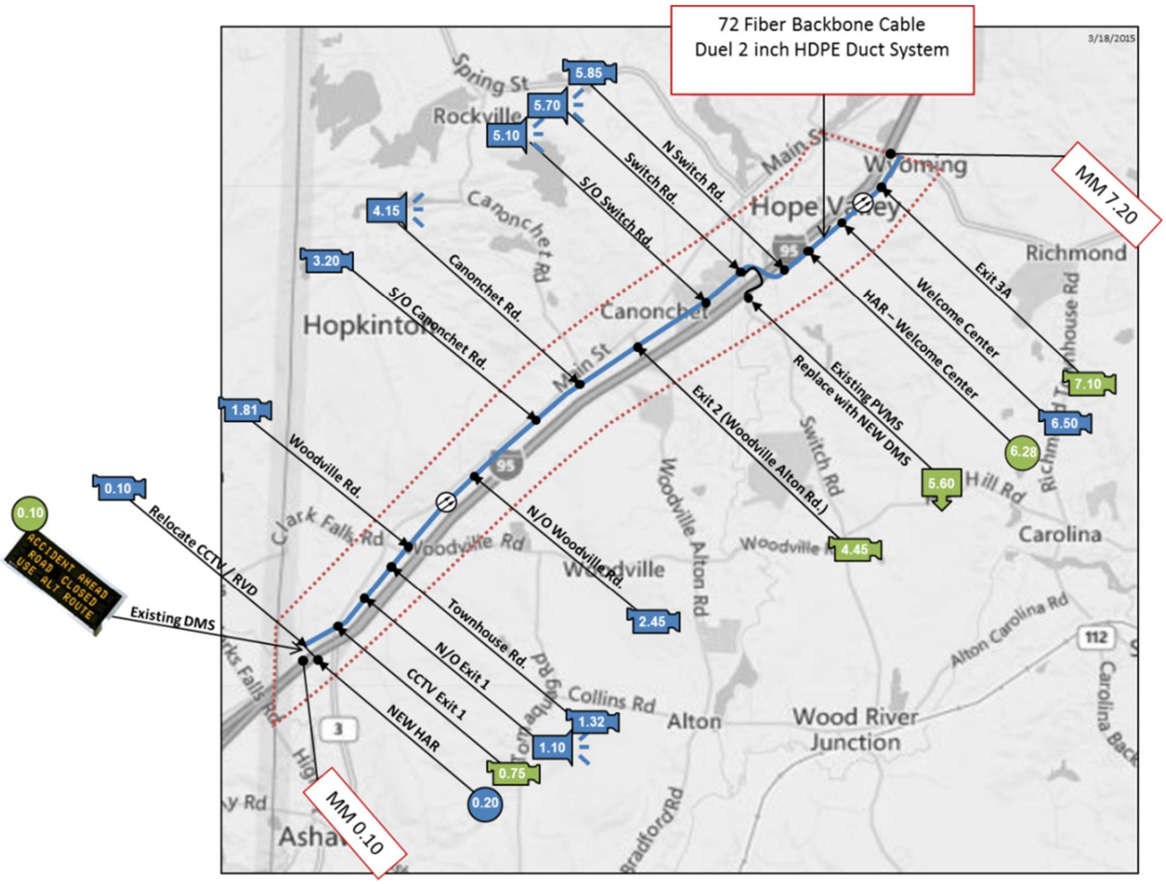
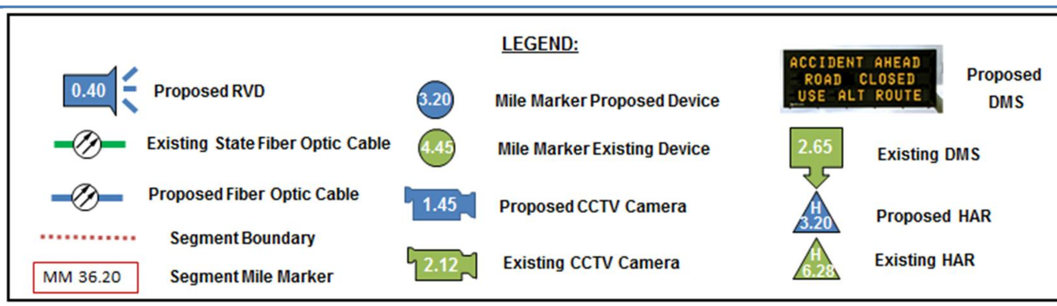


Figure 14: I-95 Segment 1 ITS Recommendations

Table 9: I-95 Segment 1 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	6	$293,650.00
RVD Locations, Including Co-located with CCTV	13	$171,050.00
DMS Locations, Including Structure	1	$320,000.00
New HAR Installations	2	$90,000.00
Supporting Construction (conduit, cable, splicing, etc.)		$1,089,094.00
Total ITS Elements and Construction Cost	**22**	**$1,963,794.00**



9.1.2 Segment 2 I-95: Exit 3A to Victory Highway

Interstate 95 Segment 2 begins at Exit 3A MM 7.20 and ends at Victory Highway MM 14.00. There are currently existing PVMS and CCTV along this segment.

The portion of the segment from Exit 3 to Exit 5 also has limited access to power off the ROW, except at the existing exits and a few overpass crossings, including the Welcome Center. Power surveys during design will affect final distances between ITS installations.

The Highway ROW is somewhat open but does have some dense trees on the outside of ROW fence.

The Highway travel lanes are separated by a Jersey type barrier wall which ends at the 9.5 MM and opens up into an open grass median that has an approximate width of 125', and narrows down to approximately 60' at MM 11.5.

A 72 Fiber Backbone Cable Duel 2 inch HDPE Duct System is being proposed for the entire segment and will have several potential splice points into the State Fiber cable at these crossovers, including the end of this segment (Exit 5).

Currently there are no RVD installations co-located with the existing CCTV locations. Every camera location provides an opportunity to co-late an RVD to leverage the pole, power and communications which can be shared.

Figure 13 pinpoints the location of the proposed ITS devices for Segment 2. The total cost of the ITS and communications deployment for this segment are $1,125,354.

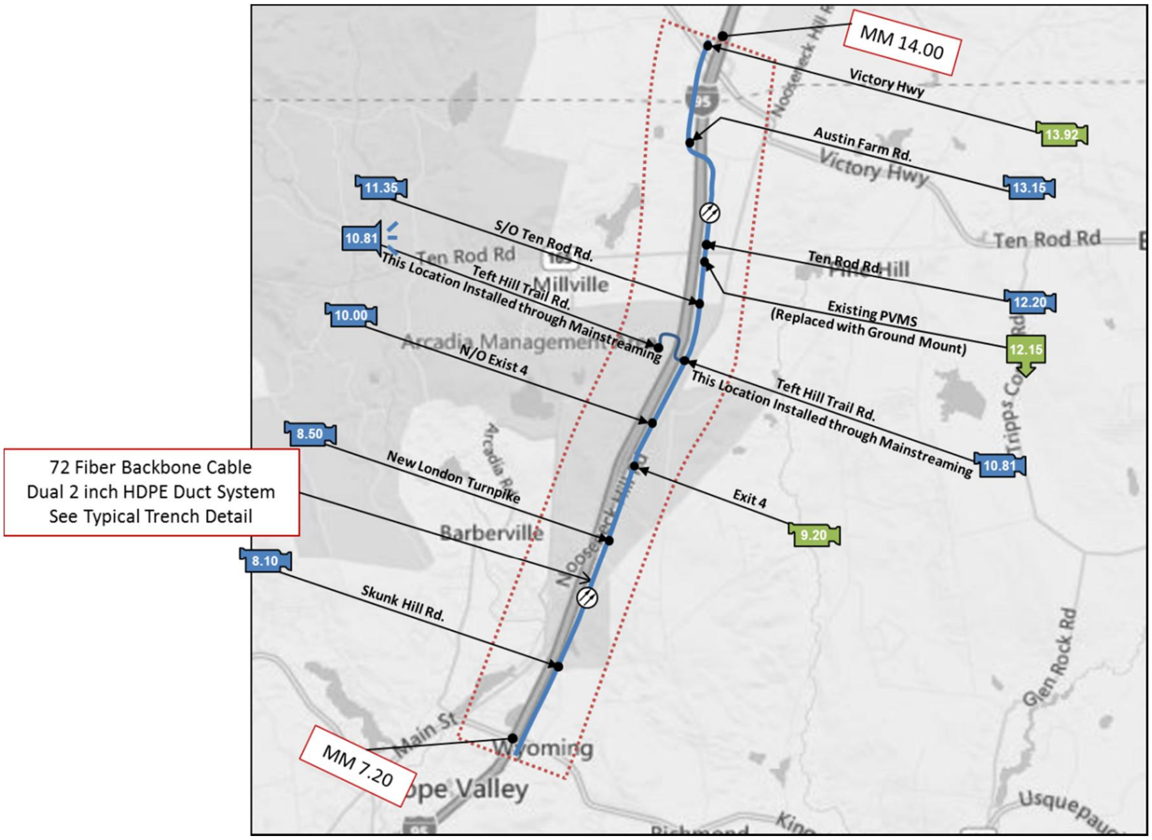
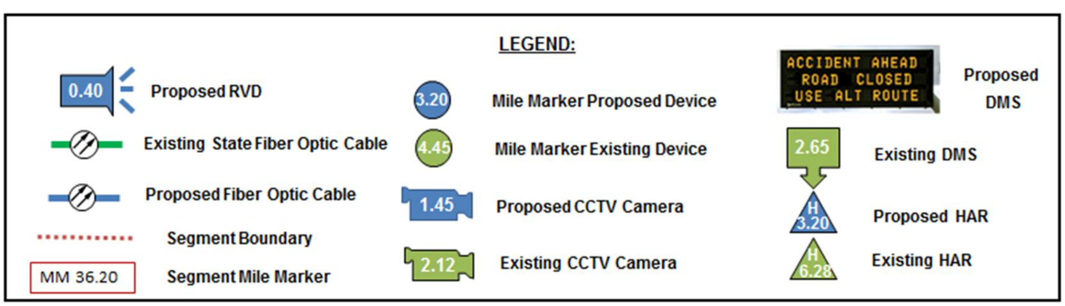


Figure 15: I-95 Segment 2 ITS Recommendations

Table 10: I- 95 Segment 2 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	7	$265,812.00
RVD Locations, Including Co-located with CCTV	10	$94,012.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$765,530.00
Total ITS Elements and Construction Cost	**17**	**$1,125,354.00**



9.1.3 Segment 3 I-95: Victory Highway to Nooseneck Hill Road

Interstate 95 Segment 3 begins at Victory Hill MM14.00 and ends Nooseneck Hill Road MM 18.12. There are currently existing CCTV, RVD and DMS along this route

This portion of I-95 from Exit 5 to Exit 6 also has limited access to power off the ROW, except at the existing Exits and a few overpass crossings. There are some surface streets that run parallel that may provide additional power connections.

The Highway ROW is somewhat open but does have some dense trees on the outside of ROW fence. The portion of Highway from Weaver Hill Road has guardrail mounted on the shoulder on the Median of the northbound travel lanes for the remainder of this segment.

A 72 Fiber Backbone Cable Duel 2 inch HDPE Duct System is being proposed for the entire segment and has a few potential splice points into the State Fiber cable at these crossovers, including the end of this segment (Exit 6). Figure 14 pinpoints the location of the proposed ITS devices for Segment 3. The total cost of the ITS and communications deployment for this segment are $1,676,238.

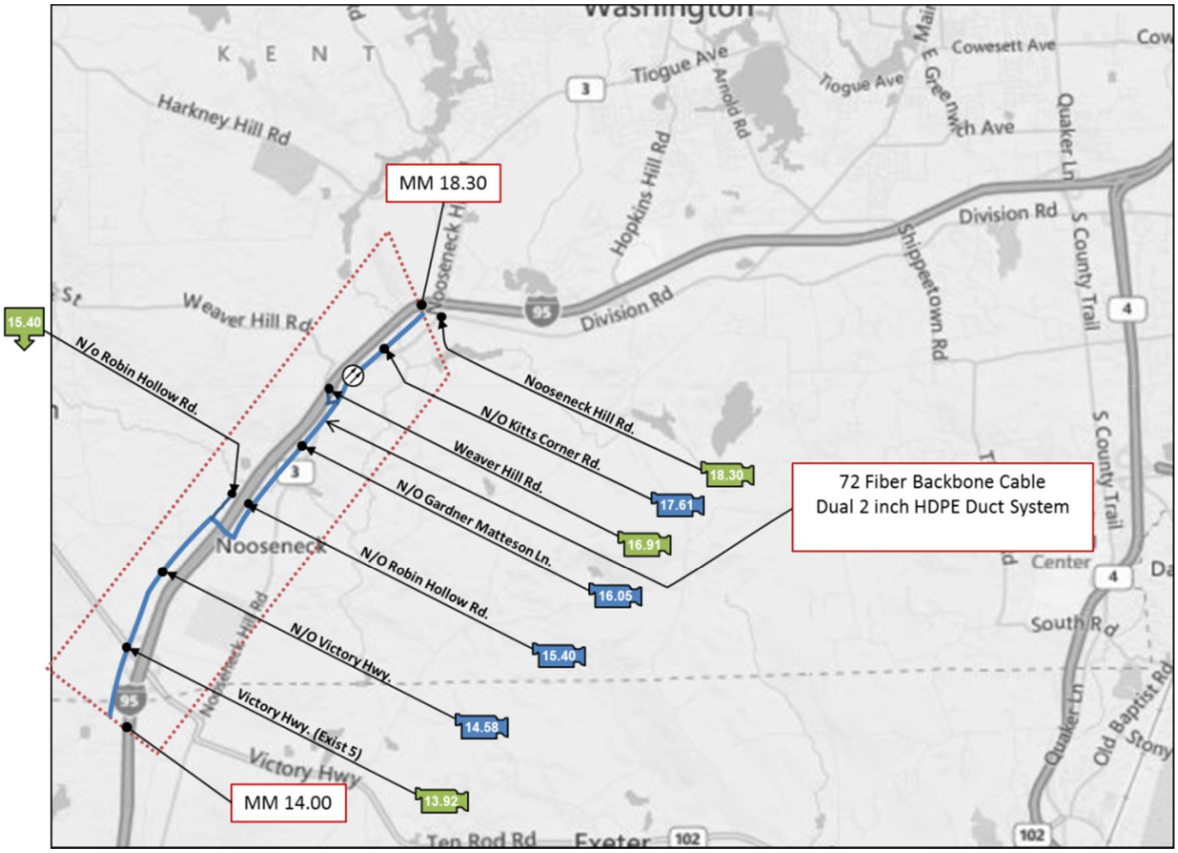
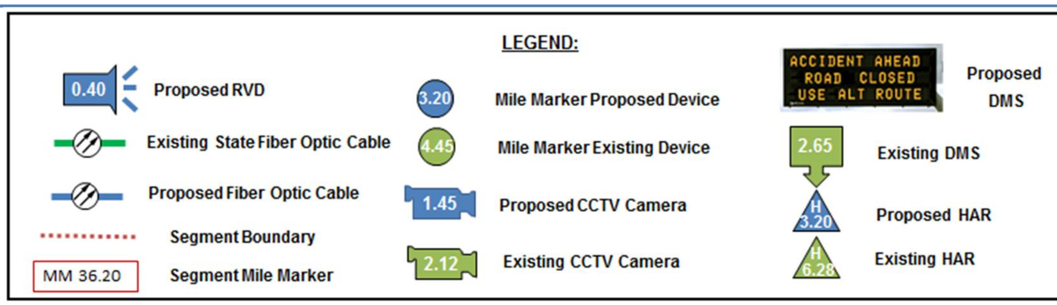


Figure 16: I-95 Segment 3 ITS Recommendations

Table 11: I- 95 Segment 3 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	4	$298,012.00
RVD Locations, Including Co-located with CCTV	5	$97,012.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$1,281,214.00
Total ITS Elements and Construction Cost	**9**	**$1,676,238.00**



9.1.4 Segment 4 I-95: Nooseneck Hill Road to Route 4

Interstate 95 Segment 4 begins at Nooseneck Hill Road MM 18.12 and ends at Route 4 MM 24.55. This area experiences increased seasonal congestion at the junction of Route 4 as well as commuter traffic approaching the Providence Metro Area. There are existing CCTV, RVD and HAR along this route.

This portion of I-95 from Exit 6 to just prior to Exit 8 also has limited access to power off the North bound, except at the existing Exits and a few overpass crossings. There are more power alternatives that run parallel to the southbound side of the roadway that may provide additional power connections. The highway ROW is somewhat open but does have some dense trees on the outside of ROW fence.

The portion of highway from Nooseneck Hill Road has guardrail mounted on the shoulder on the median of the northbound travel lanes until the Quaker Lane exit, at which point the roadway flares apart to a grass median past the junction with RT 4.

A 72 Fiber Backbone Cable Duel 2 inch HDPE Duct System is being proposed for the entire segment and has a few potential splice points into the State Fiber cable at these crossovers, including the end of this segment (Exit 6).

Figure 15 pinpoints the location of the proposed ITS devices for Segment 4. The total cost of the ITS and communications deployment for this segment are $1,262,937.

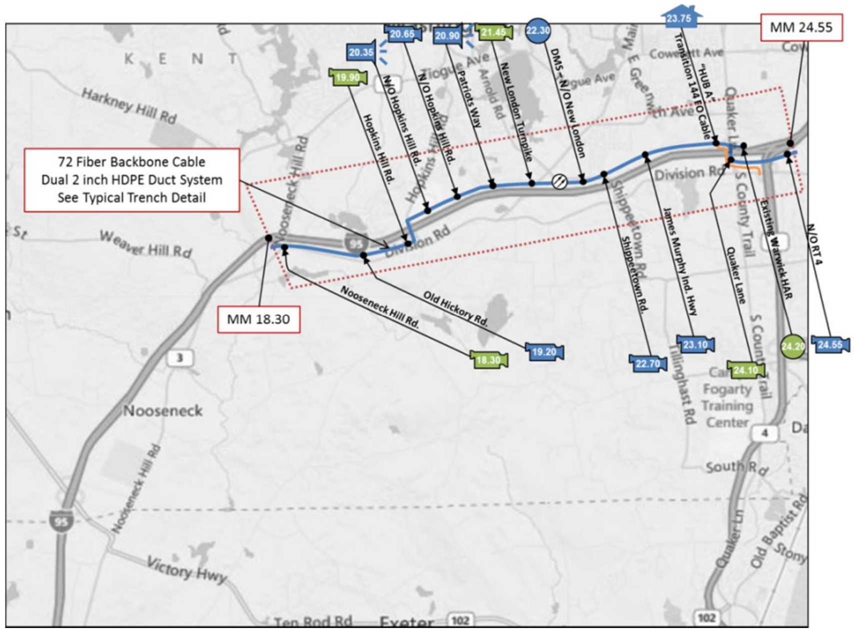
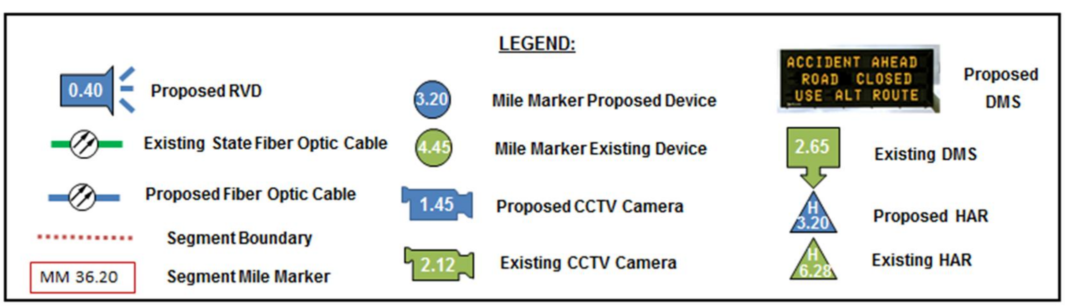


Figure 17: I-95 Segment 4 ITS Recommendations

Table 12: I- 95 Segment 4 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	5	$193,025.00
RVD Locations, Including Co-located with CCTV	7	$37,825.00
DMS Locations, Including Structure	1	$320,000.00
Supporting Construction (conduit, cable, splicing, etc.)		$712,087.00
Total ITS Elements and Construction Cost	**13**	**$1,262,937.00**



9.1.5 Segment 5 I-95: Route 4 to Route 37

Interstate 95 Segment 5 begins at Route 4 MM 24.55 and ends at Route 37 MM 31.00. This area experiences increased congestion approaching the Providence Metro Area as well as the Airport and the junction of Interstate 295 and Route 37. There are existing CCTV, DMS and HAR along this route.

This portion of I-95 from the junction with RT 4 to Exit 10 also has limited access to power off the ROW, except at the existing few overpass crossings. One power source is north of Exit 10 where there is residential and commercial development.

The highway ROW is somewhat open but does have some dense trees on the outside of ROW fence and in the median. The portion of highway from approximately MM 25.6 has guardrail mounted in the median begins and continues to the Toll Gate Rd. Interchange where the median opens for the Interchange ramp for I-295. The median closes into a barrier wall median at the East Avenue interchange and continues for the remainder of this segment.

Additionally, the Pawtuxet River meanders along the southbound side of the interstate which may force construction to the northbound side due to environmental constraints and permitting.

A 144 Fiber Backbone Cable Duel 2 inch HDPE Duct System is being proposed for the entire segment and has a few potential splice points into the State Fiber cable at these crossovers. Figure 16 pinpoints the location of the proposed ITS devices for Segment 5. The total cost of the ITS and communications deployment for this segment are $1,902,418.

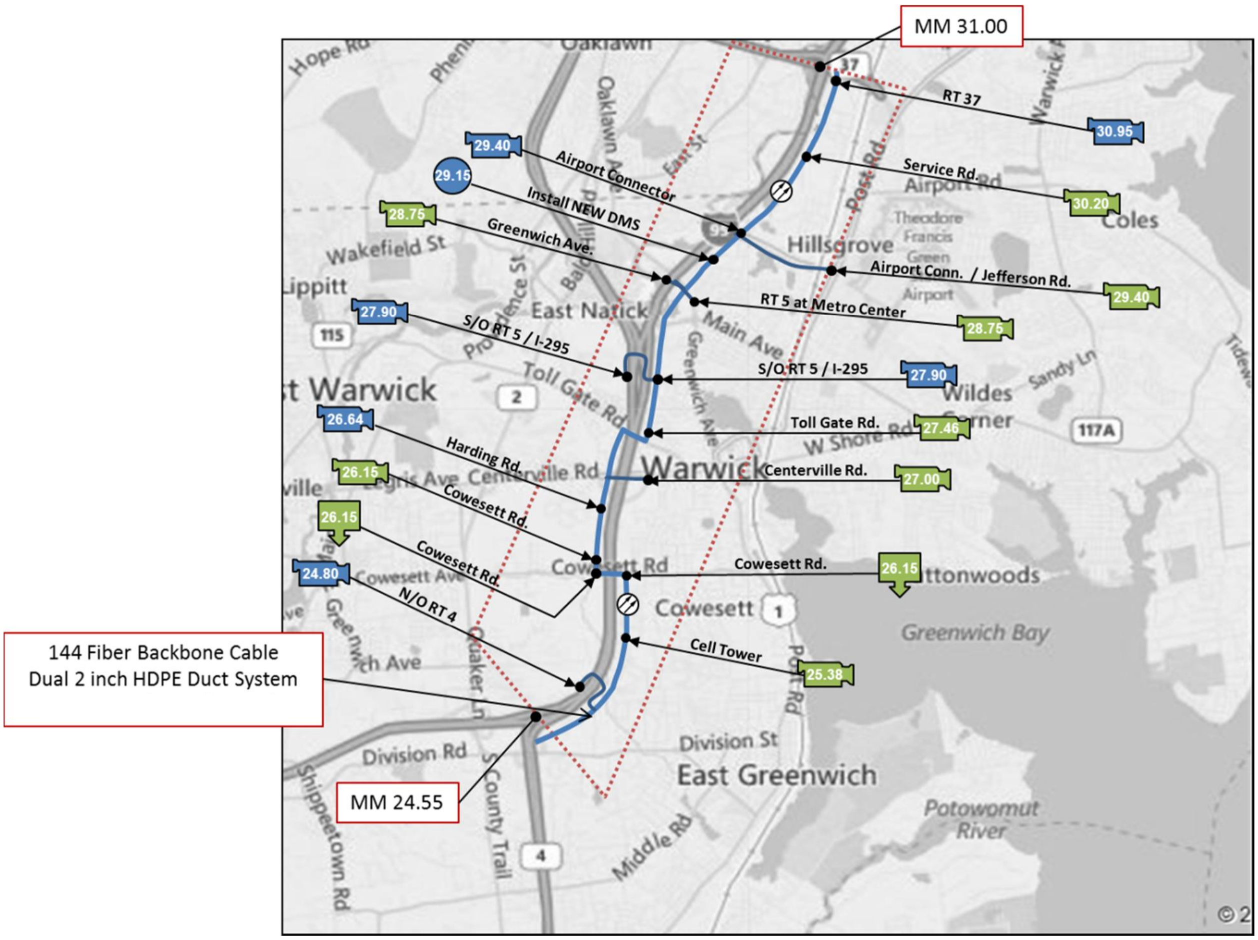
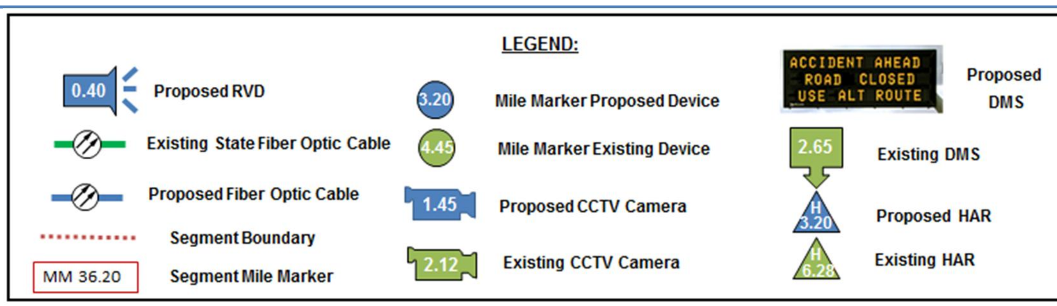


Figure 18: I-95 Segment 5 ITS Recommendations

Table 13: I- 95 Segment 5 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	6	$318,062.00
RVD Locations, Including Co-located with CCTV	8	$91,862.00
DMS Locations, Including Structure	1	$320,000.00
Supporting Construction (conduit, cable, splicing, etc.)		$729,494.00
Total ITS Elements and Construction Cost	**15**	**$1,902,418.00**



9.1.6 Segment 6 I-95: Route 37 to Eddy Street

Interstate 95 Segment 6 begins at Route 37 MM 31.00 and ends at Eddy Street MM 36.20. Segments 6 and 7 experience the most congestion surrounding the Providence Metro Area and approaching the junction of I-195. There are currently CCTV, DMS, RVD and HAR along this route.

This portion of I-95 from the junction with RT 37 and the remainder of this segment does not have any power availability issues. There are both residential and commercial developments bordering both sides of the Interstate that may make power available to new devices.

The highway ROW is somewhat tight with planter type barrier walls which will make conduit and cable installation a little more difficult.

The highway travel lanes are separated by a Jersey type barrier wall that begins at RT 37 and continues for this entire segment. There are a few elevated sections of road that will require that any conduit will be required to be installed by either a suspended duct system under the decking or attached to the Parapet wall.

New Backbone Cable is being proposed to a point at MM 35.84 Public St. where the proposed Backbone cable will be spliced into existing State Fiber cable, cable size and count is to be determined. Figure #17 pinpoints the location of the proposed ITS devices for Segment 6. The total cost of the ITS and communications deployment for this segment are $958,566.

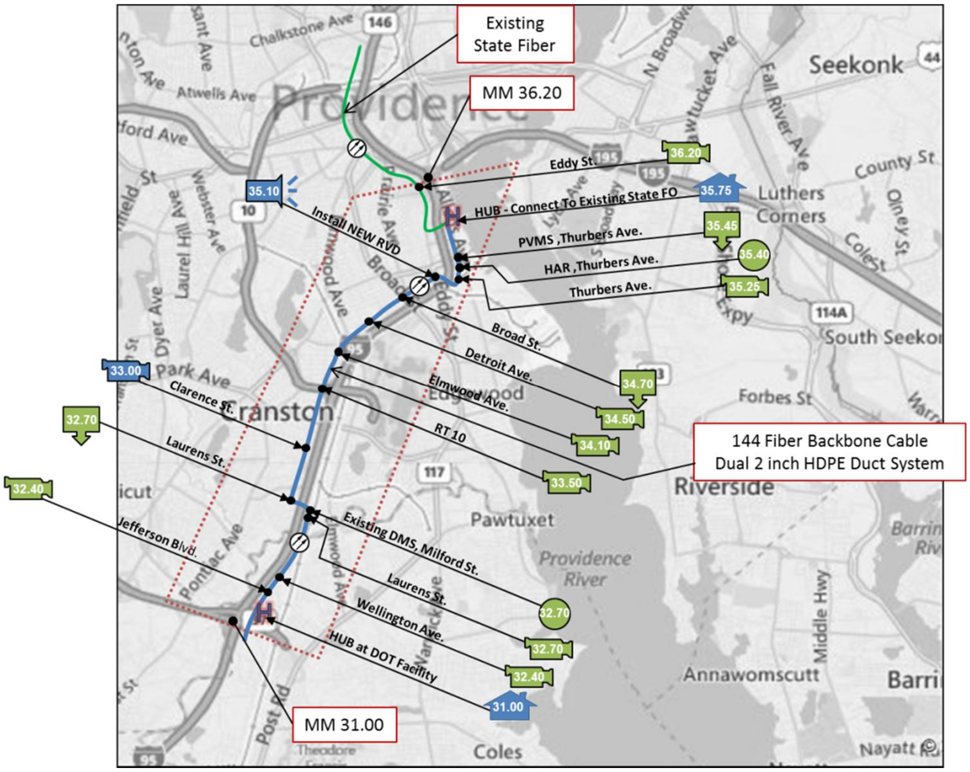
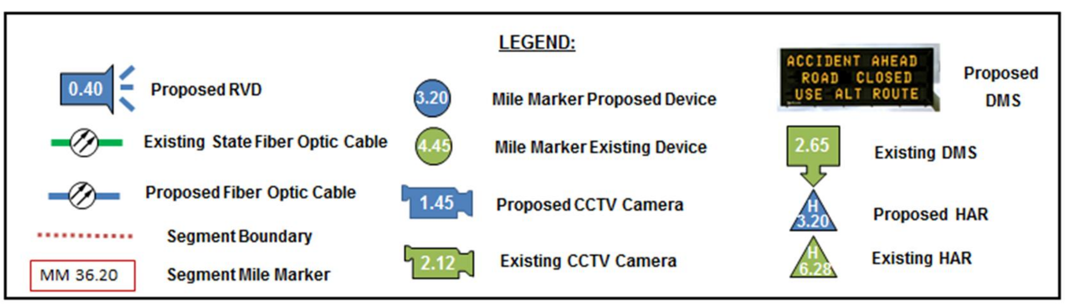


Figure 19: I-95 Segment 6 ITS Recommendations

Table 14: I- 95 Segment 6 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	1	$47,325.00
RVD Locations, Including Co-located with CCTV	2	$25,125.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$866,116.00
Total ITS Elements and Construction Cost	**3**	**$958,566.00**



9.1.7 Segment 7 I-95: Eddy Street to Massachusetts State Line

Interstate 95 Segment 7 begins at Eddy Street MM 36.20 and ends at the Massachusetts State Line MM 43.10. As stated, Segments 6 and 7 experience the most congestion surrounding the Providence Metro Area. Section 7 also includes the Statewide TMC. There are currently existing CCTV, DMS and RVD along this route.

This portion of I-95 from the junction with Route 37 for the remainder of this segment does not have any power availability issues. There are both residential and commercial developments bordering both sides of the Interstate that may make power available to new devices.

The Highway ROW is somewhat tight due to the metropolitan area making conduit and cable installation a little more difficult.

This section of I-95 has sufficient existing CCTV installations and none are proposed at this time. The strategy for this section is to connect all of the existing ITS field devices to one common backbone cable and deliver all data directly back to the TMC, thereby removing all third party cost and bandwidth limitations.

The Highway travel lanes are separated by a Jersey type barrier wall for this entire segment. There are additional elevated sections of road that will require that conduit to be installed by either a suspended duct system under the decking or attached to the Parapet wall.

New Backbone Cable is being proposed from a point at MM 38.15 where the proposed Backbone cable will be spliced into existing State Fiber cable. Cable size and count is to be determined and continue north to the end of the segment. Figure 18 pinpoints the location of the proposed ITS devices for Segment 7. The total cost of the ITS and communications deployment for this segment are $1,148,682.

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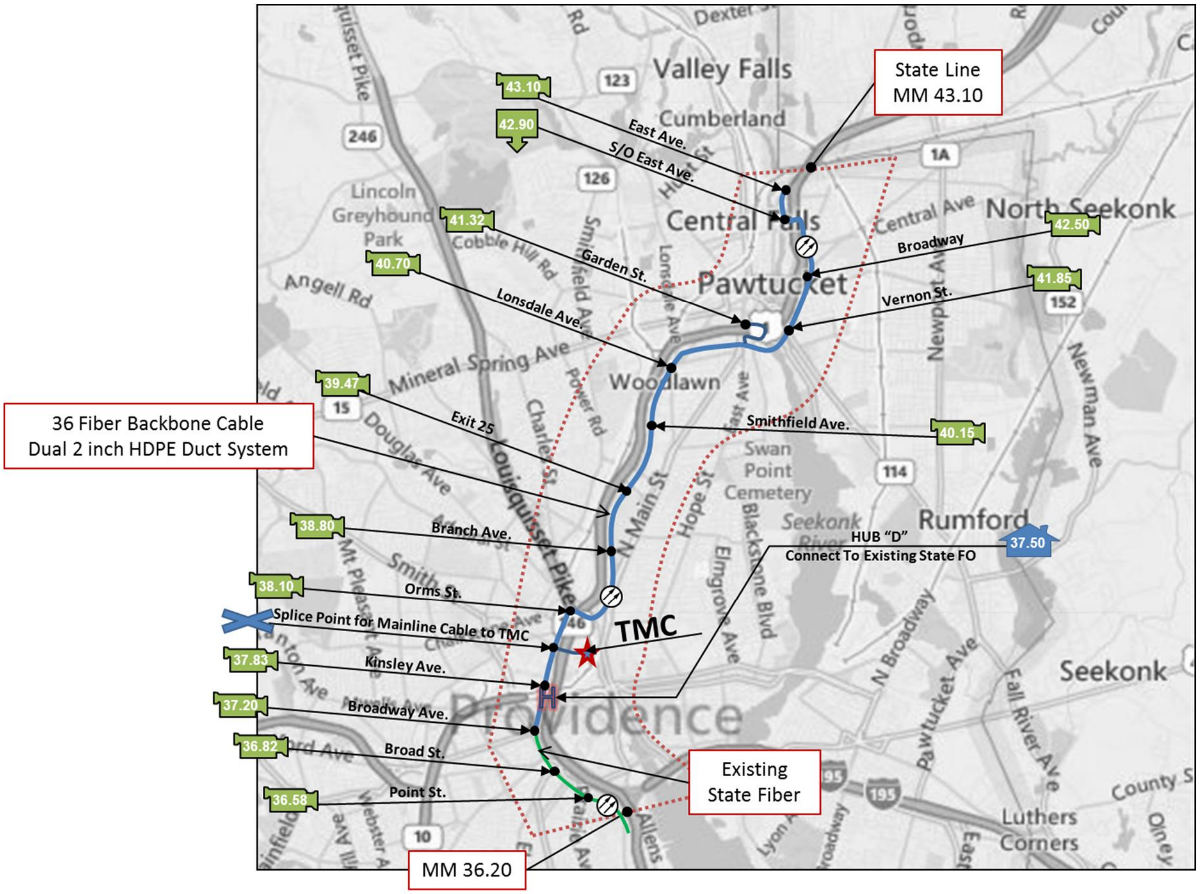
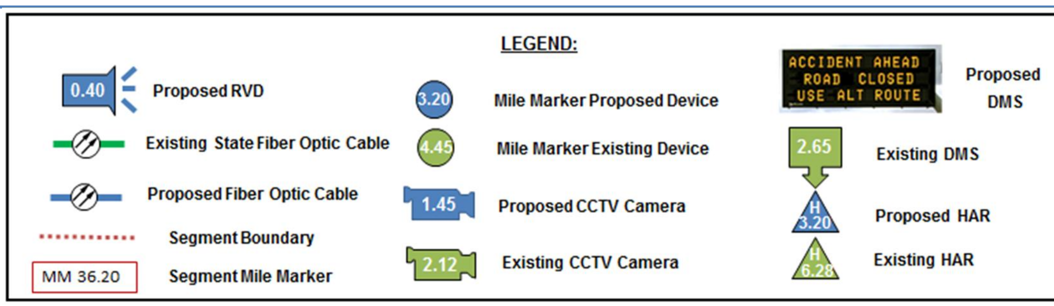


Figure 20: I-95 Segment 7 ITS Recommendations

Table 15: I- 95 Segment 7 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	0	$3,862.00
RVD Locations, Including Co-located with CCTV	1	$15,622.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$1,129,198.00
Total ITS Elements and Construction	**1**	**$1,148,682.00**



9.2 Interstate 295 Summary

Interstate 295 was divided into four segments for recommendations. As a major travel corridor around the Providence Metro Area, this highway begins at Interstate 95 and ends at the Massachusetts State Line.

This report recommends 100% coverage all along Interstate 295. Recurring congestion is greatest in Segments 1 and 4 and are given the highest priority weighting

As illustrated in Figure #19, I-295 Segments increase numerically from the junction of I-95 to the Massachusetts State line beginning in one and ending in four.

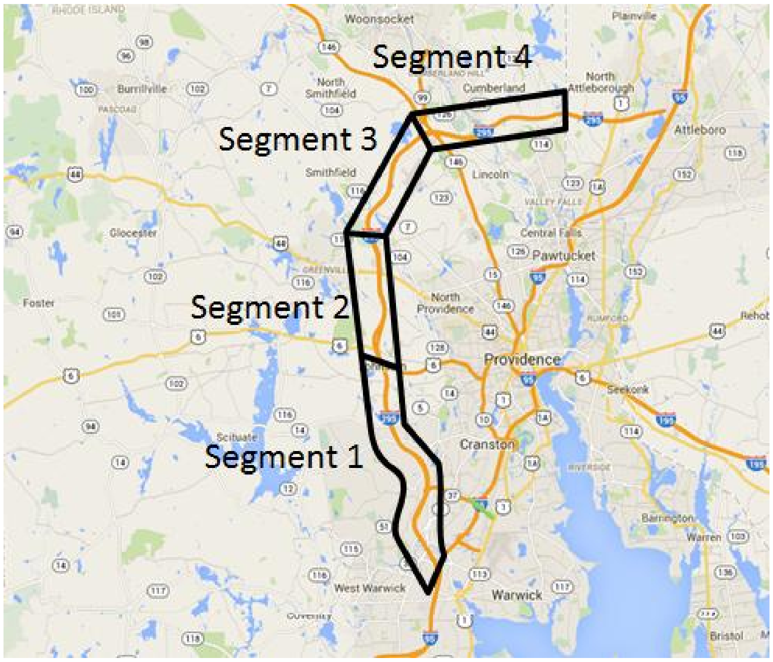


Figure 21: Interstate 295 Segments

Table 16: Interstate 295 Segments Recommended ITS Summary

Route & Segment	Segment Length (mi)	No. of New CCTV	No. of New DMS	No. of New RVD	No. of New HAR	Total Cost
I-295 Segment 1	8.5	10	0	24	0	$2,257,564.00
I-295 Segment 2	5.4	3	0	9	0	$1,151,342.00
I-295 Segment 3	4.3	3	0	7	0	$375,780.00
I-295 Segment 4	5.1	5	0	12	0	$521,630.00
Total	**23.3**	**21**	**0**	**52**	**0**	**$4,306,346.00**

9.2.1 Segment 1 I-295: I-95 North to Route 6

The portion of I-295 beginning at the I-95 interchange heading north has a large area for the Interchange that has a grass median but limited power except at the East Ave. There is limited power access from both businesses and residential developments on either side, but sporadic in some places.

This segment currently has existing ITS equipment, but additional devices are required to fill in gaps, including a new DMS location.

The Interstate travel lanes are separated by a wide grass median, 150 ft. plus at some locations. This will require installing two independent RVDs for either off the shoulder or in the median installations.

New Backbone Cable is being proposed for this segment with splicing into new fiber cable for RT 37 at approximately MM 3.55 and new cable for RT 6 at the end of this segment, MM 8.40. The most desirable location for this cable is in the median, but there are obstacles that will need to be avoided, i.e. water detention areas and ledges.

Figure 20 pinpoints the location of the proposed ITS devices for Segment 1.The total cost of the recommendations for this segment is $2,257,564.

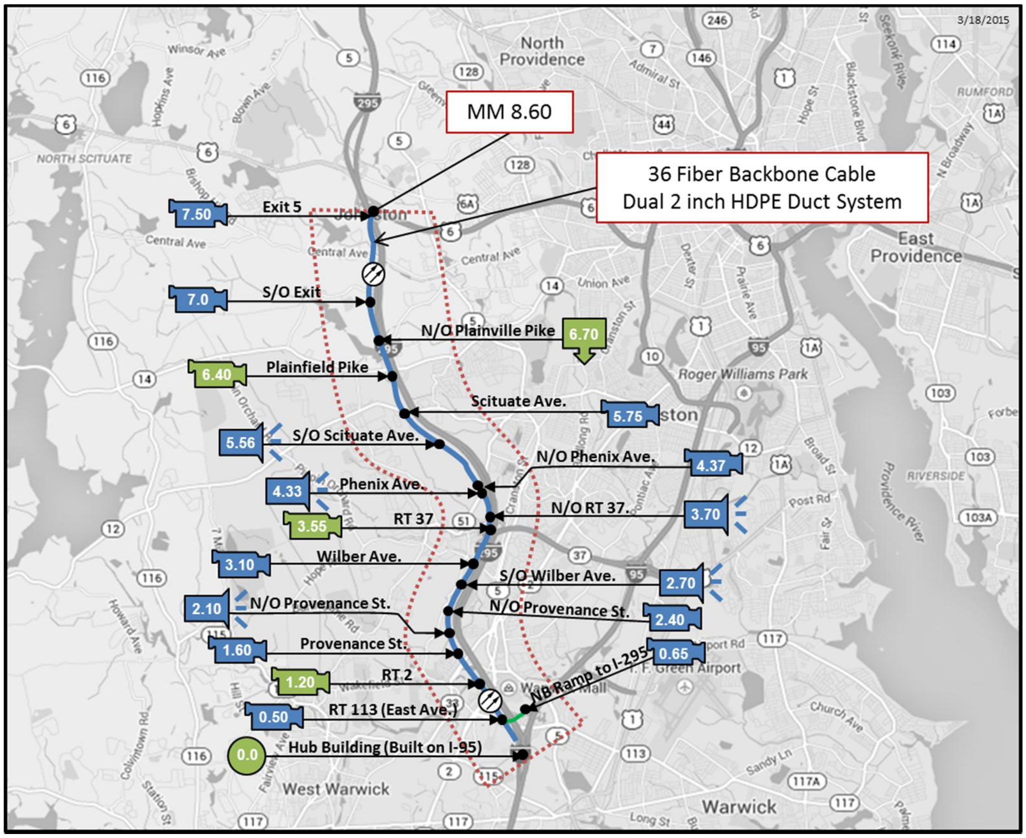
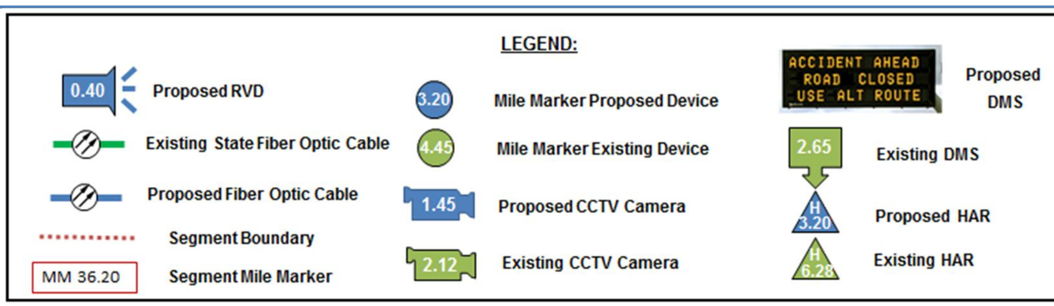


Figure 22: I-295 Segment 1 ITS Recommendations

Table 17: I-295 Segment 1 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	10	$482,337.00
RVD Locations, Including Co-located with CCTV	24	$332,573.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$1,442,654.00
Total ITS Elements and Construction Cost	**34**	**$2,257,564.00**



9.2.2 Segment 2 I-295: Route 6 North to Farnum Pike

The portion for this section, heading north has a large area where median width separates the north and southbound travel lanes to the extent that additional CCTV locations will be required for full coverage. There is limited power access from either side.

This Interstate currently has ITS equipment, but additional devices are required to fill in gaps.

The Highway travel lanes are separated by a wide grass median, 150 ft. plus at some places. This may require installing two RVDs at a particular location, at either off the shoulder or in the median installations.

A 36 Fiber Backbone Cable Duel 2 inch HDPE Duct System is being proposed for this segment only to approximately MM12.0, where the cable will be spliced into the existing State Fiber System.

Figure 21 pinpoints the location of the proposed ITS devices for Segment 2. The total cost of the recommendations for this segment is $1,151,342.

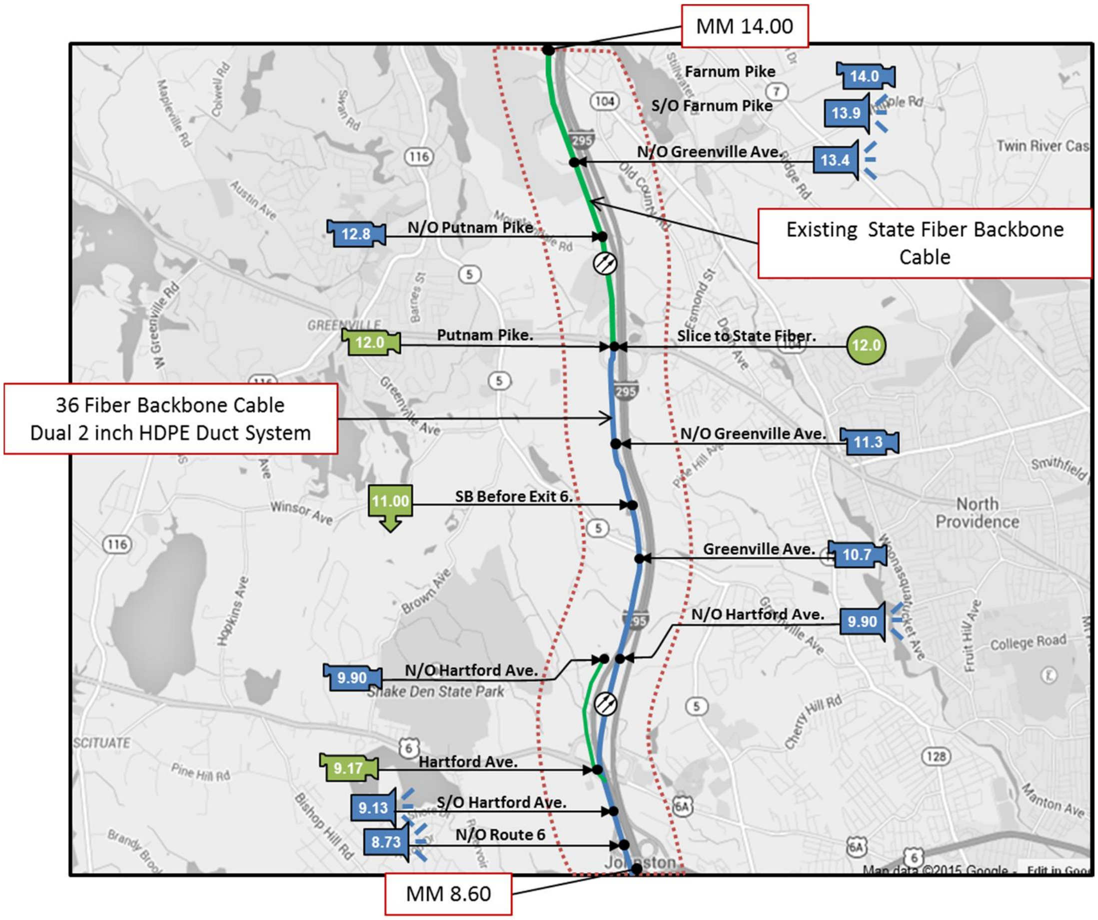
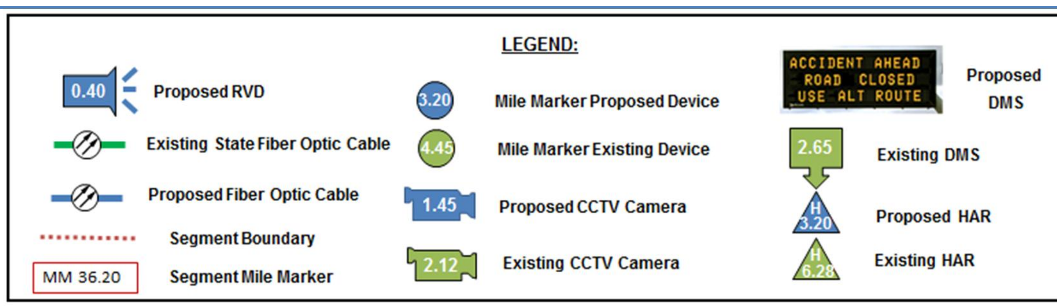


Figure 23: I-295 Segment 2 ITS Recommendations

Table 18: I-295 Segment 2 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	3	$161,450.00
RVD Locations, Including Co-located with CCTV	9	$140,250.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$849,642.00
Total ITS Elements and Construction Cost	**12**	**$1,151,342.00**



9.2.3 Segment 3 I-295: Route 104 North to Eddie Dowling Highway

The portion for this segment, heading north has a large areas were the roadway is separated, so additional CCTV locations maybe required to obtain full coverage.

There is limited power access from either side, but sporadic in some places and at overpasses.

This highway currently has ITS equipment located on it with new locations recommended. The Highway travel lanes are separated by a wide grass median, 150 ft. plus at some places. This may require installing two RVDs at a particular location, for either off the shoulder or in the median installation.

The Backbone Cable for this segment will be a continuation of the State Fiber System.

Figure 22 pinpoints the location of the proposed ITS devices for Segment 3. The total cost of the recommendations for this segment is $375,780.

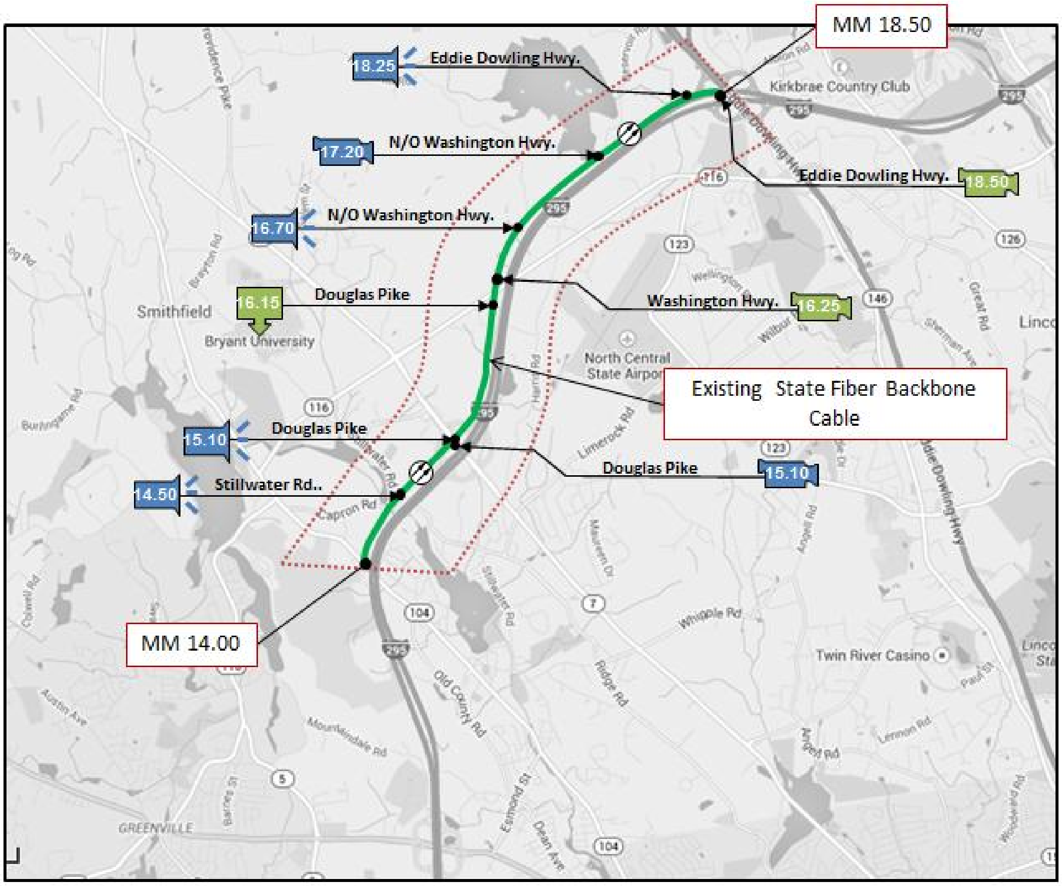
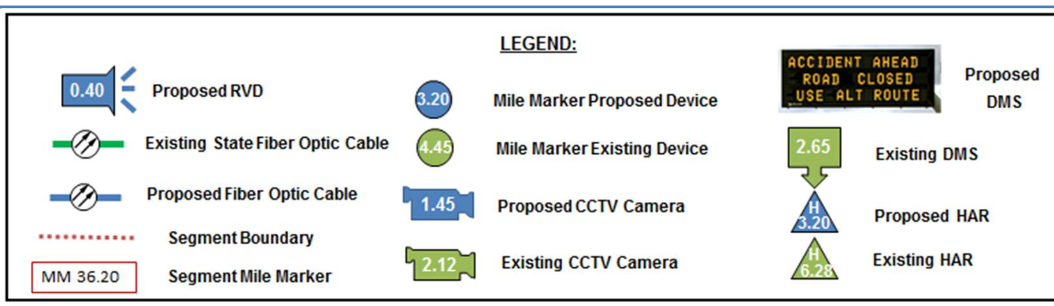


Figure 24: I-295 Segment 3 ITS Recommendations

Table 19: I-295 Segment 3 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	3	$159,900.00
RVD Locations, Including Co-located with CCTV	7	$120,100.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$95,780.00
Total ITS Elements and Construction Cost	**10**	**$375,780.00**



9.2.4 Segment 4 I-295: Eddie Dowling Highway to Massachusetts State Line

The portion for this segment, heading north has a large areas were the roadway is separated, so additional CCTV locations maybe required to obtain full coverage. There is limited power access from either side, but sporadic in some places and at overpasses. This does change a little when approaching the Massachusetts State Line.

This highway currently has ITS equipment located on it with new devices recommended to fill in gaps.

The highway travel lanes are separated by a wide grass median. This may require installing two RVDs at a particular location, for either off the shoulder or in the median installation.

The Backbone Cable for this segment will be a continuation of the State Fiber System.

Figure 23 pinpoints the location of the proposed ITS devices for Segment 4. The total cost of the recommendations for this segment is $521,630.

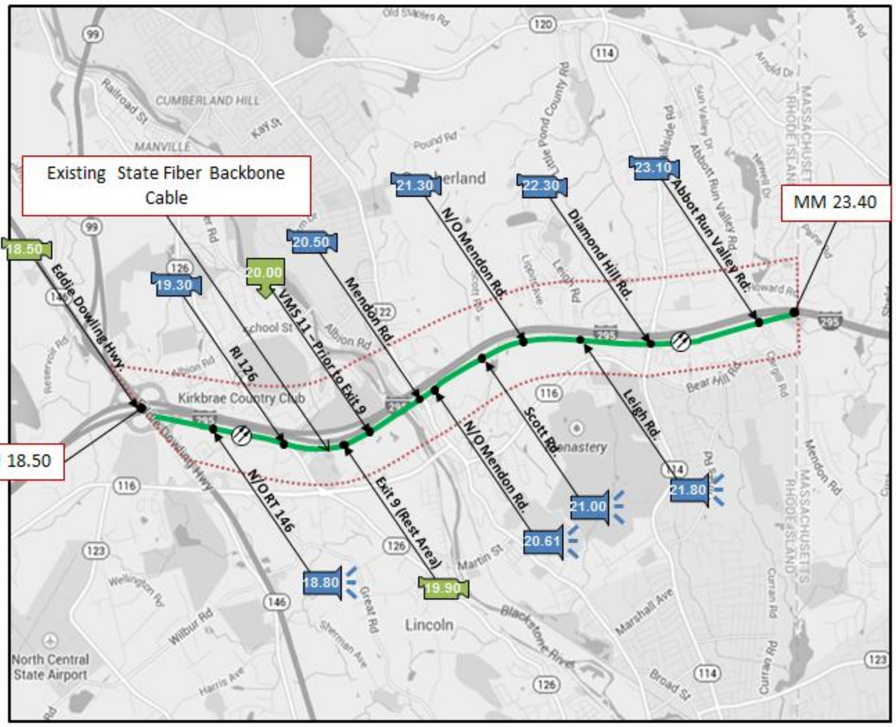
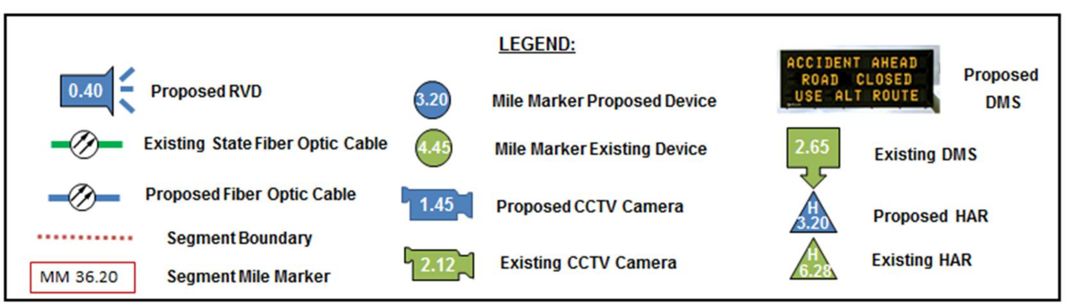


Figure 25: I-295 Segment 4 ITS Recommendations

Table 20: I-295 Segment 4 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	5	$242,962.00
RVD Locations, Including Co-located with CCTV	12	$145,562.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$133,106.00
Total ITS Elements and Construction Cost	**17**	**$521,630.00**



9.3 **Interstate 195**

The portion of I-195 beginning at the I-95 interchange (Split), heading east to the Massachusetts border, has limited access to power from either side of the highway due to the elevated roadway.

This highway currently has ITS equipment located on it with only two new locations recommended.

The highway travel lanes are separated by a Jersey type barrier wall that begins at I-95 and continues for the entire segment.

A 72 Fiber Backbone Cable Duel 2 inch HDPE Duct System is being proposed for this segment with splicing into existing State fiber at approximately MM 2.40.

Figure 24 blow pinpoints the location of the proposed ITS devices on this Segment. The total cost of the recommendations for this segment is $444,386.00.

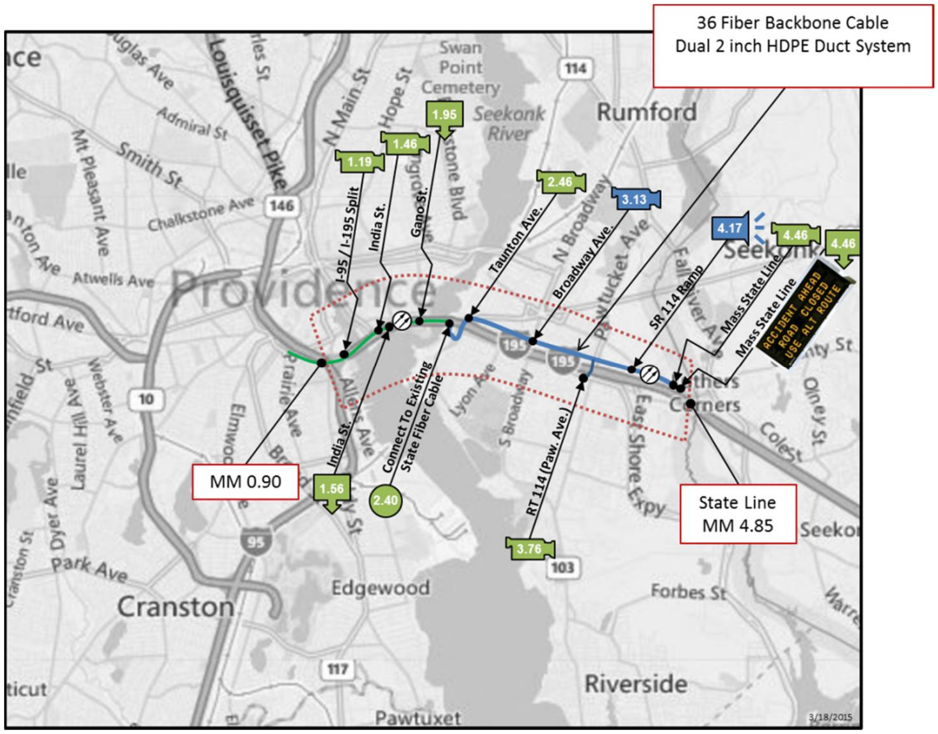
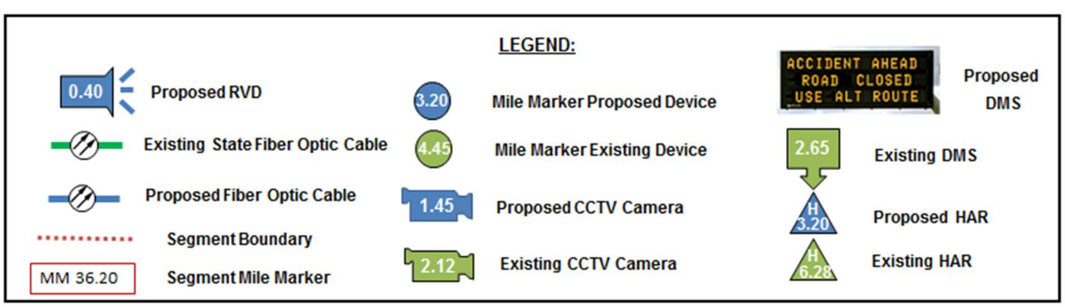


Figure 26: Interstate 195 ITS Recommendations

Table 21: Interstate 195 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	1	$49,412.00
RVD Locations, Including Co-located with CCTV	2	$27,212.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$367,762.00
Total ITS Elements and Construction Cost	**3**	**$444,386.00**



9.4 Route 146 Summary

Route 146 is a major arterial entering Rhode Island from Massachusetts and ends at Interstate 95 north of Providence Metro Area. This route is used by commuters daily and generates bottlenecks at the junctions of Interstate 295 and Interstate 95. This route was separated into two segments for recommendations; Segment 1 runs between Interstate 295 and Interstate 95 while Segment 2 runs between Interstate 295 and the Massachusetts State Line.

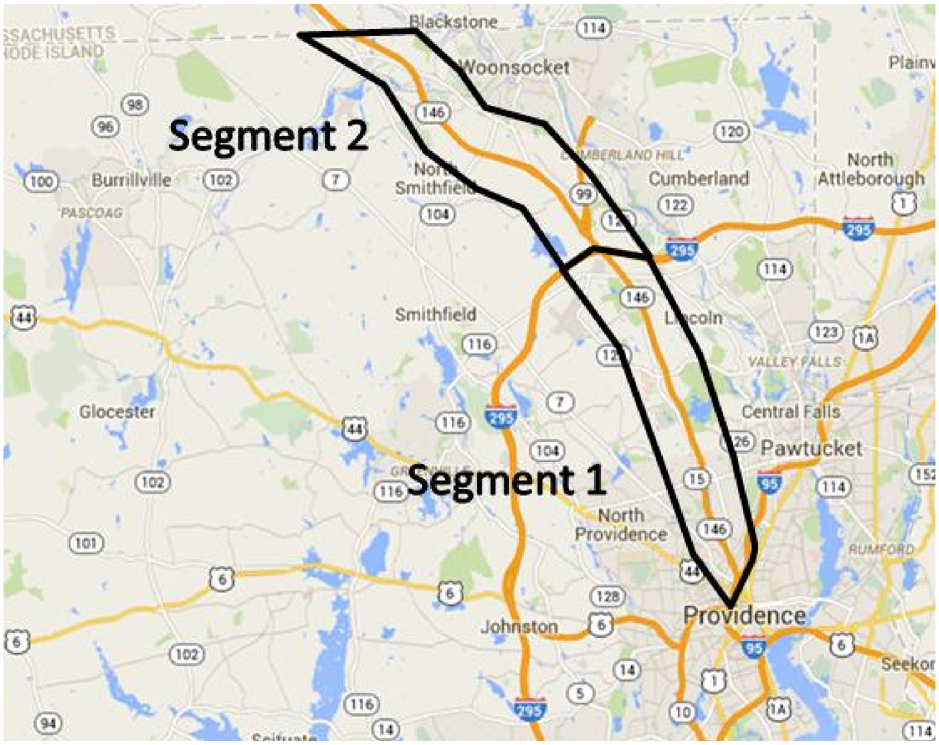


Figure 27: Route 146 Segments

Table 21: Route 146 Segments Recommended ITS Summary

Route & Segment	Segment Length (mi)	No. of New CCTV	No. of New DMS	No. of New RVD	No. of New HAR	Total Cost
RT 146 Segment 1	8.5	7	0	13	0	$702,505.00
RT 146 Segment 2	6.9	4	1	4	0	$1,689,458.00
Total	**15.4**	**11**	**1**	**17**	**0**	**$2,391,963.00**

9.4.1 Segment 1 Route 146: I-95 North to I-295

This portion of RT 146 has a few elevated road segments in the vicinity of the I-95 Interchange. The highway ROW is somewhat open until approximately the three mile marker where dense foliage begins to constrict the ROW. This may limit or lengthen distances between ITS installations. The Highway travel lanes are separated by a Jersey type barrier wall for this entire segment.

Power appears to be readily available until approximately the five mile marker, where it becomes a little sparse close to ROW.

No Backbone Cable is being proposed due to the fact that the entire segment has State Fiber cable present. The proposed installation along this route will be connected (spliced) to the State fiber with SM FO Drop cables.

Figure 25 pinpoints the location of the proposed ITS devices for Segment 1. The total cost of the ITS and communications deployment for this segment is $702,505.

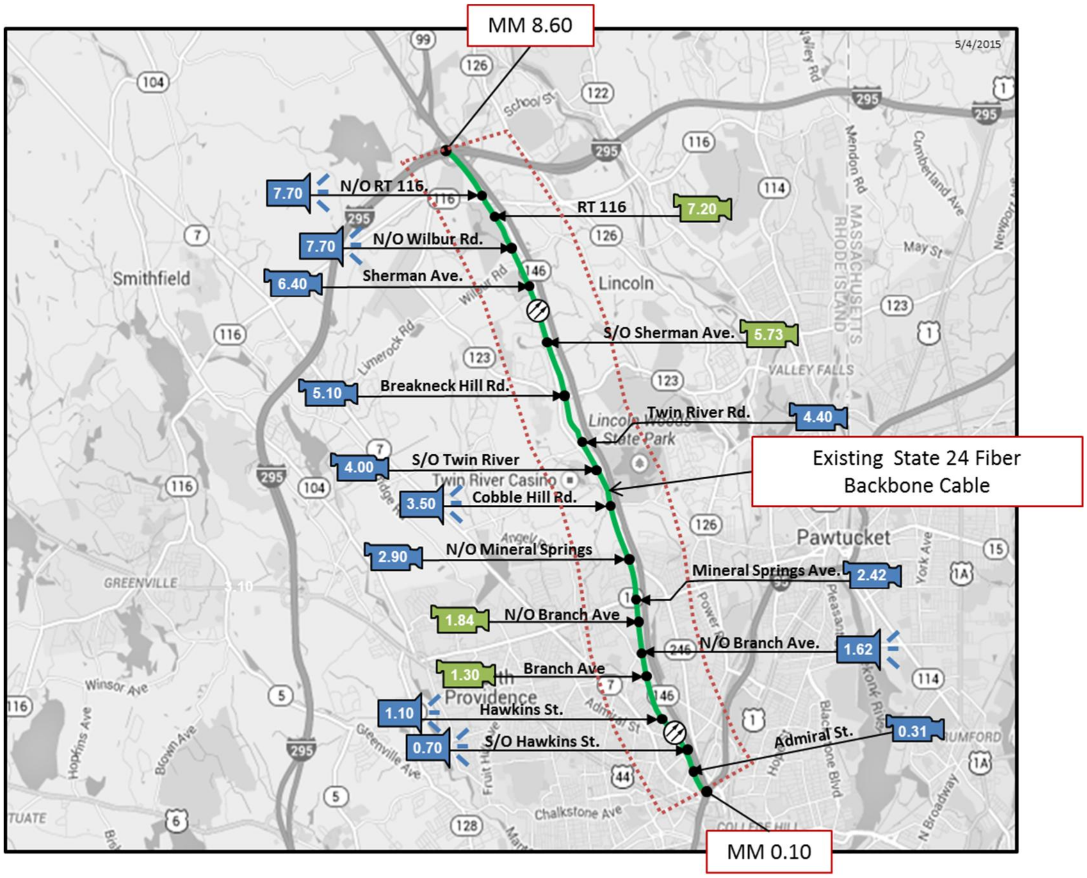
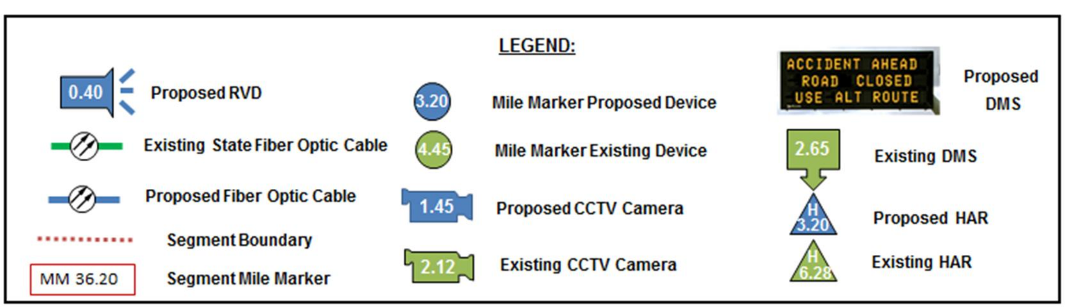


Figure 28: Route 146 Segment 1 ITS Recommendations

Table 22: Route 146 Segment 1 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	7	$329,825.00
RVD Locations, Including Co-located with CCTV	13	$162,625.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$210,055.00
Total ITS Elements and Construction Cost	**20**	**$702,505.00**



9.4.2 Segment 2 Route 146: I-295 North to Massachusetts State Line

The highway travel lanes widens out at the I-295 interchange with additional collective distributor lanes. The highway travel lanes are separated by a Jersey type barrier wall until an at grade Intersection (Sayles Hill Rd.) where this segment of the roadway is no longer limited access. There are no ITS devices installed at this location. The limited access roadway resumes just north of this Intersection.

Power appears to be readily available until approximately the RT 146A Split, ten and a half mile marker, where it becomes a little sparse close to ROW. The Jersey barrier gives way to a median separated highway at the 146A Split as well.

A new Backbone Cable is being proposed for the entire segment. The proposed installation along this route will be connected (spliced) to the State fiber at the point of intersection with the first segment at I-295.

A new DMS location is proposed at the rest area for southbound traffic, this will be a good diversionary route to 146A as a bypass.

Figure 26 pinpoints the location of the proposed ITS devices for Segment 2. The total cost of the ITS and communications deployment for this segment is $1,689,458.

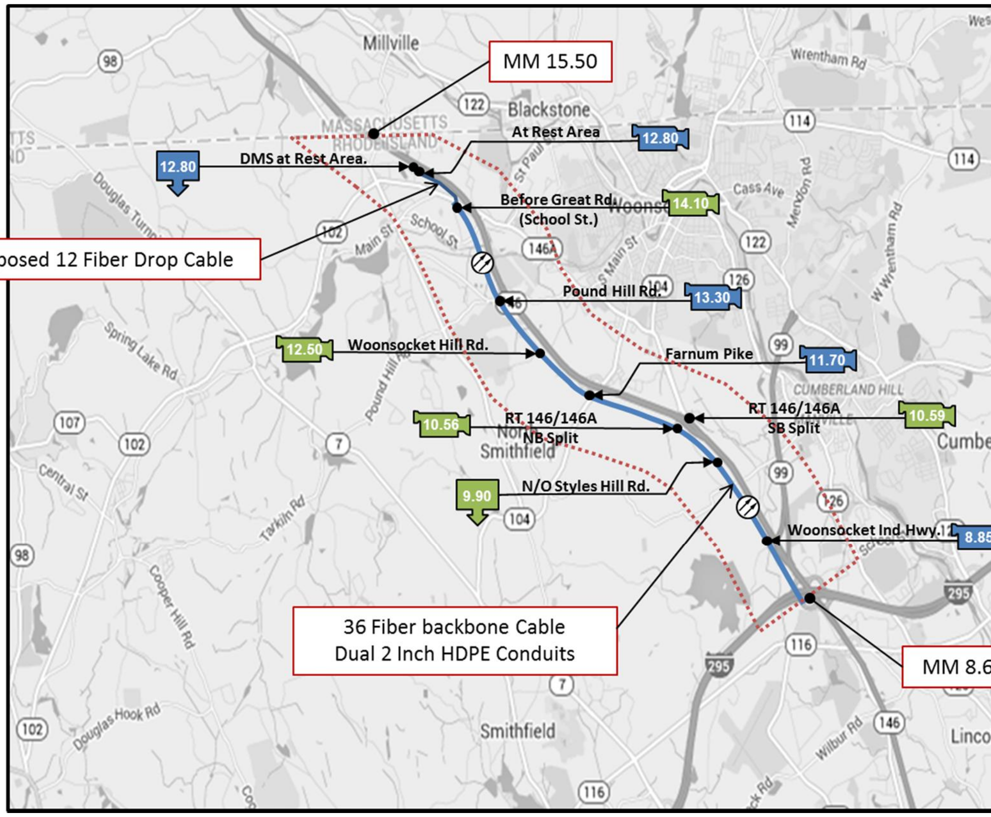
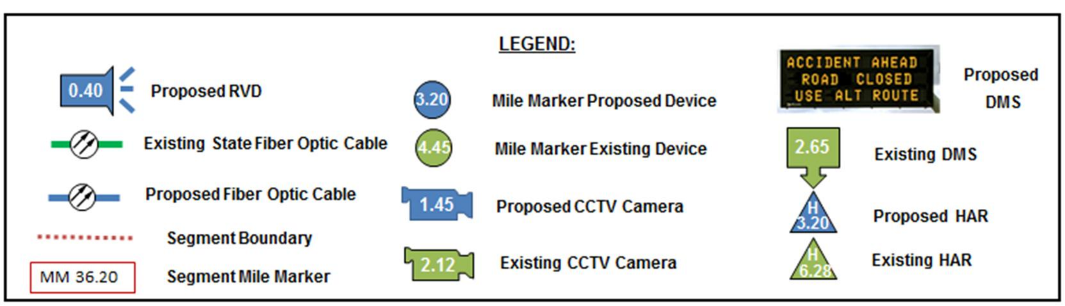


Figure 29: Route 146 Segment 2 ITS Recommendations

Table 23: Route 146 Segment 2 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	4	$176,950.00
RVD Locations, Including Co-located with CCTV	4	$40,950.00
DMS Locations, Including Structure	1	$325,000.00
Supporting Construction (conduit, cable, splicing, etc.)		$1,146,558.00
Total ITS Elements and Construction Cost	**9**	**$1,689,458.00**



9.5 Route 6 and 10

Route 6 and Route 10 are important roadways servicing the Providence and North Providence Metro Area. Route 6 is located in the mid-section of the state and the limited access portion that is being highlighted here allows travelers to bypass the southern portions of I-295. Route 6 connects to Route 10 and continues on a loop connecting with I-95 in the Downtown vicinity.

Route 10 begins at Park Avenue in Cranston and intersects I-95 and continues on a loop to intersect with Route 6 and becomes Route 6/10. This route carries heavy traffic in both directions bringing traffic to the Downtown area.

Both of these routes have a number of ITS devices installed but are deficient in covering all of the traffic movements, therefore additional ITS and communications equipment is recommended.

As illustrated in figure 27 these three routes bring traffic from I-95 and I-295 in both directions and therefore help relieve some of the interstate congestion.

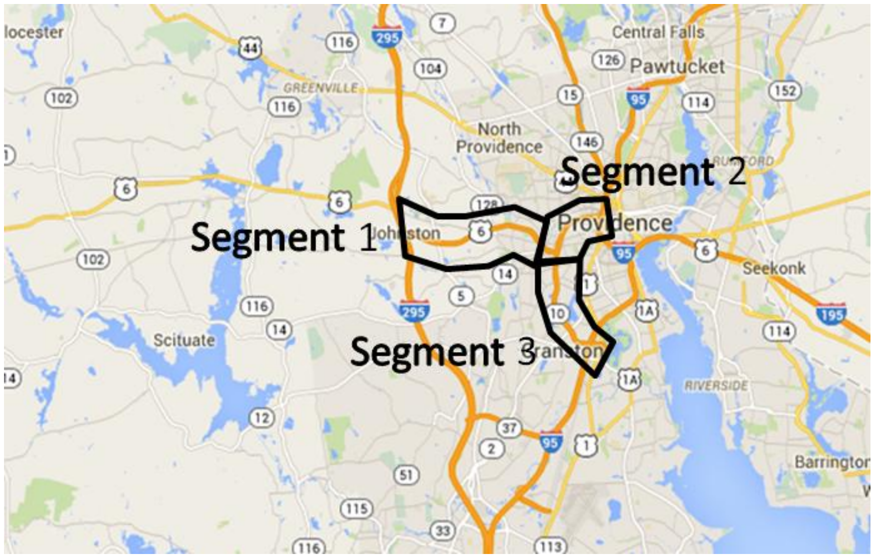


Figure 30: Route 6 and Route 10 Segments

Route & Segment	Segment Length (mi)	No. of New CCTV	No. of New DMS	No. of New RVD	No. of New HAR	Total Cost
Rte. 6 West Segment 1	4.1	3	0	5	0	$789,159
Rte. 6/10 Segment 2	1.4	2	0	3	0	$452,981
Rte. 10 Segment 3	3.1	5	1	4	0	$1,052,310
Total	**8.6**	**10**	**1**	**12**	**0**	**$2,289,450**

9.5.1 Segment 1: Route 6 West

The highway travel lanes are separated by a forty foot grass median, beginning at MM 0.50 to just after the Atwood Ave. Interchange where a guardrail type barrier begins and continues to approximately MM 2.15 where a Jersey type barrier wall begins and continues for the remainder of this segment. Power seems readily accessible from approximately MM 2.35 to the end of this segment.

A new Backbone Cable is being proposed for the entire segment and has two planned Splice points into the existing State Fiber at I-295 and RT 6/10, along with a few potential splice points into at crossovers.

The portion of RT 6 from the I-295 Interchange to Atwood Ave. has a frontage road on the south side and business with residential should have access to power off the ROW, including the Interchange.

The total cost of the ITS and communications deployment for this segment is $789,159.

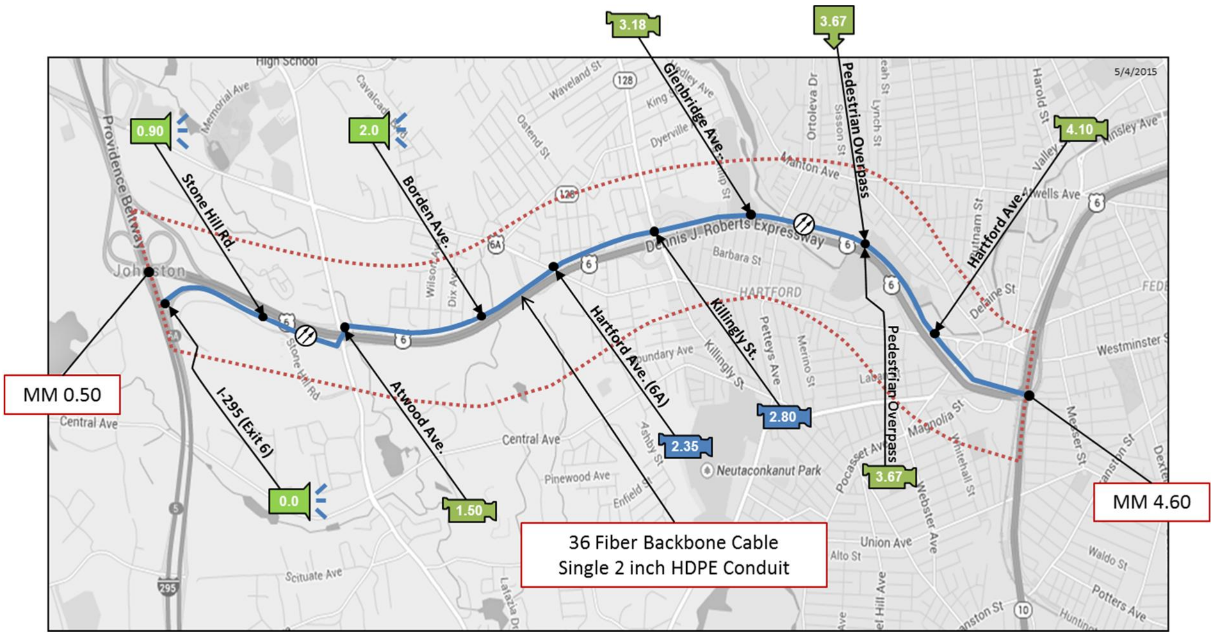
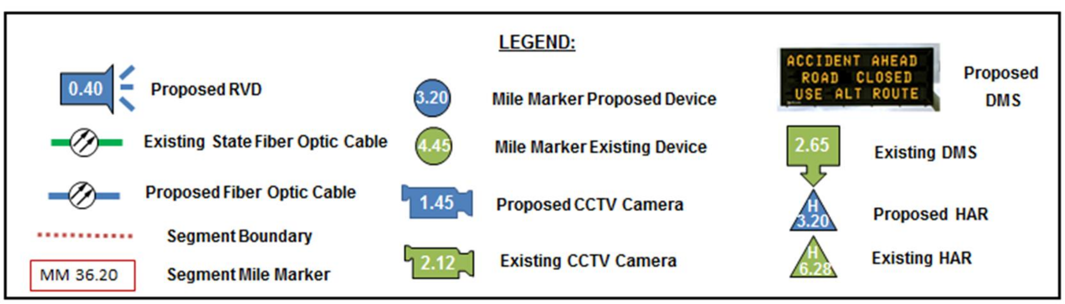


Figure 31: Route 6 West Segment 1 ITS Recommendations

Table 24: Route 6/10 Segment 1 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	3	$96,837.00
RVD Locations, Including Co-located with CCTV	5	$28,837.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$663,485.00
Total ITS Elements and Construction Cost	**8**	**$789,159.00**



9.5.2 Segment 2: Route 6/10

The highway travel lanes are separated by a Jersey type barrier wall that begins just south of Toby Street overpass (MM 0.21) and continues for the remainder of this segment.

There is new backbone cable and conduit proposed for this route.

The highway ROW on the northbound side is somewhat open for power connections while the southbound side is restricted due to Amtrak train tracks located outside the right-of-way for the entire segment.

The total cost of the ITS and communications deployment for this segment is $452,981.

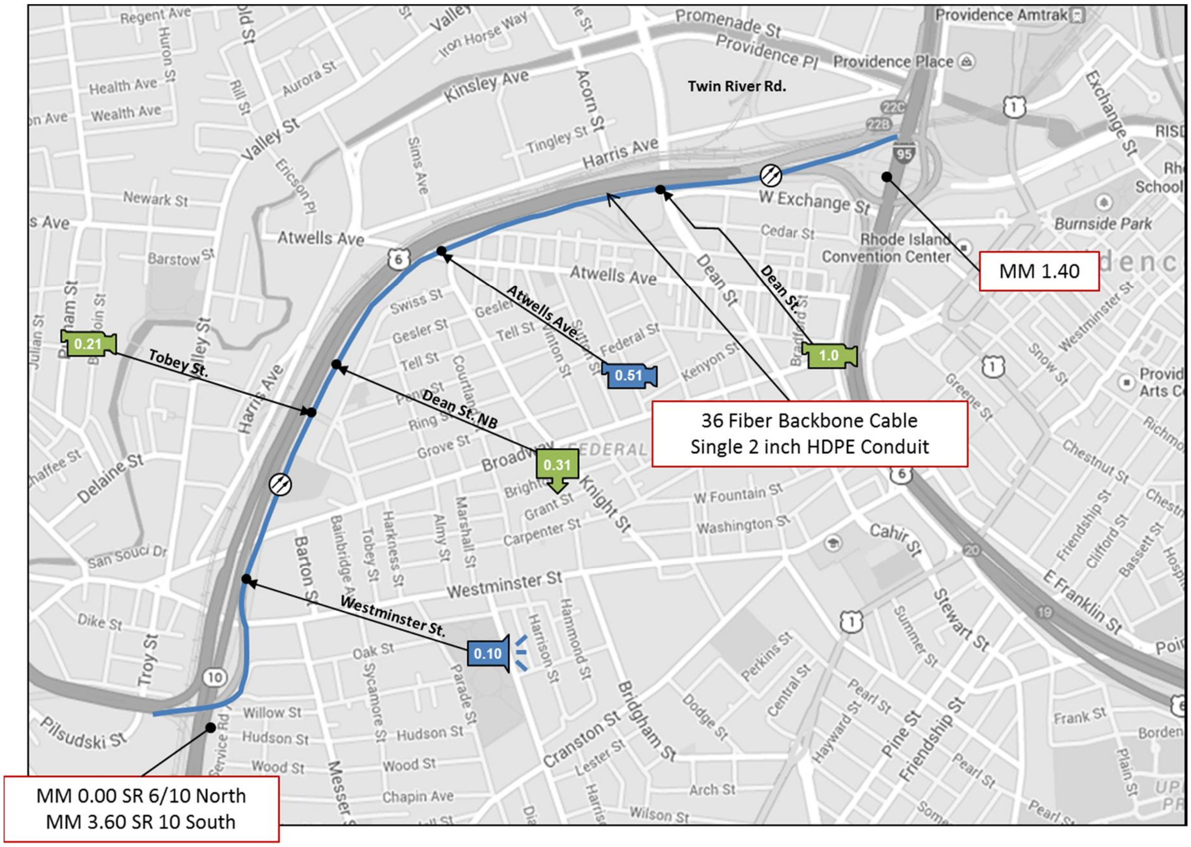
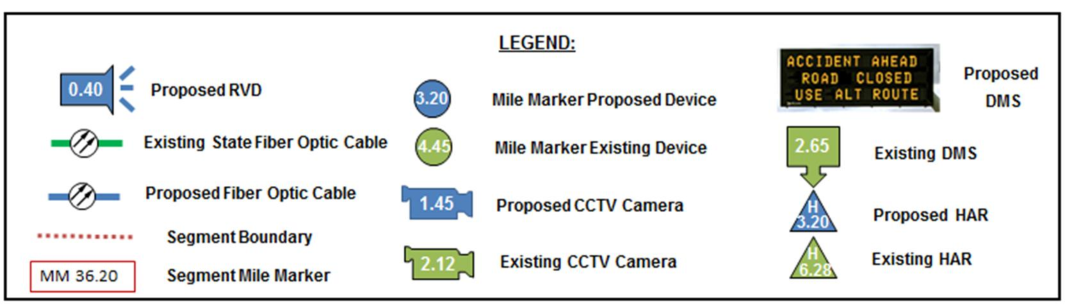


Figure 32: Route 6/10 Segment 2 ITS Recommendations

Table 25: Route 6/10 Segment 2 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	2	$97,750.00
RVD Locations, Including Co-located with CCTV	3	$41,550.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$313,681.00
Total ITS Elements and Construction Cost	**5**	**$452,981.00**



9.5.3 Segment 3: Route 10

The highway ROW is somewhat open but does have some dense trees on the outside of ROW fence. The highway ROW on the northbound side is somewhat open for power connections while the southbound side is restricted due to Amtrak train tracks located outside the right-of-way from MM 2.70 north for the remainder of this segment.

The highway travel lanes are separated by a Jersey type barrier wall that begins at the Elmwood Ave. overpass to MM 1.20, where the median opens up and a Cable barrier begins throughout this segment with guardrail type barrier inter-dispersed, as well.

A New Backbone Cable is being proposed for the entire segment and has a few potential splice points into the State Fiber cable at crossovers with main splicing at the I-95 and RT 6/10 interchanges.

The total cost of the ITS and communications deployment for this segment is $1,052,310.

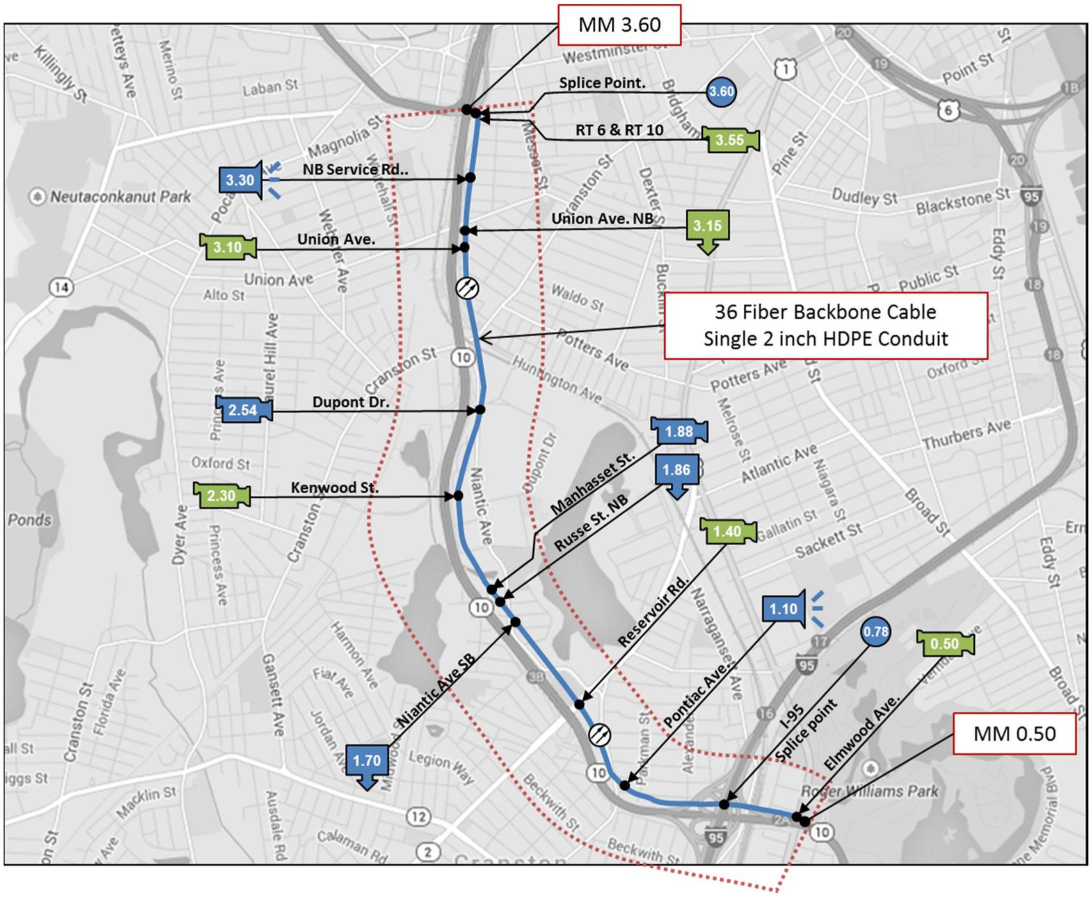
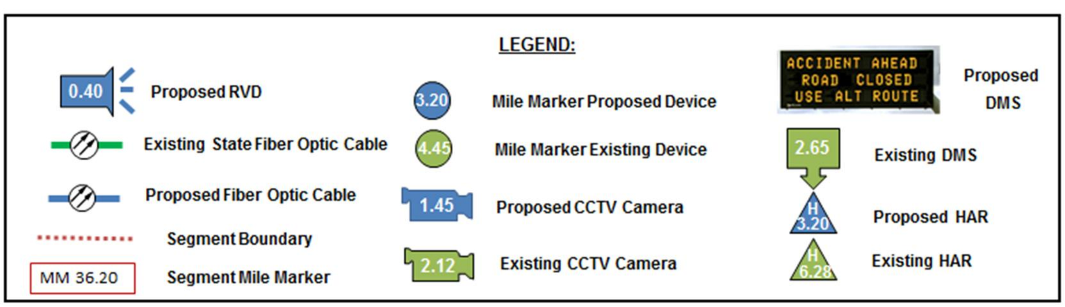


Figure 33: Route 10 Segment 3 ITS Recommendations

Table 26: Route 10 Segment 3 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	5	$108,412.00
RVD Locations, Including Co-located with CCTV	4	$64,012.00
DMS Locations, Including Structure	1	$325,000.00
Supporting Construction (conduit, cable, splicing, etc.)		**$554,886.00**
Total ITS Elements and Construction Cost	**10**	**$1,052,310.00**



9.6 **Route 24**

The highway ROW is somewhat open but does have some dense trees and large areas of vacant property on the outside of ROW fence. There is development that borders the highway. This holds true until the intersection of Main Road, where there is little development and access to power. This development continues power at the road crossing and interchanges. Beginning at the Mass State Line, highway travel lanes are separated by a 50’ grass median until just northeast of the interchange with Main Road, where a Jersey type barrier wall begins and continues to Boyd Lane. The median opens up to a 30’-40’ grass median and continues through this segment. It should be noted that at the 3.0 MM, there is ledge which may alter installed cable depths.

This segment of RT 24 that is Limited Access will have new 36 FO Backbone Cable proposed beginning at the SR 114 Split and continues to a point just north of Boyd Lane where it is planned to splice into existing State Fiber cable (Approx. MM 4.10). This State Fiber Cable extends to main Road (MM 3.31) where the new 24 FO Backbone Cable will begin again and installed to the end of the Route.

Figure 30 pinpoints the location of the proposed ITS devices for this Segment. The total cost of the ITS and communications deployment for this segment is $1,238,134.

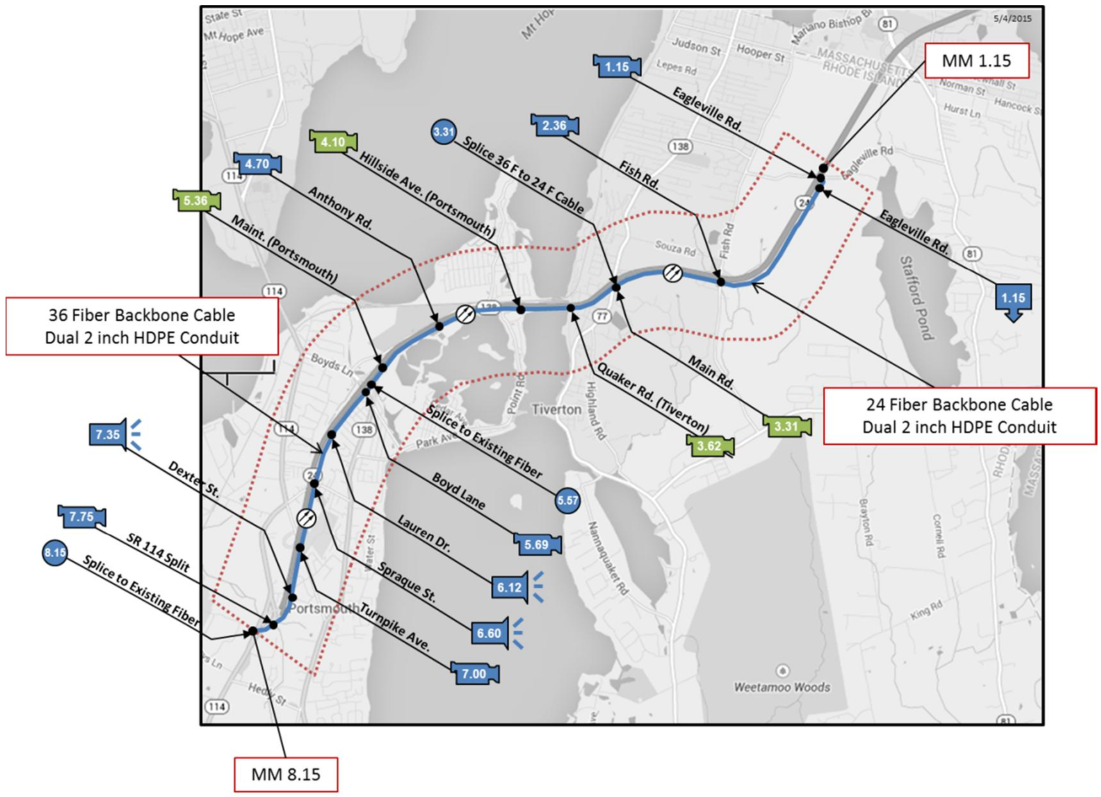
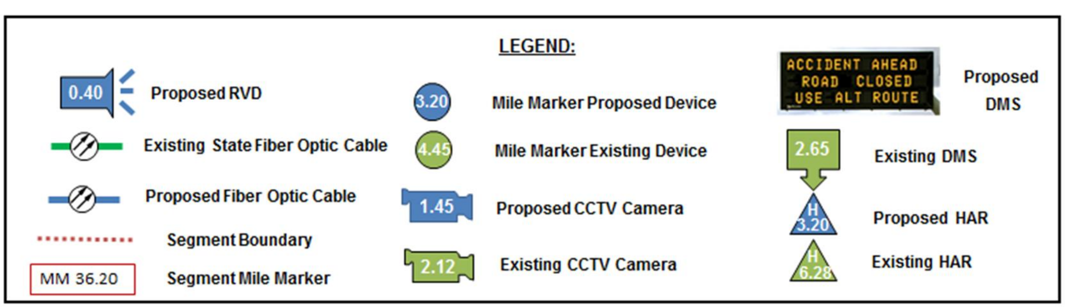


Figure 34: Route 24 ITS Recommendations

Table 27: Route 24 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	6	$283,787.00
RVD Locations, Including Co-located with CCTV	9	$115,187.00
DMS Locations, Including Structure	1	$325,000.00
Supporting Construction (conduit, cable, splicing, etc.)		$514,160.00
Total ITS Elements and Construction Cost	**16**	**$1,238,134.00**

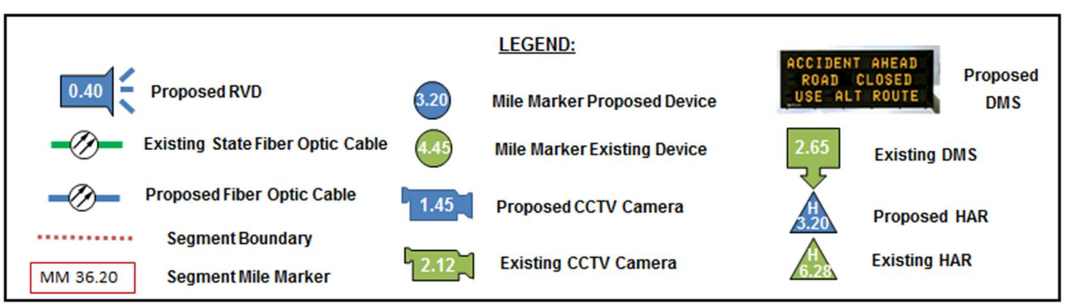


9.7 **Route 4**

The portion of RT 4 beginning at the RT 1 (Tower Hill Rd.) intersection, heading north, has limited access to power except from a few crossovers and some limited developments on either side of the roadway. The highway ROW is somewhat open but does have some dense trees on the outside of ROW fence. The roadway travel lanes are separated by a fairly wide grass median with only periodic guardrail at the overpasses. This grass median may be utilized for the location of the backbone cable and conduit. There is drainage present in the median.

A 36 Fiber Backbone Cable Duel 2 inch HDPE Duct System is being proposed for the entire segment with splicing to the proposed Hub Building "A" to be located on I-95 at Quaker Lane.

Figure 31 pinpoints the location of the proposed ITS devices for this Segment. The total cost of the ITS and communications deployment for this segment is $3,999,590.



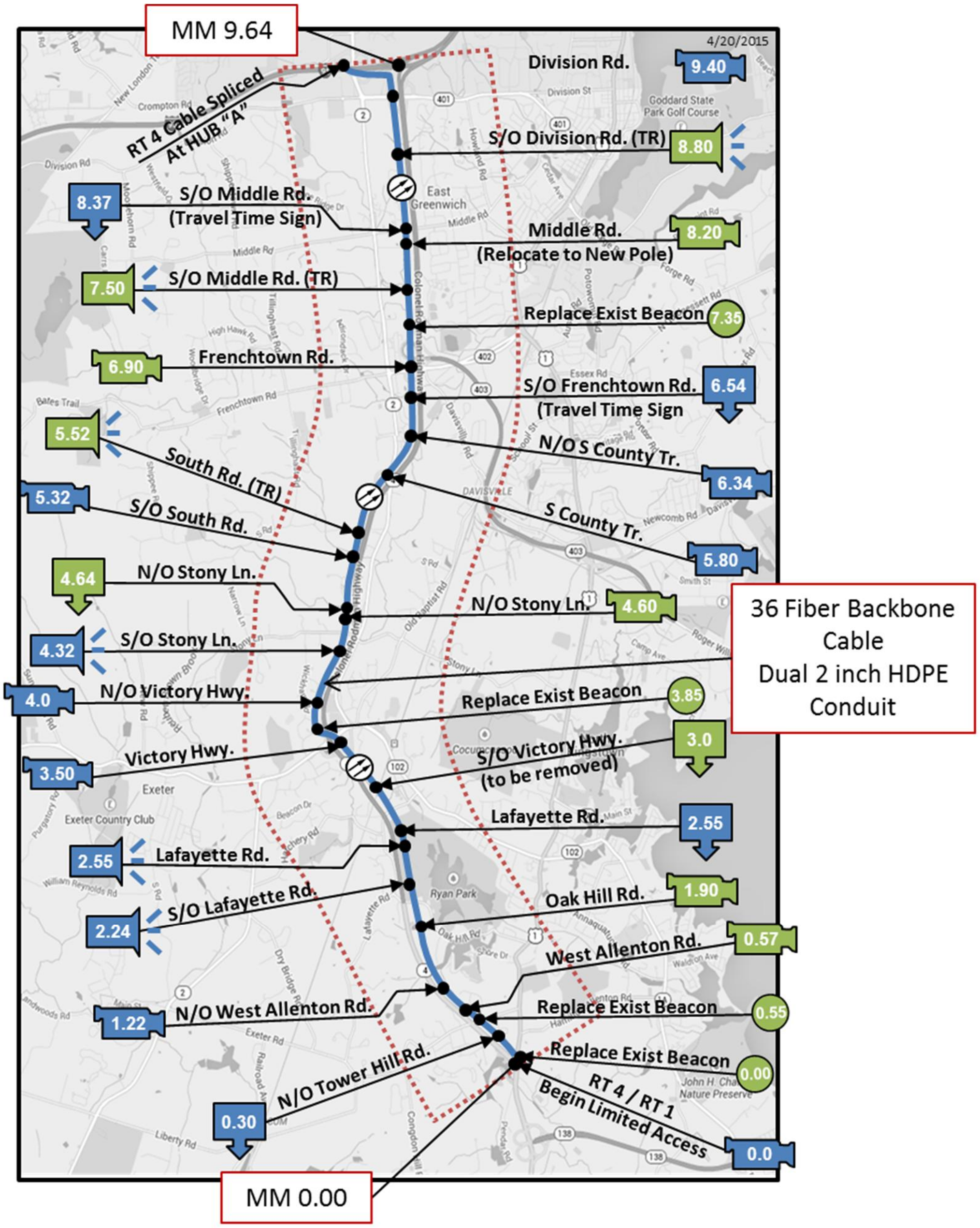


Figure 35: Route 4 ITS Recommendations

Table 28: Route 4 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	10	$485,350.00
RVD Locations, Including Co-located with CCTV	14	$205,742.00
DMS Locations, Including Structure	4	$500,000.00
Supporting Construction (conduit, cable, splicing, etc.)		$2,808,498.00
Total ITS Elements and Construction Cost	**28**	**$3,999,590.00**

9.8 **Route 37**

The portion of RT 37 beginning at the I-295 intersection, heading east to the ramps for New London Avenue, has access to power from either side of the highway. Other than the roadway crossing, from this point East to I-95, there is limited access to power off the ROW.

The highway ROW is somewhat open but does have some dense trees in the outside of ROW fence. This opens up again after crossing I-95 where there is a RIDOT Facility on the I-95 ROW and access to the RIDOT Maintenance Headquarters off of Jefferson Blvd.

The highway travel lanes are separated by a Jersey type barrier wall that begins at I-295 and continues to a point just west of I-95 where the median opens up to a wide separation for the entrance and exit ramps to I-95.

A 36 Fiber Backbone Cable Duel 2 inch HDPE Duct System is being proposed for the entire segment with splicing to the proposed Hub Building to be located at the RIDOT Facility.

Currently, there are no plans to incorporate the existing Cranston HAR and beacons into the fiber system.

Figure 32 pinpoints the location of the proposed ITS devices for this Segment. The total cost of the ITS and communications deployment for this segment is $638,037.

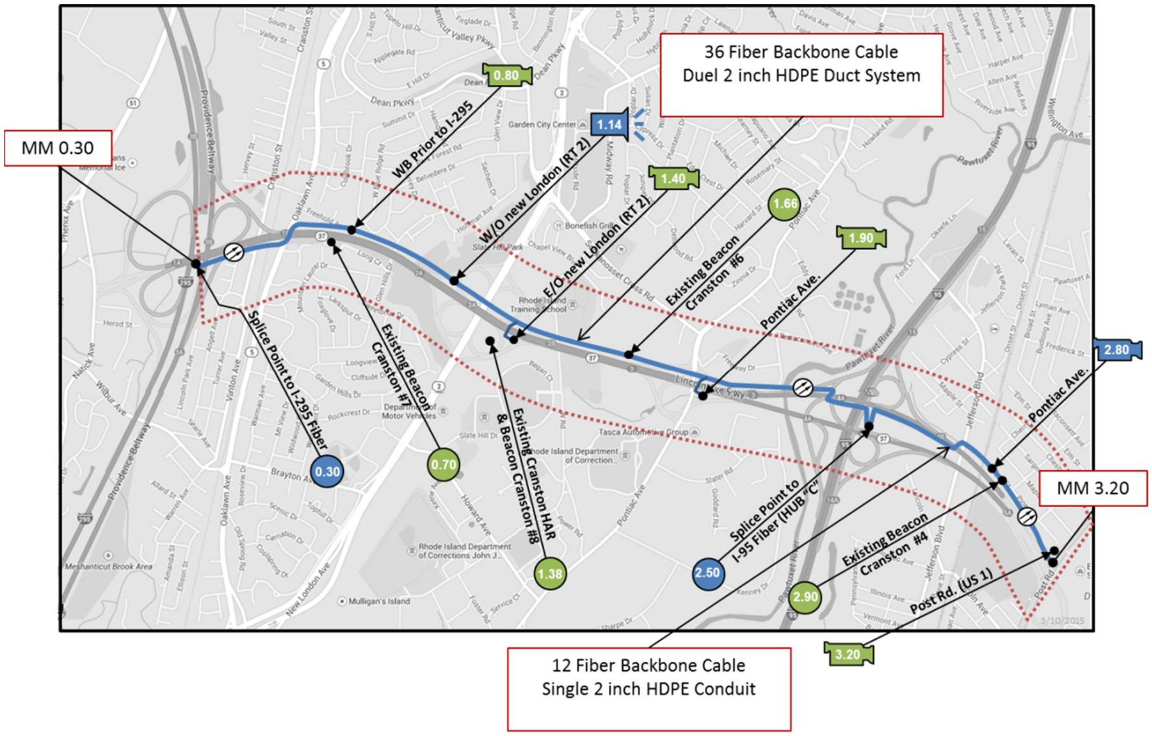
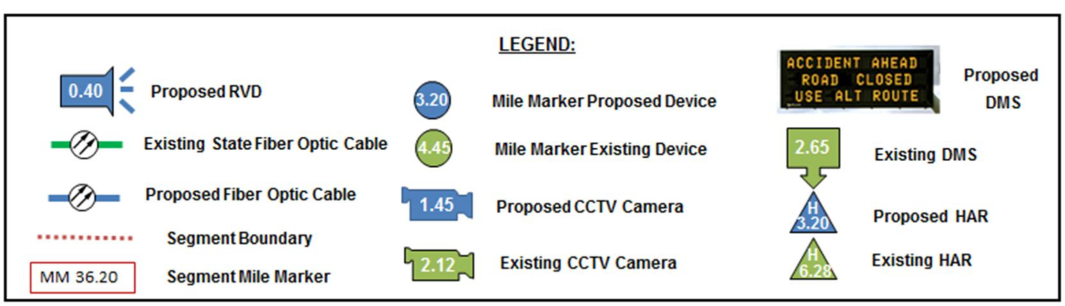


Figure 36: Route 37 ITS Recommendations

Table 29: Route 37 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	2	$68,900.00
RVD Locations, Including Co-located with CCTV	2	$27,700.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$541,437.00
Total ITS Elements and Construction Cost	**4**	**$638,037.00**



9.9 **Route 138**

The highway ROW is somewhat open but does have some dense trees off the ROW. The roadway travel lanes are separated by a fairly wide grass median until MM 0.80, west of the Jamestown Bridge where a Jersey Type Barrier wall begins and continues for the remainder of this segment.

New Backbone Cable is being proposed for the beginning segment, from MM 0.10 to RI 1A MM 2.20, where at this point the cable is proposed to be spliced into existing State fiber. New Backbone Cable is being proposed from a point east of the Jamestown Bridge and continuing along the remainder of this segment. A proposed section of US 1 is to have cable installed and connect the RT 138 backbone cable to the RT 4 fiber system, which will then connect to the I-95 Backbone Cable.

The portion of RT 138 beginning at the US 1 (Tower Hill Rd.) intersection, continuing east to RI 1A, has very limited access to power except for one crossover at Gilbert Stuart Rd.

Figure 33 pinpoints the location of the proposed ITS devices for this Segment. The total cost of the ITS and communications deployment for this segment is $1,214,865.

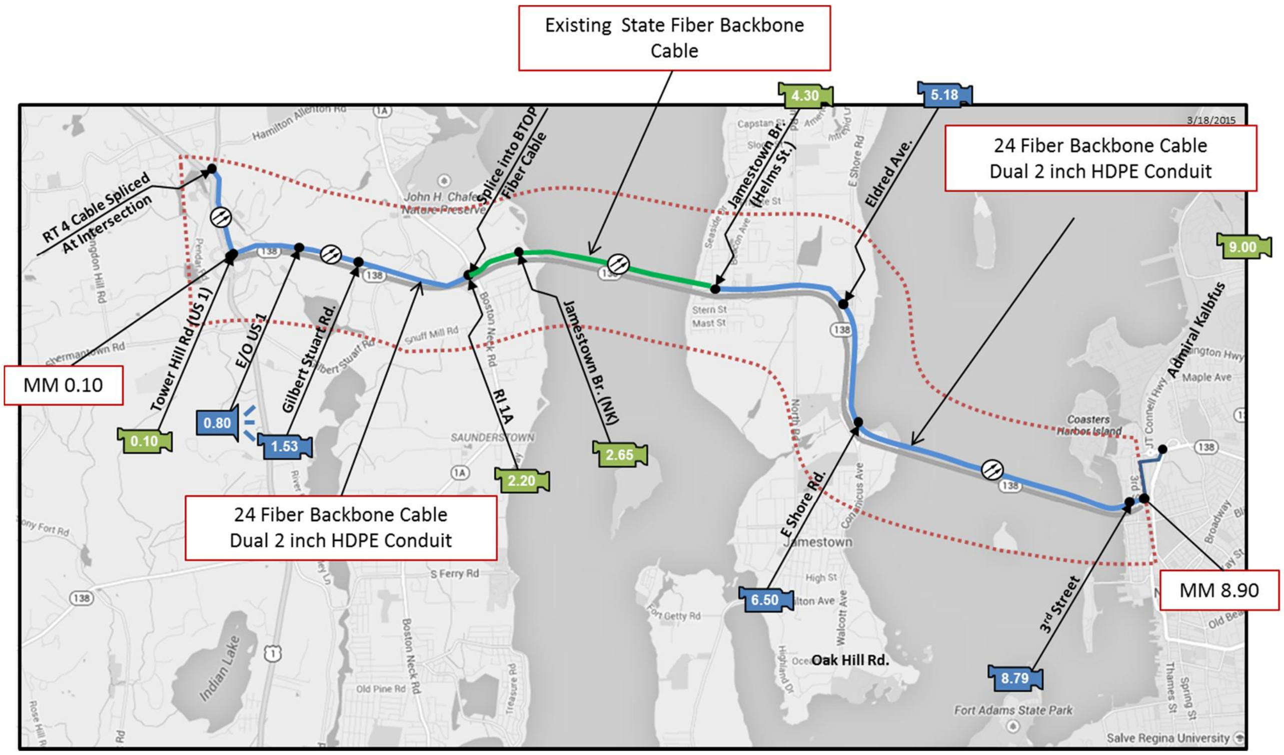
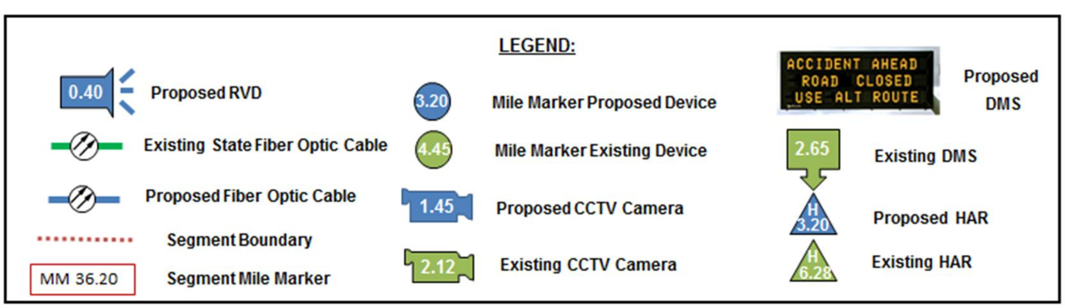


Figure 37: Route 138 ITS Recommendations

Table 30: Route138 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	5	$205,562.00
RVD Locations, Including Co-located with CCTV	6	$67,162.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$942,141.00
Total ITS Elements and Construction Cost	**11**	**$1,214,865.00**



9.10 **Route 78**

The highway ROW is somewhat open but does have some dense trees, both on and off the ROW. The roadway travel lanes are single lane in each direction, separated by Jersey type barrier wall that begins at the State line and continues for the remainder of this segment.

The portion of RT 78 beginning at the Rhode Island State Line, just west of White Rock Rd., continuing east to Oak Street, has some limited access to power. There is a fairly wide area to the ROW fence (235’ +/- from centerline). The East side of the roadway does not have access to power from approx. MM 2.32 (Oak St.) south to US 1.

New Backbone Cable is being proposed for the entire segment, no state fiber to connect to at this time.

The total cost of the ITS and communications deployment for this segment is $659,058.

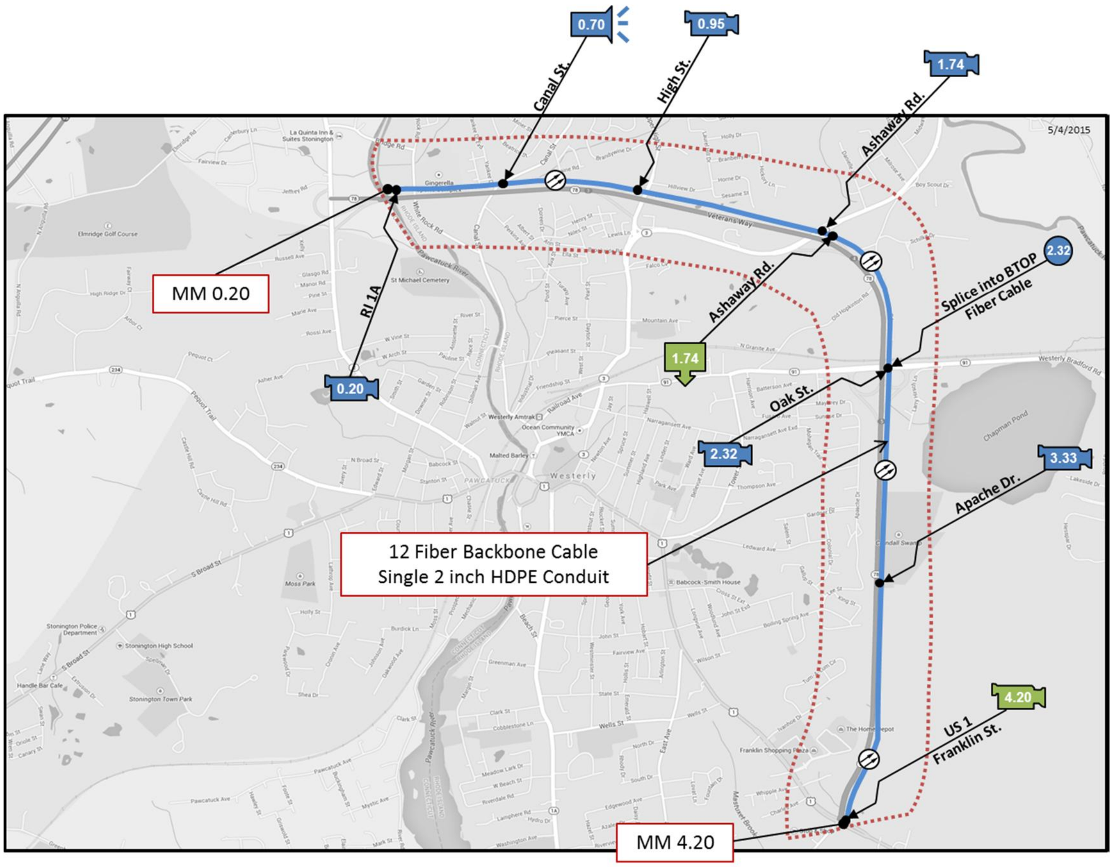
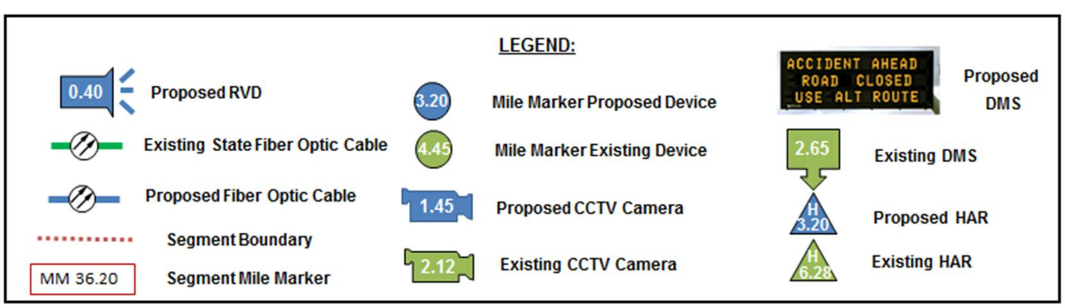


Figure 38: Route 78 ITS Recommendations

Table 31: Route 78 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	5	$225,012.00
RVD Locations, Including Co-located with CCTV	6	$66,812.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$367,234.00
Total ITS Elements and Construction Cost	**11**	**$659,058.00**



9.11 **Route 403**

The highway ROW is somewhat open but does have some dense trees, both on and off the ROW. The east bound side of the roadway has Amtrak train tracks alongside of the roadway from approx. MM 1.20 to MM 2.50.The roadway travel lanes are separated by a Jersey type barrier wall that begins at RT 4 and continues for the remainder of this segment until just prior to the intersection of Roger Williams Way.

The portion of RT 403 beginning at RT 4, continuing east to Devils Foot Road, has some limited access to power only at crossroads, this may limit installations. Access to power is improved after devils Foot Rd but only from the north side.

A 24 Fiber Backbone Cable Single 2 inch HDPE Duct System is being proposed from the beginning of the segment, from MM 0.20 to the end of the segment MM 4.20 (Roger Williams Way).

The total cost of the ITS and communications deployment for this segment is $516,632.

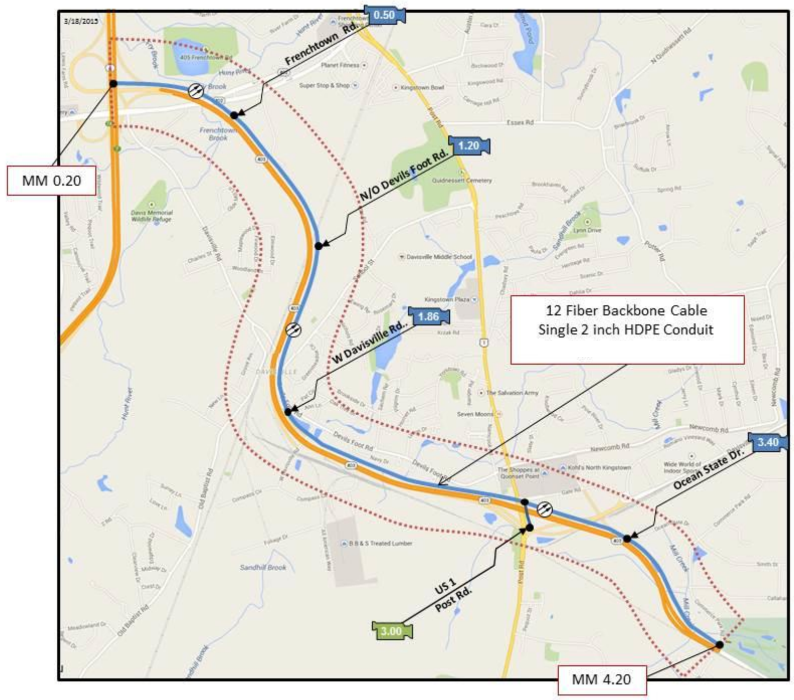
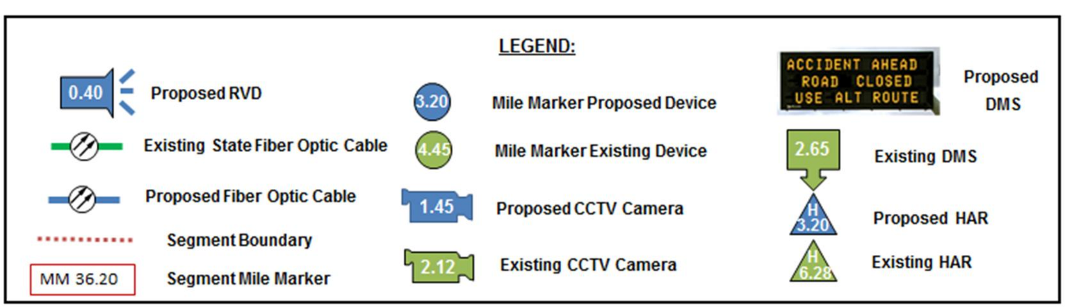


Figure 39: Route 403 ITS Recommendations

Table 32: Route 403 ITS Recommendations Cost Summary

ITS Elements and Construction	No. of New Devices	Cost
CCTV Camera Locations, Including Poles	4	$177,400.00
RVD Locations, Including Co-located with CCTV	4	$41,400.00
DMS Locations, Including Structure	0	$0.00
Supporting Construction (conduit, cable, splicing, etc.)		$218,800.00
Total ITS Elements and Construction Cost	**8**	**$516,632.00**



10 Service Patrols

Across the Nation, many Municipalities, Cities and States have forged into the Traffic Management arena by implementing Service Patrols or Safety Service Patrol (SSP) programs on their more congested thoroughfares. These endeavors have yielded benefits on two fronts: quicker incident clearing times aiding in the safety of responders, and a positive public awareness of the value of the DOT.

Service Patrols monitor predefined high usage routes to quickly and safely remove minor obstructions before they trigger a more serious impact. Service Patrols often handle minor incidents independently and faster than traditional first responders and free up first responders for more critical roles. Service Patrol Operators (SPO) may also be the first to notice an incident and call the TMC to trigger Incident Management procedures for more serious incidents. For this reason the SPO must have a certain level of Incident Management (IM) training and experience.

In some jurisdictions, Service Patrol Operators will work with other public safety organizations (including law enforcement, fire, emergency medical services, and towing and recovery professionals), to rapidly and safely address more complex traffic incidents. However, the capabilities of these service patrols vary among the major metropolitan areas.

The FHWA encourages the largest metropolitan jurisdictions and their States to establish or upgrade their service patrols. To assist in these efforts, FHWA develops guidelines and planning tools to aid jurisdictions in improving the quality, number of miles covered and consistency of Service Patrols throughout the country.

FHWA notes that the quick clearance assistance Service Patrols provide assistance in reducing secondary accidents that generally occur in the backup. The following statement comes directly from the FHWA TIM handbook.

> *Information presented at the National Conference on Traffic Incident Management indicated that secondary crashes account for more than 20 percent of all crashes. The U.S. Department of Transportation (USDOT) estimates that 18 percent of the fatalities occurring on Interstates are due to secondary crashes. Overall findings show that improvement in all aspects of TIM, especially in incident duration and responder*

roadside exposure, reduces the probability of secondary crashes. An additional finding states that TIM improvements promote a significant safety benefit as well. [8]

FHWA Traffic Incident Management Program Manager Paul Jodoin stated to the TMC on 01/9/2013 that Service Patrols "are the most well-received program that any DOT can do." Paul has offered to speak in behalf of the benefits of service patrols and FHWA's support at the request of the DOT. We noted to Paul that within the RIDOT, we often get asked if other states are doing Service Patrols. His response was that Rhode Island is the only top-40 metropolitan area in the United States which does not have a Service Patrol program.

> *Service Patrols "are the most well-received program that any DOT can do." Paul Jodoin, FHWA*

A Request for Proposals (RFP) was prepared for RIDOT in 2013 to create a Service Patrol program for Rhode Island, but has not been advertised due to budgeting priorities. The scope of work in the RFP consists of providing trained operators using specially equipped service vehicles to routinely patrol the more congested segments of state highways during morning and afternoon peak travel hours.

- Route A – Defined as beginning at the junction of Route 4 and Frenchtown Road, north to I-95, then north to the junction of I-95 and RT 37, both northbound and southbound (approx. 9.2 route miles).
- Route B – Defined as beginning on Interstate Route 1-95 from the junction of RT 37 and I-95, then north to the junction of I-95/I-195, then East on I-195 to the median crossing just past the Massachusetts State Line, both northbound and southbound on I-95 and eastbound and westbound on I-195 (approx. 9.1 route miles).
- Route C – Defined as beginning at the junction of East Street and I-95, then south to the junction of I-95/I-195 and then north on I-95 to RT 146, then north on RT 146 to the junction of RT 146 and Mineral Springs Road, both northbound and southbound on both routes (approx. 9.2 route miles).

The main objective is to quickly get stopped vehicles moving and out of harms' way by locating, assisting, and/or calling for the removal of any disabled vehicles or debris thereon as soon as possible. Safety lights on the service Patrol vehicle add a layer of protection for both the SPO and the stopped motorist. The RFP proposed three (3) service vehicles to be provided by the Contractor.

[8] http://www.ops.fhwa.dot.gov/eto_tim_pse/publications/timhandbook/chap3.htm

The cost estimate to operate Service Patrols as described in the RFP is approximately $270,064 a year, including operations, maintenance and insurance.

A Service Patrol Sponsor may offset the operating cost for RIDOT. For example, State Farm insurance pays $850,000 a year to Ohio DOT to have its logo displayed on state vehicles, uniforms and roadway signs. The Ohio freeway service patrol was rebranded as the State Farm Freeway Patrol. Ohio is just one of twelve states that State Farm has partnered with to sponsor Service Patrols.

A telephone survey was conducted by the Transportation Research Board (TRB) with managers of 53 freeway service patrols in 22 states. Approximately 47% of the surveyed patrols are sponsored exclusively by Department of Transportations; Approximately 34% of the patrols receive federal support funding. Finally, 27% of the patrols operate with private funding sources.[9]

[9] http://trid.trb.org/view.aspx?id=541874

11 Maintenance Costs

Maintenance costs are not included in the ITS Deployment Strategy recommendations or cost tables, but are included in this section as collateral information pertinent to the total funding requirements of ITS for RIDOT.

11.1 Obsolescence Remediation and Replacement Costs

The ITS equipment including cameras, electronic signs, computers, and power supplies for example, will age and need repair and replacement. In addition, most of the technologies rely on software and firmware that becomes obsolete and incompatible with other equipment with which they must communicate and integrate. A carefully schedule obsolescent remediation plan considers the age and compatibility issues and formulates a replacement strategy that keeps equipment current and operational over time in a fiscally responsible manner. This includes planned or scheduled replacements before wide spread failure and eases the financial burden by spreading the replacements over time.

For example, DMS signs have an expected 10 year support life span by the manufacturers. From hands on experience, we know that we can expect up to another 5 years of operation. If by example the RIDOT purchased and installed 5 DMS at one time, a good plan is to schedule replacements beginning in year 10, and replace one sign every year thereafter. By year 15, all signs have been replaced and in the interim, you may have salvaged enough parts to keep the remaining signs working should the DMS manufacturer no longer support the parts replacements.

The first step in an obsolescence remediation is to identify the life cycle of each product. This is done through a Life Cycle Analysis. Expiration of a devices' useful life considers the harsh environment to which the equipment is exposed, such as the elements, age, and subjection to road salts and other contaminants. Another major factor is the technological nature of the equipment, the software that controls it and the interaction and associated compatibility requirements to connected systems. For example, software must be compatible with the computer hardware and operating system on which it resides. As technology improvements occur, such as improved video quality of cameras, the software and communications must maintain a standard to keep all parts functioning.

As shown in the figure below, Product Lifecycles can be represented over time. The green area represents the time a product is fully supported by the manufacturer. The gray area represents the stage in the equipment life-cycle due to age and technology evolution where vendor support diminishes or where there is reduced parts availability.

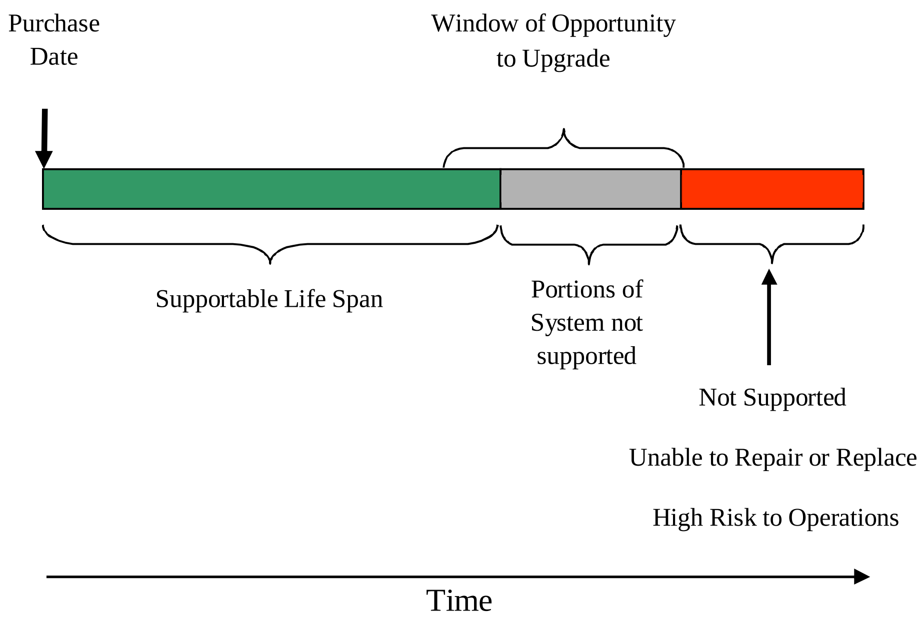


Figure 40: Product Lifecycle

The graph identifies that the time to replace a piece of equipment is *before* the equipment is unsupportable. Long lead times to purchase or replace equipment increases the urgency to begin the replacement strategy. By the time the equipment is in the red area of its life cycle, repair parts cannot be obtained and or vendor support does not exist, resulting in inability to repair or replace. There are also hidden and higher costs to replacing equipment in an emergency. This may include expedited support or shipping costs as well as the inability to solicit competitive bids. But, the major cost is the down time of the equipment.

An ITS Lifecycle Analysis was conducted in 2015 that identified a replacement strategy that sought to create:

- A life cycle schedule that will assist in down time prevention and capital planning including costs savings attained from planned purchases and competitive bidding;
- Identification of critical assets and needed replacements;
- A schedule of improvements to database and processes to better manage assets; and
- A clear picture of the current outlay of assets.

The chart below shows the scheduled replacement costs for ITS equipment as a result of the lifecycle analysis and obsolescence remediation plan. These costs are reflected in the yearly planned budgets in the Recommendations and Executive Summary sections of this document.

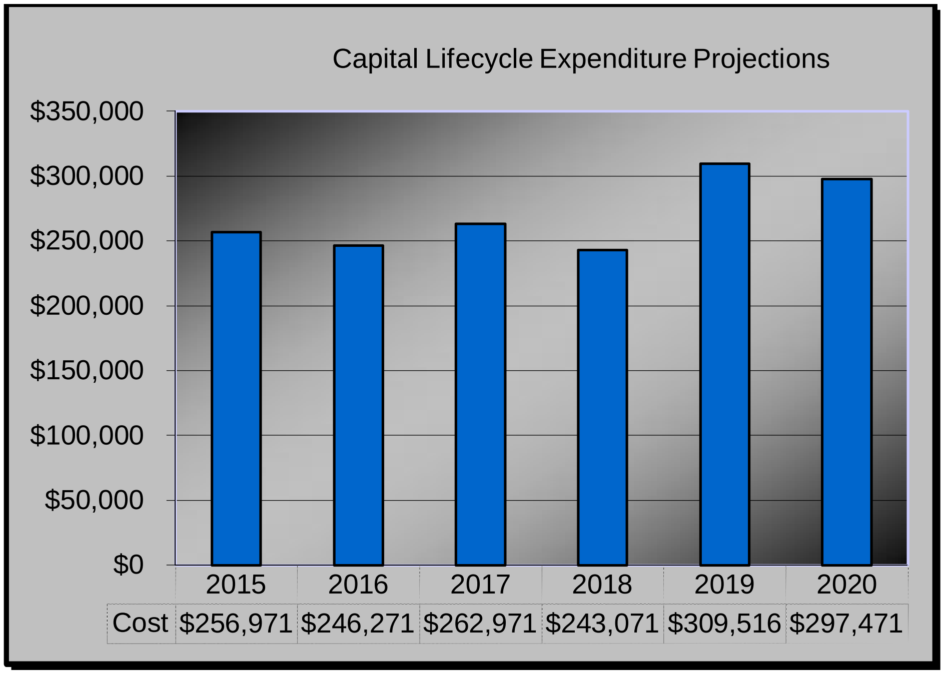


Figure 41: Equipment Replacement Costs 2015-2020

The following table summarizes the expenditures expected by category including CCTV, DMS, radar, etc.

Table 33: Equipment Replacement Costs per Device 2015-2020

ITS Devices	2015	2016	2017	2018	2019	2020
Video (CCTV)	$120,000	$120,000	$80,000	$24,700	$24,700	$24,700
HAR	$120,970	$65,970	$175,970	$65,970	$126,215	$120,970
DMS	$0	$0	$0	$120,000	$120,000	$120,000
Traffic Sensors	$16,000	$18,300	$0	$19,900	$18,400	$12,600
Network	$0	$42,000	$7,000	$12,5000	$20,200	$19,200
Total	**$256,971**	**$246,271**	**$262,971**	**$243,071**	**$309,516**	**$297,471**

It is important to realize that the scheduled obsolescence remediation (replacement) costs amount to only 2% of the total ITS capital investment of $10.8 M per year.

11.2 **Equipment Maintenance Contract Costs**

The table below shows the current and planned maintenance contracts for the support of RIDOT's ITS equipment. The ITS On-Call Construction Contract and the On-Call Camera and Video Systems Contract provide most of the funding for parts and service for some of the more common equipment failures, which is primarily camera and video equipment related.

Unfortunately, even though the contracts with line item parts are budgeted and approved, each item to be repaired or replaced must go through a separate approval process resulting in delays of days to weeks to repair critical infrastructure. Delayed equipment repairs create the potential for operations to not recognize and respond to a roadway incident in a timely manner. Timely incident response is the key to reducing congestion and the chances of secondary incidents, so delays in purchasing parts can have a direct affect to highway safety. The following table identifies the yearly current and recommended maintenance costs.

Recommendation: The "critical expense" solicitation process should be streamlined to expedite emergency equipment repairs.

Delays in purchasing parts can have a direct affect to highway safety and performance metrics.

Maintenance Contract	Per year
ITS On-Call Maintenance (includes camera cleaning, bucket trucks, traffic set ups, equipment troubleshooting and repairs)	$ 130,000
ITS On-Call Construction (camera poles, cabinets, trenching, conduit)	$ 130,000
On-Call Camera and Video Systems Contract (provides new cameras and equipment; Amities and Crestron video management system service)	$ 130,000
Daktronics Overhead Sign Parts & Maintenance and Software Support	$ 80,000
HVAC Maintenance (server room units, boiler, Trane software, AHU)	$ 2,000
MH Corbin (HAR parts)	$ 16,666
CARS Maintenance & Operations	$ 105,000
Wavetronix Software Maintenance Contract (needed)	~$ 38,000
Generator Maintenance Contract (needed)	~$ 2,000
ITS Maintenance for kiosk, Planar video cubes, Jupiter video switch	~$ 20,000
UPS Maintenance (paid by DoIT)	$0
Wrong Way Driver system repair parts (covered under current 3-year warranty, then TMC needs to support)	$ TBD
Total	$653,666

Table 34: Summary of ITS Maintenance Costs

12 Criteria and Recommendations Matrices

The phased deployment recommendations are the result of the application of ITS criteria and function as well as the $5 Million annual budget for RIDOT ITS construction. While this report supports all of the recommendations, the purpose of the recommendations matrices is to rank their importance to assign which projects will be recommended for short term, and which will be recommended for long term to provide RIDOT the highest Return on Investment (ROI). Each Criteria and Functional Benefit is weighted equally to assign an Overall Score that subsequently sets a level of priority for the yearly ITS recommendations.

The Service Patrol Program is recommended to be deployed as soon as possible and is considered an annual cost. The replacement cost, maintenance and obsolesce remediation should be planned for and is a line item of the expected construction budget for ITS.

Deployment Recommendation and Needs Assessment Matrix

Recommendations by Route and Segment

Corridor	Cost	Criteria					Functional Benefit				Cost	Priority	Level
		Congestion	Bottlenecks	Crash Frequency	Traveler Info	General (Power, Comm., etc.)	Reduce Congestion	Incident Management	Improve Safety	Federal Data Requirements			
I-95 Segment 7	**$ 1,148,682**	◆	◆	◆	◆	◆	◆	◆	◆	◆	$ $ $	1	◆
I-95 Segment 6	**$ 958,566**	◆	◆	◆	◆	◆	◆	◆	◆	◆	$ $	2	◆
Rte. 146 Segment 1	**$ 702,505**	◆	◆	◆	◆	◆	◆	◆	◆	△	$ $	3	◆
I-95 Segment 5	**$ 1,902,418**	◆	◆	◆	◆	△	◆	◆	◆	◆	$ $ $	4	◆
Interstate 195	**$ 444,386**	◆	◆	◆	◆	△	◆	◆	◆	△	$	5	◆
Rte. 6/10 Segment 2	**$ 452,981**	◆	◆	◆	◆	●	◆	◆	◆	△	$	6	◆
Route 10 Segment 3	**$ 1,047,310**	◆	◆	◆	△	△	◆	◆	△	◆	$ $ $	7	◆
Rte. 6 West Segment 1	**$ 789,159**	◆	◆	◆	△	●	◆	◆	◆	◆	$ $	8	◆
I-295 Segment 1	**$ 2,257,594**	◆	◆	◆	△	◆	△	△	△	◆	$ $ $	9	◆
Route 37	**$ 638,037**	◆	◆	◆	◆	△	◆	●	●	◆	$ $	10	◆

Deployment Recommendation and Needs Assessment Matrix

Recommendations by Route and Segment

Corridor	Cost	Criteria					Functional Benefit				Cost	Priority	Level
		Congestion	Bottlenecks	Crash Frequency	Traveler Info	General (Power, Comm., etc.)	Reduce Congestion	Incident Management	Improve Safety	Federal Data Requirements			
Service Patrols (2017-2020)	**$ 1,080,256**	△	△	△	●	●	◆	◆	◆	●	$ $	11	△
Route 4	**$ 3,999,590**	◆	◆	△	△	△	◆	●	●	◆	$ $ $	12	△
Route 138	**$ 1,214,865**	◆	◆	△	△	△	◆	●	●	◆	$ $	13	△
I-95 Segment 4	**$ 1,262,937**	△	△	△	△	△	●	●	△	◆	$ $ $	14	△
I-95 Segment 3	**$ 1,676,238**	●	●	△	△	△	◆	△	△	◆	$ $ $	15	△
I-95 Segment 2	**$ 1,125,354**	●	●	△	△	△	◆	△	△	◆	$ $ $	16	△
I-95 Segment 1	**$ 1,963,794**	●	●	△	△	△	◆	△	△	◆	$ $ $	17	△
Rte. 146 Segment 2	**$ 1,689,458**	△	△	△	△	△	●	△	△	△	$ $	18	△
I-295 Segment 3	**$ 375,780**	●	●	△	△	●	●	△	△	◆	$	19	●
I-295 Segment 4	**$ 521,630**	●	●	△	△	●	●	△	△	◆	$ $	20	●
I-295 Segment 2	**$ 1,151,342**	●	●	△	△	●	●	△	△	◆	$ $ $	21	●
Route 24	**$ 1,238,134**	●	●	●	●	●	●	●	●	●	$ $ $	22	●
Route 403	**$ 516,633**	●	●	●	●	●	●	●	●	●	$	23	●
Route 78	**$ 659,058**	●	●	●	●	●	●	●	●	●	$ $	24	●

Need	Greatest	◆
	Moderate	△
	Lower	●
Cost	< 1M	$
	1M < x <2M	$ $
	2M	$ $ $

Table 35: Deployment Needs Recommendations Matrix

13 Recommendations

All of the recommended projects from ITS Deployment Recommendations have been assigned a priority based on the Criteria and Needs Assessment. The projects were then put in order of priority in a table to determine which projects are to be short term recommendations versus long term recommendations. This Plan assumes a budget of $5 Million between 2010-2015 for Short Term Projects for a total of $25 Million. The project recommendations after the budget years are Long Term Recommendations. As stated, the Service Patrol Program and the replacement costs have also been included as line items for the upcoming short term budgets.

13.1 Short Term Recommendations (2015-2020)

Short Term Recommendations			
Recommendations by Route and Segment			
	2015		
Corridor	**Cost**	**Priority**	**Level**
I-95 Segment 7	***$ 1,148,682***	***1***	◆
I-95 Segment 6	***$ 958,566***	***2***	◆
Rte. 146 Segment 1	***$ 702,505***	***3***	◆
I-95 Segment 5	***$ 1,902,418***	***4***	◆
Total 2015 Cost	**$ 4,712,171**		

Highest Priority ◆
Moderate Priority ▲
Lowest Priority ●

2016				
Corridor	Cost		Priority	Level
Interstate 195	*$*	*444,386*	*5*	◆
Rte. 6/10 Segment 2	*$*	*452,981*	*6*	◆
Route 10 Segment 3	*$*	*1,047,310*	*7*	◆
Rte. 6 West Segment 1	*$*	*789,159*	*8*	◆
I-295 Segment 1	*$*	*2,257,594*	*9*	◆
Total 2016 Cost	$			4,991,430

2017				
Corridor	Cost		Priority	Level
Route 37	*$*	*638,037*	*10*	◆
Service Patrols	*$*	*270,064*	*11*	△
Route 138	*$*	*1,214,865*	*13*	△
I-95 Segment 4	*$*	*1,262,937*	*14*	△
I-95 Segment 2	*$*	*1,125,354*	*16*	△
Total 2017 Cost	$			4,511,257

2018				
Corridor	Cost		Priority	Level
Service Patrols	*$*	*270,064*	*11*	△
Route 4	*$*	*3,999,590*	*12*	△
Total 2018 Cost	$			4,269,654

2019				
Corridor	Cost		Priority	Level
I-95 Segment 3	*$*	*1,676,238*	*15*	△
I-95 Segment 1	*$*	*1,963,794*	*17*	△
Service Patrols	*$*	*270,064*	*11*	△
Total 2019 Cost	$			3,910,096

2020				
Corridor	**Cost**		**Priority**	**Level**
Service Patrols	**$**	**270,064**	***11***	
Rte. 146 Segment 2	***$***	***1,689,458***	***18***	
I-295 Segment 3	***$***	***375,780***	***19***	
I-295 Segment 4	***$***	***521,630***	***20***	
I-295 Segment 2	***$***	***1,151,342***	***21***	
Total 2019 Cost	**$**			**4,008,274**

Figure 42: Short Term Recommendations 2015-2020

13.2 Long Term Recommendations

ITS Projects

Long term recommendations are those items and services that cannot be reasonably expected to be funded in the short term (2015-2020), but are considered of value. Long range ITS projects include those ITS improvement projects in the following table.

Long Range Projects (Beyond 2020)			
Corridor	Cost	Priority	Level
Service Patrols (per year)	***$ 270,064***	***11***	
Route 24	***$ 1,238,134***	***22***	
Route 403	***$ 516,633***	***23***	
Route 78	***$ 659,058***	***24***	
Total Cost	**$ 2,683,889**		

Figure 43: Long Term Recommendations 2020 & Beyond

Highest Priority
Moderate Priority
Lowest Priority

Service Patrols

This Plan recommends soliciting public/private partnerships to fund the Service Patrol program. As shown, the yearly cost to have three vehicles patrol the major areas of congestion during peak travel times is $270,064 a year.

Lifecycle Analysis

The Lifecycle Analysis should be reviewed and updated yearly to account for new and replaced systems. The Lifecycle Analysis looks at the value and age of equipment as well as the risk to the Department if the equipment were to fail. The current Lifecycle Analysis suggests a yearly outlay of $270,000 to maintain current infrastructure.

14 Vision for the Future

In addition to the proposed devices, this ITS Strategic Deployment Plan recommends RIDOT ITS Programs Unit stay well-informed of the private and public sector developments and their effect on the national and local transportation networks. For example, in the private sector, many of the current new cars on the market are equipped with wireless internet, cameras, GPS, blind spot sensors and a variety of data tools to determine diagnostic information about the car. This approach to vehicle technology, through sensors and communications, is quickly advancing to remove a human driver from the picture all together.

14.1 Connected Vehicles

Connected vehicle technology, through sensors and communications, is quickly advancing. V2X operates on wireless communication technology. It is capable of analyzing data like speed and direction from other vehicles and collecting information from surrounding infrastructure such as road signs and traffic lights across a two kilometer distance. The data creates 360-degree awareness for each vehicle's surroundings and may reduce multi-car accidents by 80 percent, according to a U.S. Department of Transportation study.

Ford CEO, Mark Fields, believes that a car company will introduce an autonomous (self-driving) vehicle on the market in the next five years. While traditional vehicles will certainly still exist, the DOT will need to evaluate the effects these vehicles and changes will have on safety, congestion, incident management and infrastructure.

Figure 44: Connected Vehicle Example

14.2 Regional Intermodal Traveler Information Systems

In the near term, RIDOT may choose to review opportunities such as integrated traveler information systems to increase use of transit to relieve some of the roadways congestion. Pilot projects have been done nationally where travel time information is displayed for both roadway and alternative transit to show motorists the value of utilizing public transit during times of congestion. Systems may include electronic message boards on roadways showing alternate travel times and the number of available parking spaces. By example, the following graphic shows the roadway travel times for Monday through Friday in May of 2015 in proximity to the Wickford Junction rail station to the rail terminus at South Station in Boston MA. The scheduled travel time for rail between stations is 110 minutes, showing that on average the rail travel time is slightly shorter during peak periods. However, should an incident occur on either the roadway or the rail, the difference could be significant. Travel time option information could greatly assist the public and reduce congestion in these situations.

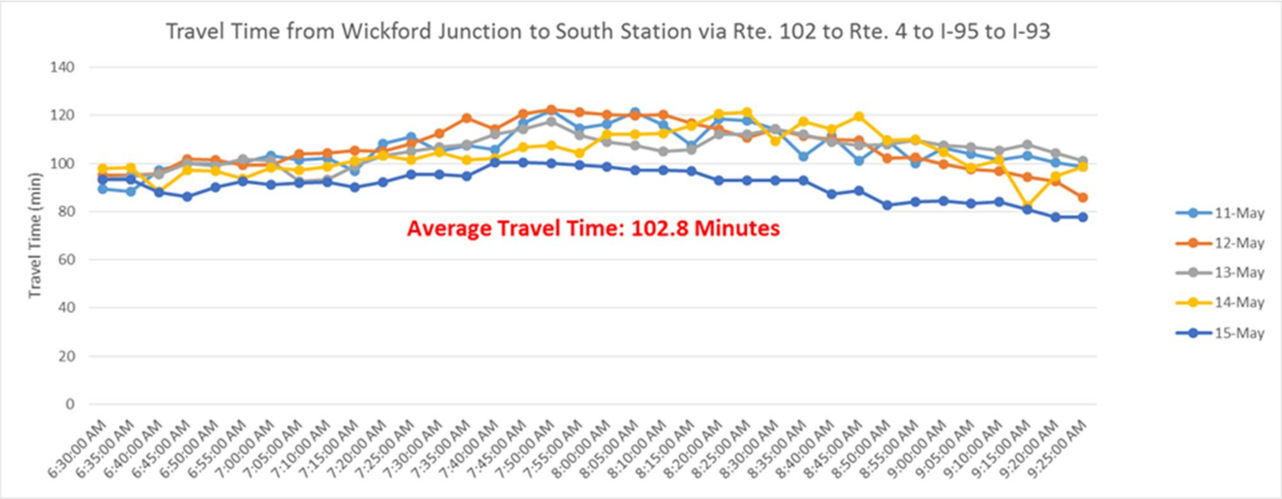


Figure 45: Travel Time Graphic

We can also post number of available parking spaces to rail services on a roadway DMS.

14.3 Regional Data Sharing

New Hampshire (NHDOT), Maine (Maine DOT) and Vermont (VTrans) are collaborating on a consolidated Advanced Transportation Management System (ATMS) and Traveler Information System (TIS) procurement. Within this project:

1. An ATMS will monitor and control ITS field devices as well as provide a system to report, manage and review incidents and events,
2. A TIS will provide multistate traveler information website and an e-mail and text alert subscription service, and a
3. A Data Hub will facilitate the exchange of information between the ATMS and TIS for several states. The Data Hub is a standards-based platform that will collect store, integrate, analyze, and disseminate data to various states, the TIS, and to third party providers through a 1201 data feed.

The ATMS/TIS system architecture allows for multiple states to integrate into this system through the Data Hub. The benefits of this approach include:

1. A common TIS platform for the New England Region.

2. The ability for multiple applications developers, information providers, or research institutions to access traveler information from multiple states from one source.
3. The ability to share information (such as weather forecasts) and facilitate operations (such as evacuations or flooding emergency response) on a regional basis.
4. The ability to manage cost by minimizing integration activities between states.

14.4 Coastal and Special Event Travel Management

Rhode Island has significant seasonal congestion for beach traffic and tourist destinations such as to coastal areas including the state beaches and Newport. These same routes may also be associated with flood and hurricane evacuation routes. Some states with similar conditions have developed "Reach the Beach" programs, that offer traveler information specific to these needs.

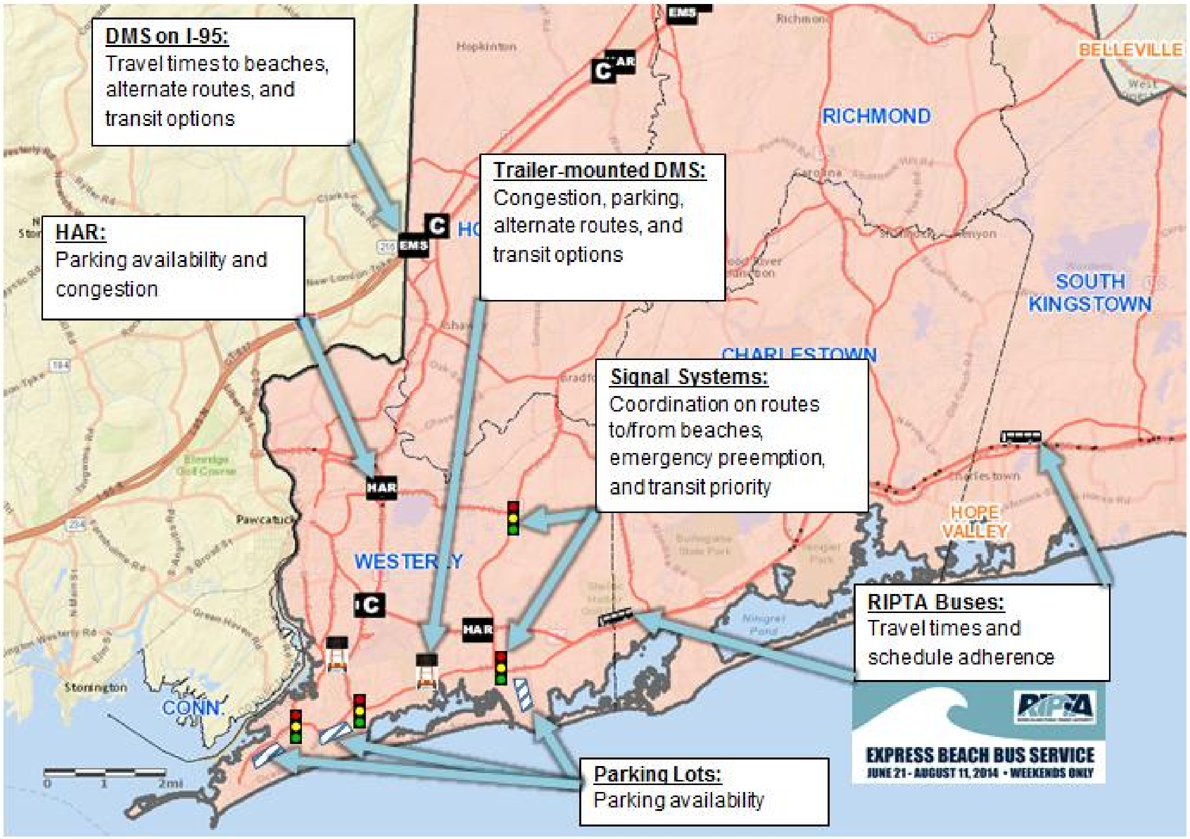


Figure 46: Coastal and Special Event Traveler Information Map

Common strategies include adding fixed and electronic signage approaching and departing target locations with information about parking availability, alternate routes and alternate modes of transportation – all with the goal of relieving congestion. Use of existing RIDOT ITS infrastructure such as DMS, HAR, RIDOT web site, 511, as well as portable message boards can be used. In areas with frequent events, new DMS, changeable destination signs and other lane control equipment can be installed. Shared data and operational strategies between event organizers, RIDOT, RIPTA, and local responders can be used to manage traffic flows, respond to incidents, and minimize congestion.

14.5 Adaptive Transit Signal Priority (ATSP) System

An ATSP project utilizes the existing GPS/AVL systems installed on buses to continuously monitor bus location and speed to predict bus arrival times at intersections. This is an improvement over existing signal priority systems that rely on transceivers that trigger an intersection controller. The ATSP system prioritizes the type of signal priority based on the data collected from the AVL system, which determines if priority is necessary, and if so, if elongating the green will be sufficient. If the vehicle is unlikely to make the signal with an elongated green phase, the system will request an early green for the next phase, shortening the green phase of the cross-traffic, which can be disruptive to the system.

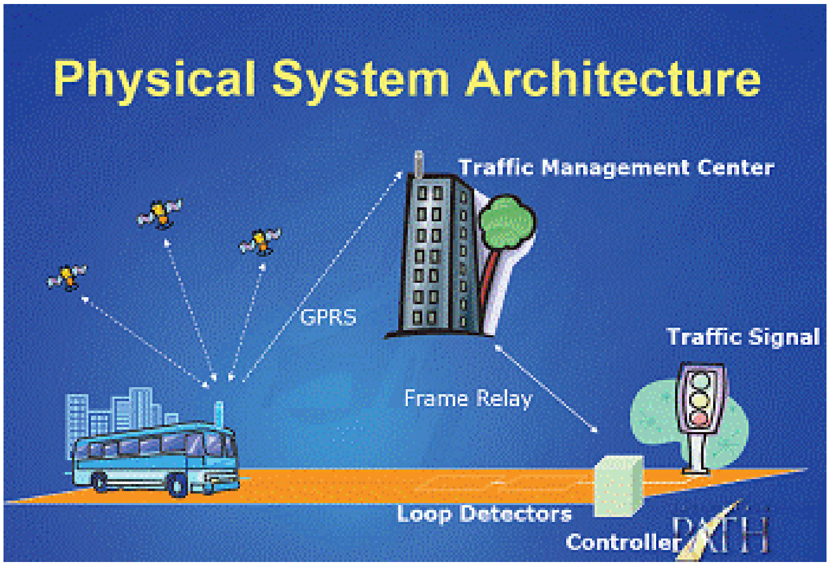


Figure 47: Adaptive Traffic Signal Architecture