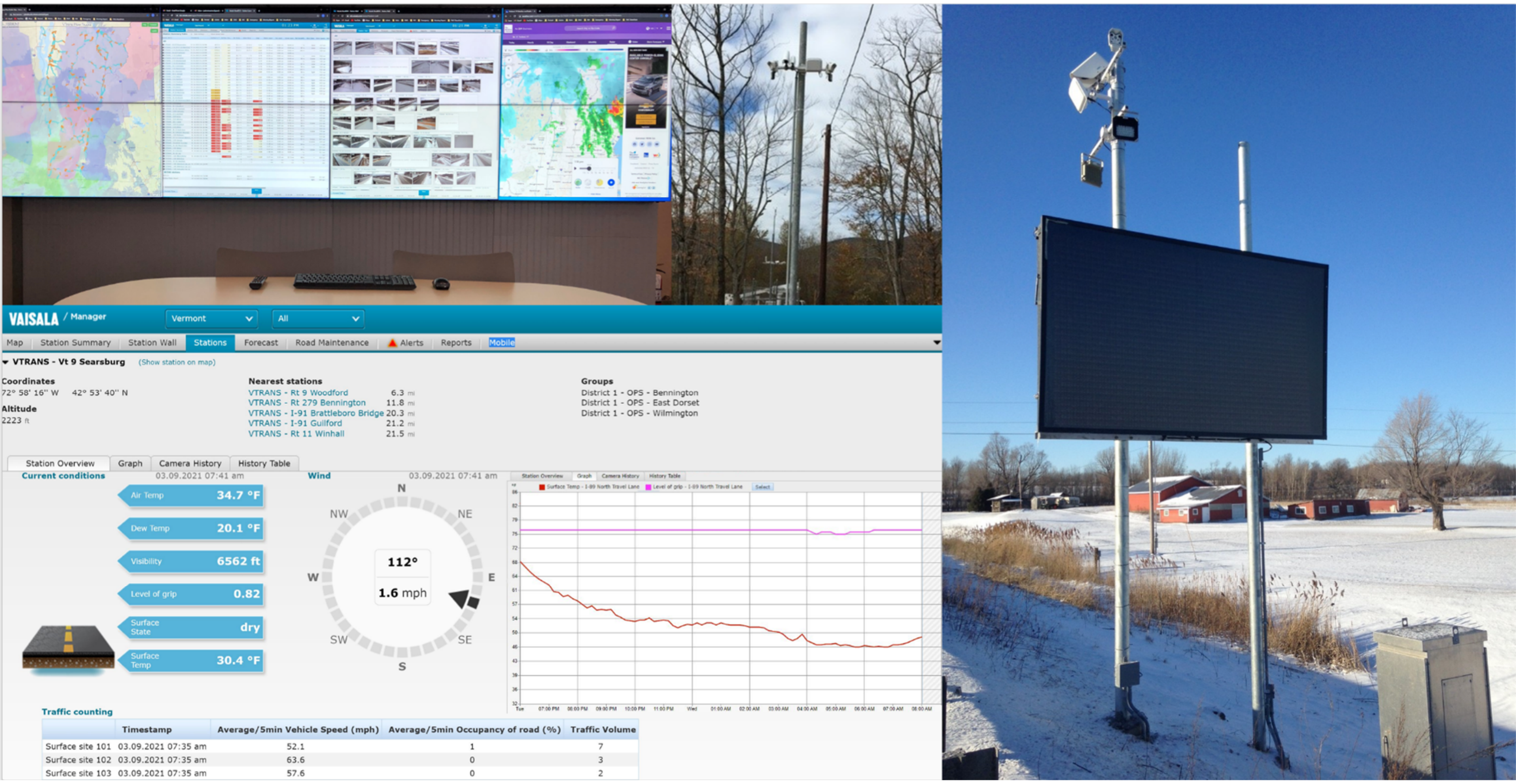

Intelligent Transportation Systems (ITS) Management Plan

PREPARED FOR

Vermont Agency of Transportation

VTrans Working to Get You There
Vermont Agency of Transportation

MAY 2022

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List of Acronyms

AADT	Annual Average Daily Traffic
ADS	Agency of Digital Services
ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation
ATMS	Advanced Transportation Management System
AVL	Automated Vehicle Location
CAD	Computer Aided Dispatch
CCRPC	Chittenden County Regional Planning Commission
CCTV	Closed Circuit Television
CMMA	Capability and Maturity Model Assessment
CMS	Changeable Message Sign
CV	Connected Vehicle
CVO	Commercial Vehicle Operation
FAST Act	Fixing America's Surface Transportation Act
FHWA	Federal Highway Administration
FHWA Rule 940	FHWA Final Rule, Intelligent Transportation System Architecture and Standards
HAZMAT	Hazardous Materials
ITS	Intelligent Transportation Systems
LMR	Land Mobile Radio
MaineDOT	Maine Department of Transportation
MTQ	Ministry of Transportation Quebec
NHDOT	New Hampshire Department of Transportation
NYSDOT	New York State Department of Transportation
P25 Standards	Project 25 Standards
PCMS	Portable Changeable Message Sign
RAD-IT	Regional Architecture Development for Intelligent Transportation
RPC	Regional Planning Commission
RWIS	Road Weather Information System
SEOC	Vermont State Emergency and Operation
SET-IT	Systems Engineering Tool for Intelligent Transportation
TMC	Traffic Management Center
TT	Travel Time
UHF	Ultra High Frequency
USDOT	United States Department of Transportation
VEM	Vermont Emergency Management
VHF	Very High Frequency
VSP	Vermont State Police
VTrans	Vermont Agency of Transportation
WIM	Weigh In Motion

1

Intelligent Transportation Systems (ITS) Management Plan

INTRODUCTION

Intelligent Transportation Systems (ITS) as defined by the United States Department of Transportation is the integration of advanced communication technologies and vehicles encompassing a broad range of wireless and wire line communications-based information and electronic technologies. The Vermont Agency of Transportation (VTrans) invests in ITS to better understand roadway conditions and operations and uses that data to better inform the public and make decisions regarding its assets. The ITS Program at VTrans now consists of 14 dedicated personnel who deploy, operate, and maintain over 300 devices throughout the network.

This ITS Management Plan has been developed to illustrate the connection between VTrans' Mission, Vision, and Objectives and the daily activities and assets of the VTrans ITS program and determine which projects that the Agency needs to invest in to best continue to meet those objectives.

Project Participation

A seven-person Project Team was formed to advance the ITS Management Plan. The participants of this Project Team included internal VTrans staff and stakeholders from outside the Agency that interact with the program on a regular basis. Representatives on the Project Team included:

- ITS Manager (VTrans) – Derek Lyman
- State Traffic Engineer (VTrans) – Ian Degutis
- Transportation Management Center Supervisor (VTrans) – Ryan Knapp
- ITS Operations Manager (VTrans) – Mark Gerrish
- Transportation Planning Engineer (Chittenden County Regional Planning Commission) – Sai Sarepalli

- Safety and Operations Programs Manager (Federal Highway Administration) – Roger Thompson
- Network Engineer (Agency of Digital Services) – Michael Dente

The Chittenden County Regional Planning Commission (CCRPC), which is the only regional planning commission with a regional ITS plan, was included in the Project Team to provide insight from the creation and use of their plan and to allow proper coordination between the plans. A representative from the FHWA was included to help to guide the plan through the systems engineering process, to provide insight on potential funding opportunities, and to ensure the management plan was meeting FHWA requirements. Because ITS relies on technology, the Agency of Digital Services participated in the Project Team throughout the process. Additional stakeholders were brought into the process through participation in a Capability and Maturity Model Analysis and individual meetings and interviews. VTrans stakeholders from Policy and Planning, Maintenance, Safety and Operations, Project Delivery, Public Transit, Aviation, and Construction were all engaged. Outside of VTrans, meetings were also held with Vermont Department of Motor Vehicles.

ITS Management Plan Development

VTrans, in partnership with FHWA Vermont Division, developed this ITS Management Plan through a typical planning process. The steps are outlined below.

Identify ITS Vision and Objectives: The Project Team discussed the Vision and Objectives of the ITS Program and how those items tie into VTrans' overall Vision and Goals. During this task, a Capability and Maturity Model Assessment (CMMA) was undertaken to identify processes that may be holding the program back from greater success. Stakeholders were engaged during this process and throughout the project.

Review of Existing ITS Program: To develop a complete understanding of the status of VTrans' ITS program, documentation was collected on all technologies included in the ITS program and connections between devices and VTrans were inventoried. Operational and proposed projects were identified, described, and updated in VTrans' ITS Architecture.

Needs Assessment: Based on the information collected about the program and input from key stakeholders, the Project Team began to develop a list of what the ITS Program needs to be successful, both from an infrastructure and a process point of view. This needs assessment was conducted in conjunction with developing an understanding of the funding requirements to meet these needs. As shown in **Figure 1**, the Needs Assessment was used to inform future sections of the ITS Management Plan.

ITS Project Prioritization: The ITS Project Team developed criteria for ranking the importance and timeline for each of the ITS projects identified. In addition to project needs, the Project Team identified ITS Strategies to increase the maturity of the ITS Program and respond to the CMMA. For example, standard criteria for consideration of different ITS devices depending on the type, duration, and location of VTrans projects was developed to ensure that all VTrans entities are aware of ITS needs and that there is process for evaluating and including them in future projects. Finally, project considerations and criteria were developed to standardize how VTrans approaches the incorporation of the installation and repair of ITS devices in planned maintenance and construction projects.

Preparation of the ITS Management Plan: Finally, the Project Team incorporated all these tasks into this ITS Management Plan. This plan outlines the existing ITS Program, the future ITS Program, and how VTrans will achieve these goals.

As shown in Figure 1, outreach and stakeholder engagement were key items woven throughout each task.

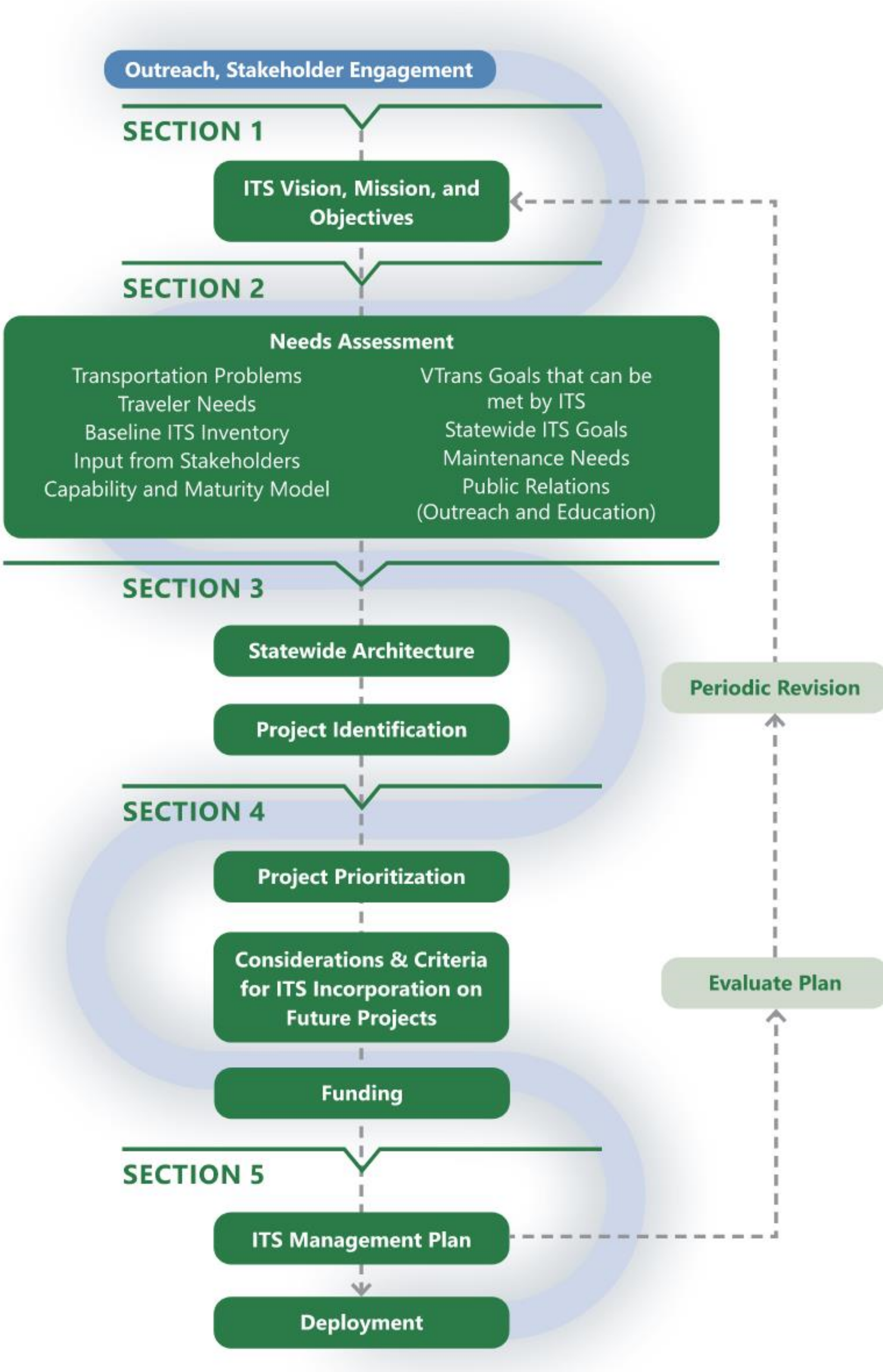

Figure 1: ITS Management Plan Process

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Mission, Vision, Objectives

INTRODUCTION

A plan will achieve greater success if it provides a clear purpose and direction through its Mission and Vision. The Mission statement will define what ITS is and what ITS does; the Vision statement will focus on what ITS will be and the role it will play in the future. The Mission, Vision, and Objectives of the ITS Program and VTrans will be described throughout Chapter 2.

MISSION STATEMENT

The ITS Project Team developed the ITS Program Mission outlined below. As shown, it is consistent with and supportive of the larger VTrans Mission. The VTrans and ITS Mission statements are shown in **Figure 2** below.

VTrans Mission Statement

Through excellent customer service, provide for the safe and efficient movement of people and goods.

ITS Mission Statement

Implement transportation technologies to support the VTrans Mission to provide excellent customer service and ensure the safe and efficient movement of people and goods.

Figure 2: Mission Statement

VISION STATEMENT

The ITS Project Team developed the ITS Program Vision to identify what the ITS Program strives to be and its role in the future. As ITS is an integral piece of the larger VTrans organization, it is important that the Vision for the ITS Program is cohesive with that of the greater organization. The VTrans and ITS Vision statements are shown in **Figure 3** below.

VTrans Vision Statement

A safe, reliable, and multimodal transportation system that grows the economy, is affordable to use and operate, and serves vulnerable populations.

ITS Vision Statement

Through Intelligent Transportation Systems, to support the VTrans Vision and Mission by providing relevant, actionable real time traffic information to the public and state agencies, and an archive of historic data for use by decision makers to allow for a safer and more efficient transportation system for all modes throughout Vermont.

Figure 3: Vision Statement

GOALS AND OBJECTIVES

In addition to a clear and defined Mission and Vision, ITS Program Objectives were developed to support that Mission and provide steps toward achieving the ITS Program's Vision. As shown in **Figure 4**, these Objectives also connect to the Goals that have been identified for the overall Agency of Transportation.

Goals and Objectives

VTrans Strategic Goals

1. Promote organizational excellence by attracting, developing, and retaining a talent, diverse, and engaged workforce.
2. Grow Vermont's economy by providing safe, reliable, and efficient transportation system in a state of good repair.
3. Make Vermont more affordable and serve the vulnerable by providing accessible, convenient, and affordable travel choices.
4. Transition to an energy efficient, advanced technology transportation system.
5. Modernize and improve government efficiency through innovation, continuous improvement, and quality customer service.

ITS Objectives

1. Establish ITS as an asset to the Agency and other stakeholders and improve inter-Agency coordination and communication through education, exposure, and awareness of ITS existing and future capabilities and resources
   VTRANS GOALS: 1
2. Demonstrate the value of the intelligent transportation systems within the operations and safety bureau
   VTRANS GOALS: 1 5
3. Integrate the information provided by the following systems (traveler information, traffic management, public transportation management, maintenance and construction management, and emergency management systems) through asset management. With the goal of providing timely information to the public for safe travel and maintenance of our roadways
   VTRANS GOALS: 2 3 5
4. Collect and communicate real time, relevant, and reliable traveler information, weather conditions, and roadway incidents that impact travel to the public, first responders, and the Vermont maintenance districts through the TMC
   VTRANS GOALS: 2 3 5
5. Strategically maintain, upgrade, and expand existing ITS infrastructure through the management of assets
   VTRANS GOALS: 2 4 5
6. Invest in ITS infrastructure that strengthens the Agency's ability to adapt and utilize ever changing intelligent transportation technologies and engage in transportation innovation
   VTRANS GOALS: 4 5
7. Establish institutional mechanisms and clear project parameters to promote the development and deployment of ITS projects and the incorporation of ITS infrastructure in future Agency planning projects
   VTRANS GOALS: 4 5

Figure 4: Goals and Objectives

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3

Statewide Architecture Overview

INTRODUCTION

Statewide ITS Architecture is a resource that ensures that ITS projects support the envisioned transportation system. It also provides overall context for ITS projects, to see how individual projects fit into the overall system. The Statewide ITS Architecture is an essential tool in transportation planning, as it allows stakeholders to collaborate and define a plan for ITS deployment. This well-defined plan provides a starting point from which projects can be developed and ensures that these projects are fulfilling the Vision, Mission, and Objectives set forth in Chapter 2 of this document.

ITS ARCHITECTURE

The United States Department of Transportation's (USDOT) Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT), is also referred to as the National ITS Reference Architecture or simply the National ITS Architecture. The National ITS Reference Architecture was developed over 25 years ago to provide a national vision for ITS, guide sound ITS planning and investments at the state and local level and identify the need for ITS standards. The National ITS Architecture provides a framework to identify key stakeholders and interrelationships, describe required activities or functions, define interconnections and interdependencies between functions, and develop a blueprint for integration into systems.

The National ITS Reference Architecture is a congressionally mandated blueprint for federally funded ITS deployments. Conformance with the National ITS Architecture is a requirement for all ITS projects funded by the Federal Highway Administration (FHWA) using Highway Trust Fund money in accordance with CFR Title 23 Section 517 of the Fixing America's Surface Transportation Act (FAST Act). Regional ITS Architectures, including Statewide ITS Architectures, shall use the National ITS Architecture as a resource (FHWA Rule 940). FHWA also encourages that the Regional/Statewide ITS Architectures be kept up to date as technologies evolve and regional transportation strategies and priorities change over time.

The first Vermont Statewide ITS Architecture was completed in 2005. In 2008, VTrans developed the Vermont Statewide ITS Architecture, which included updates to the 2005

Architecture. The updated ITS Architecture presented the framework for the deployment and integration of ITS statewide over the next 15-year period. The 2005 Architecture was updated to reflect minor changes in the Vermont Statewide Architecture and stakeholders involved. Furthermore, the 2005 Architecture was updated to Version 6.0 of the National ITS Reference Architecture format.

In 2016, VTrans undertook the ITS Architecture Update using Turbo Architecture. Turbo Architecture is a software program that supported the National ITS Reference Architecture through ARC-IT version 7.1. Most recently, in March 2021, ARC-IT was updated to Version 9.0. Previous upgrades of ARC-IT included an evolution from the Turbo Architecture to the Regional Architecture Development tool (RAD-IT). The RAD-IT tool is a software application that uses ARC-IT as a starting point to help develop regional/statewide and project-specific ITS Architectures.

STATEWIDE ITS ARCHITECTURE UPDATE

The ITS Project Team began the process to update the Vermont Statewide Architecture by first converting the 2016 Turbo Architecture file to the newer RAD-IT software tool.

The ITS Project team used the existing Stakeholders list as a starting point, in collaboration with the current Stakeholders, to update the list of Stakeholders to be included in the 2021 update. Working with these stakeholders, the ITS Project Team was able to obtain information on the status of the existing project list. Further information on the current list of stakeholders, existing project list, and status of projects can be found in the ITS Existing Conditions Report in the Appendix.

After the stakeholders list and project list was updated, the ITS Project team updated the Vermont Statewide ITS Architecture's Service Package inventory, (formerly known as Market Packages) to be compatible with the updated National ITS Reference Architecture. Service Packages identify the subsystems, people, systems, devices, and the information flows that connect them to implement a particular ITS service.

The Project Team reviewed the Service Packages included in the Vermont Statewide ITS Architecture to determine how the current list of stakeholders is integrated throughout the program, and how information flows between elements to achieve the service intended in the Service Packages as defined in the Vermont Statewide ITS Architecture. As a result of this review, the ITS Project Team updated and further defined information flows and objects involved in each Service Package.

The updated Vermont Statewide ITS Architecture can be found online: https://vermontgov.sharepoint.com/sites/VTRANS/e/itsmp/Shared%20Documents/web/index.aspx

Updating the Vermont Statewide ITS Architecture to the RAD-IT software will allow the Architecture to continue to be updated regularly and be a living database of the status of ITS operations in Vermont.

VERMONT STATEWIDE ITS OPERATIONS

The Vermont Statewide ITS Architecture includes descriptions of projects and connections that exist in the system. The Vermont Statewide ITS Architecture also includes planned projects.

Current Services

Throughout the years, VTrans has planned and deployed ITS devices across the state. **Table 1** below shows the existing Service Packages in the Vermont Statewide ITS Architecture for maintenance activities, transit operations, data, emergency response, freight movements, and traffic operations.

Table 1: Existing Service Packages in Vermont Statewide ITS Architecture

Short Name	Service Package Name
CVO01	Carrier Operations and Fleet Management
CVO02	Freight Administration
CVO03	Electronic Clearance
CVO04	CV Administrative Processes
CVO07	Roadside CVO Safety
CVO08	Smart Roadside and Virtual WIM
CVO12	HAZMAT Management
CVO13	Roadside HAZMAT Security Detection and Mitigation
CVO21	International Border Electronic Clearance
DM01	ITS Data Warehouse
DM02	Performance Monitoring
MC01	Maintenance and Construction Vehicle and Equipment Tracking
MC02	Maintenance and Construction Vehicle Maintenance
MC04	Winter Maintenance
MC05	Roadway Maintenance and Construction
MC06	Work Zone Management
MC08	Maintenance and Construction Activity Coordination

Short Name	Service Package Name
MC09	Infrastructure Monitoring
PM01	Parking Space Management
PM03	Parking Electronic Payment
PM04	Regional Parking Management
PS01	Emergency Call-Taking and Dispatch
PS02	Emergency Response
PS03	Emergency Vehicle Preemption
PS04	Mayday Notification
PS08	Roadway Service Patrols
PS09	Transportation Infrastructure Protection
PS10	Wide-Area Alert
PS11	Early Warning System
PS12	Disaster Response and Recovery
PS14	Disaster Traveler Information
PT01	Transit Vehicle Tracking
PT02	Transit Fixed-Route Operations
PT03	Dynamic Transit Operations

Table 1: Existing Service Packages in Vermont Statewide ITS Architecture (Continued)

Short Name	Service Package Name
PT04	Transit Fare Collection Management
PT05	Transit Security
PT08	Transit Traveler Information
PT14	Multi-modal Coordination
SU03	Data Distribution
SU11	Field Equipment Maintenance
SU12	Vehicle Maintenance
TI01	Broadcast Traveler Information
TI02	Personalized Traveler Information
TM01	Infrastructure-Based Traffic Surveillance
TM02	Vehicle-Based Traffic Surveillance
TM03	Traffic Signal Control
TM06	Traffic Information Dissemination
TM07	Regional Traffic Management
TM08	Traffic Incident Management System
TM09	Integrated Decision Support and Demand Management
TM12	Dynamic Roadway Warning
TM13	Standard Railroad Grade Crossing
TM15	Railroad Operations Coordination
TM23	Border Management Systems
WX01	Weather Data Collection
WX02	Weather Information Processing and Distribution

In addition, VTrans has cooperated with neighboring states to implement ITS technologies, which are grouped to provide services that implement the functions identified in the Vermont Statewide ITS Architecture.

VTrans—along with New Hampshire Department of Transportation (NHDOT) and Maine Department of Transportation (MaineDOT)—deployed the New England Compass system in 2016. The New England Compass system is an Advanced Transportation Management System (ATMS), a Regional Traveler Information System, and a Data Hub. The ATMS includes monitoring and control of ITS field devices and allows each of the three owners' systems to detect, verify, report, manage, and review incidents that occur. The Regional Traveler Information System of New England Compass is a traveler information website (http://www.newengland511.org) that provides alerts and general traveler information. The Data Hub facilitates the exchange of information among the ATMS, the Regional Traveler

Information system, the owners, and other stakeholders. VTrans' connection to the New England Compass system is through the VTrans Traffic Management Center (TMC). **Figure 5** shows the connections to the TMC.

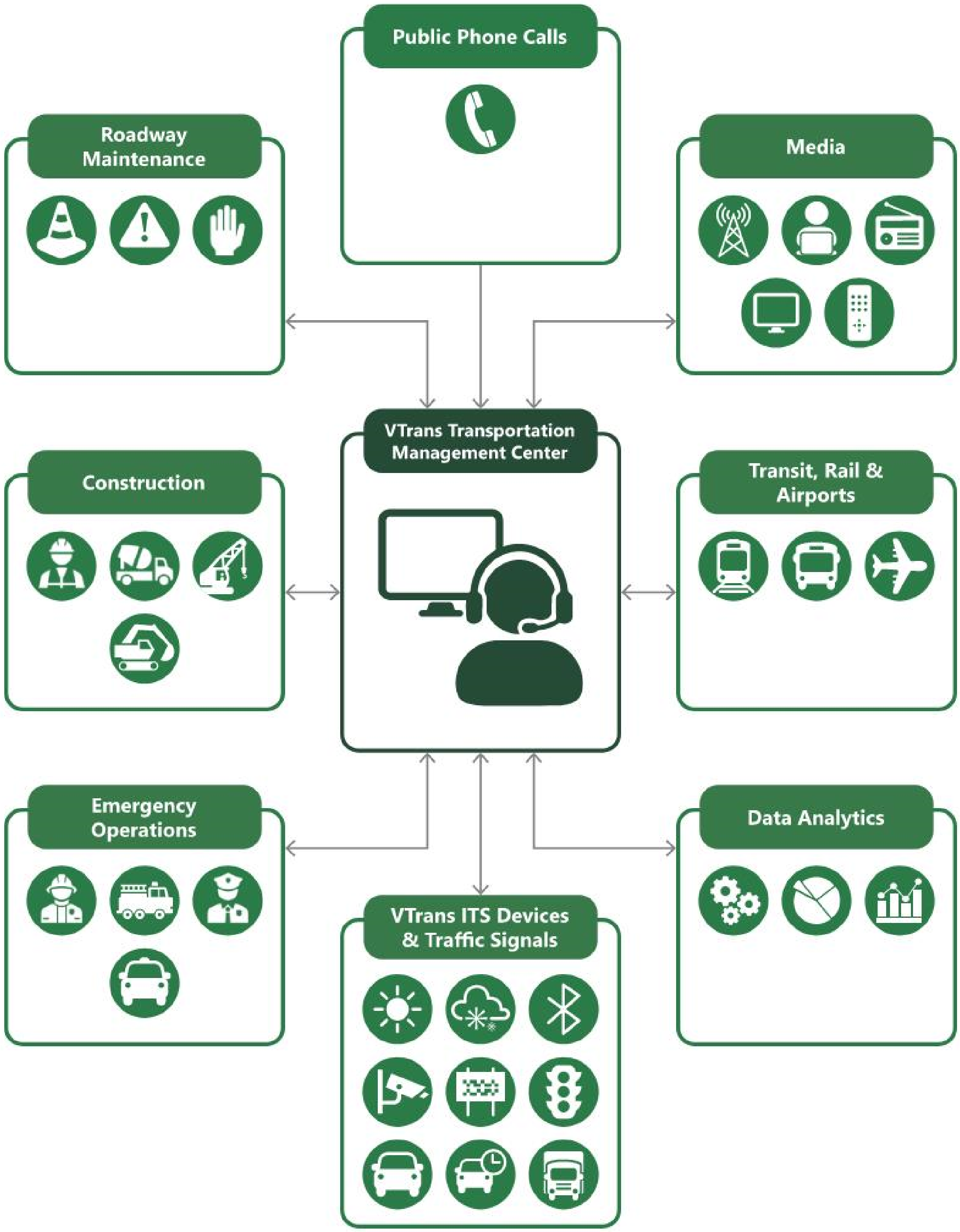

Figure 5: Connections to the TMC

Planned Services

The planned services and ITS projects have been updated in the Vermont Statewide ITS Architecture as a part of this ITS Management Plan. A more detailed look at the potential planned services and ITS projects is discussed in Chapter 5.

4

Capability and Maturity Model Assessment (CMMA)

INTRODUCTION

A Capability and Maturity Model Assessment (CMMA) was completed by VHB over a two part virtual workshop held on Tuesday, November 10th, 2021 and Tuesday, November 17th, 2021 for the VTrans ITS program. The purpose of the CMMA is to assess the current state of the ITS Program, identify the strengths and weaknesses, and determine action items for improvement. Chapter 4 will provide an overview of the CMMA process and the results.

CMMA

The CMMA provides an opportunity for an organization to assess its processes to determine the level of formality and consistency of those processes. This assessment works to determine what is holding an organization back from meeting its potential, because projects may fail or not achieve desired functionality for a variety of reasons not related to the technology. The ITS Program is more successful if processes are in place that support the program, and those processes are more successful with a supporting institutional framework as illustrated in **Figure 6.**

This effort will identify management actions to support an integrated ITS Program. It collects information from stakeholders at all levels of the organization to understand what challenges are encountered in processes. The result is a focus on what capabilities are essential to get on a path of improvement and become a leader in ITS.

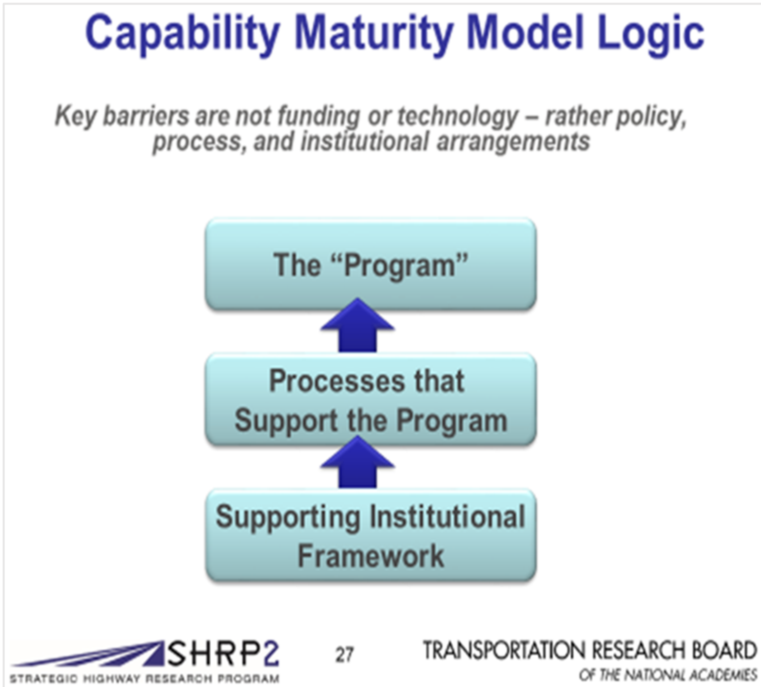

Figure 6: Capability Maturity Model Logic

Stakeholder Engagement

To understand what is holding the ITS Program back from improvement, the ITS Project Team invited representatives from the VTrans Bureaus of Project Delivery, Operations and Safety, Maintenance, and Construction and Materials in the Highway Division. Representatives from each group participated. In addition, Policy and Planning representatives were also invited. Also included was a representative of Agency of Digital Services who is assisting the ITS Program. Outside of the Agency, representatives from CCRPC and FHWA were invited to provide their perspectives. Stakeholders most closely connected to the ITS Program invited to participate included representatives from all levels. Each of these professionals interacts with the ITS Program in a different way, ranging from those who install and maintain devices daily to those who are not sure what is included in the ITS Program.

Dimensions of Capability

Six dimensions of capability have been identified. Each are essential and interrelated for the success of the ITS Program. The dimensions of capability are interdependent as shown in **Figure 7;** to improve any singular dimension, simultaneous improvements will need to be made to the others. The dimensions are broken into two categories. The first three —business processes, systems and technology, and performance measurement—are process oriented while the last three—culture, organization/staffing, and collaboration—are institutional. The six dimensions are described below.

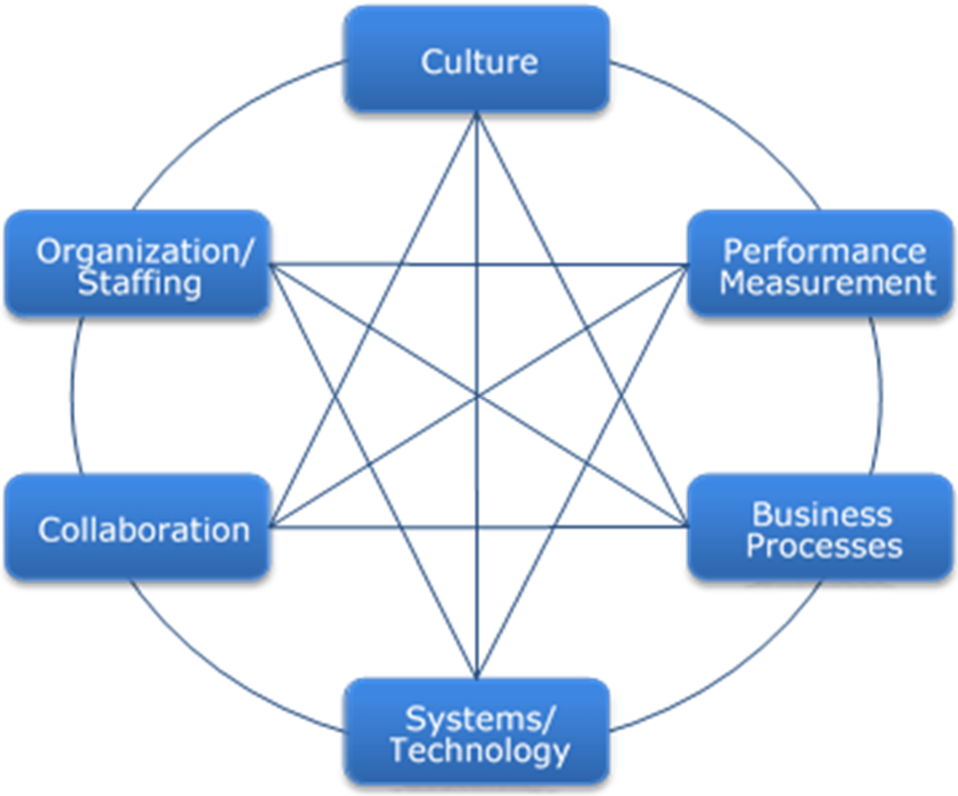

Figure 7: Dimensions of Capability (Source: FHWA, USDOT)

Business Processes

The **business processes** analyze all aspects of planning, programming, project development, and budgeting. A level 1 ranking is indicative of jurisdictions operating individually to meet their own needs, while a level 4 ranking is indicative of ITS being integrated across jurisdictions with a formal planning process.

Systems and Technology

The **systems and technology** dimension examines the use of systems engineering, systems architecture standards, interoperability, and standardization. A level 1 ranking suggests ITS system implementation occurs in response to a particular need or purpose with no big picture consideration or standard process, while a level 4 ranking suggests that the system and technology are upgraded routinely and strategically to improve system performance and integration.

Performance Measures

The **performance measures** dimension explores defined measures, data acquisition, and data utilization. On the lower end of the spectrum (level 1), some data output is measured and reported, but data output is not used efficiently or to its full potential. On the higher end of the spectrum (level 4), data is used optimally for utilization, accountability, and justification.

Culture

The **culture** dimension includes technical understanding, leadership, and outreach. A level 1 suggests the program has only individual staff champions limited throughout the state and greater organization, while a level 4 suggests the program is accepted as a formal top-level core program statewide.

Organization and Workforce

The **organization and workforce** dimension investigates organizational structure, staff development, staff recruitment, and staff retention. A level 1 indicates ITS responsibilities are given to an existing department or staff and is dependent on technical champions, while a level 4 indicates ITS senior managers are at equivalent level of other departments and staff are professionalized.

Collaboration

The **collaboration** dimension explores relationships with stakeholders, including public agencies, local government, regional planning commissions, transit providers, private-sector users, the public, etc. On the lower end of the spectrum (level 1), relationships and collaborations are as needed and on a personal basis, while on the higher end of the spectrum (level 4), coordination is at a high level among all owners and operators, including state, local, and private.

Levels of Agency Capability Maturity

As part of the CMMA, participants were given the six dimensions of capability to evaluate the current ITS Program. Each category was given a ranking between 1 and 4 known as the levels of Agency capability maturity. The final levels for each dimension based on participant input is summarized in **Figure 8** and described further in the subsequent section, CMMA Results. The model assesses the level of capability and maturity in each dimension and advises that the program needs to understand the steps required to move to the next level in that dimension.

The four levels of Agency capability maturity are:

Level 1 – Performed

Level 1 indicates the dimension is performed. All activities and relationships are as needed. The program is champion driven.

Level 2 – Managed

Level 2 suggests the dimension is managed. There is limited accountability, but processes are developed, and staff is trained.

Level 3 – Integrated

Level 3 means the dimension is integrated. Processes are documented, standardized, and budgeted. Performance is measured. The program is organized, and partners are in agreement.

Level 4 – Optimized

Level 4 represents an optimized dimension. Improvements are based on performance. The program is formalized with formal partnerships.

Figure 8 is a chart outlining the levels for each of the dimensions. Emphasis is provided on the levels that the VTrans ITS Program average scores reflected as will be further outlined in the following sections.

After participants ranked each dimension, they were also asked to list strengths and weaknesses of the program in each dimension. The more closely participants knew the program, the more detailed strengths and weaknesses were provided. Finally, participants were asked to indicate actions that were needed to advance to the next level of maturity in that dimension.

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	BUSINESS PROCESSES (PLANING AND PROGRAMMING)	SYSTEMS AND TECHNOLOGY	PERFORMANCE MEASURES	CULTURE	ORGANIZATION/STAFFING	COLLABORATION
LEVEL 4 OPTIMIZING	ITS integrated into jurisdictions' multi-sectoral plans and programs, based on a formal, continuing planning processes	Architectures and technology routinely upgraded to improve performance; systems integration/interoperability maintained on continuing basis	Performance measures reported internally for utilization and externally for accountability and program justification	ITS use commitment accountability is accepted as a formal top level core program for all Jurisdictions	ITS senior managers at equivalent level with other jurisdiction services and staff professionalized	High level of ITS coordination among owner/operators (state, local, private)
LEVEL 3 INTEGRATED	Regional program integrated into jurisdictions' overall multimodal transportation plans with related staged program	Systems & technology standardized and integrated on a regional basis with other related processes and training as appropriate	Outcome measures identified (networks, modes, impacts) and routinely utilized for objective-based program improvements	Jurisdictions' mission identifies ITS and benefits with formal program and achieves wide public visibility/understanding	ITS Managers have direct report to top management; Job specs, certification and training for core positions	Rationalization/ sharing/ formalization of responsibilities among key players through co-training, formal agreements and incentives
LEVEL 2 MANAGED	Consensus regional approach developed regarding ITS goals, deficiencies, B/C, networks, strategies and common priorities	Regional concept of operations and architectures developed and documented with costs included; appropriate procurement process employed	Output data used directly for after-action debriefings and improvements; data easily available and dash boarded	Jurisdictions' senior management understands ITS business case and educates decision makers/public	ITS specific organizational concept developed within/among jurisdictions with core capacity needs identified, collaboration takes place	Objectives, strategies and performance measures aligned among organized key players (transportation and public safety agencies) with after-action debriefing
LEVEL 1 PERFORMED	Each jurisdiction doing its own thing according to individual priorities and capabilities	Ad hoc approaches to system implementation without consideration of systems engineering and appropriate procurement processes	Some outputs measured and reported by some jurisdictions	Individual staff champions promote ITS – varying among jurisdictions	ITS added on to units within existing structure and staffing - dependent on technical champions	Relationships ad hoc, and on personal basis (public- public, public-private)

Figure 8: Final Results of the CMMA

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CMMA RESULTS

Each of the participants ranked the ITS Program in each of the dimensions of capability. The results of each of these surveys were combined to create an average ranking for each dimension, which are summarized in **Figure 9**. The capability of any program is limited by its lowest ranking dimension, however, in many cases the interrelationship resulted in similar rankings between dimensions and similar action items to advance to a higher level of maturity.

In addition to the ranking, the strengths were noted, and weaknesses inventoried. For each weakness identified, a corresponding action item was determined from the stakeholder input. Where stakeholders had not developed a corresponding action item, the ITS Project Team met and developed action items to address the weaknesses identified.

To chart the immediate course for the program, the action items were divided into those actions required to reach the next level in that dimension and those actions required to move beyond that dimension. The resulting ranking and action items determined for each dimension are summarized below starting with the lowest ranked dimension of capability. The complete list of scores, strengths, weaknesses, and action items connected to those items is provided in the Appendix of this document.

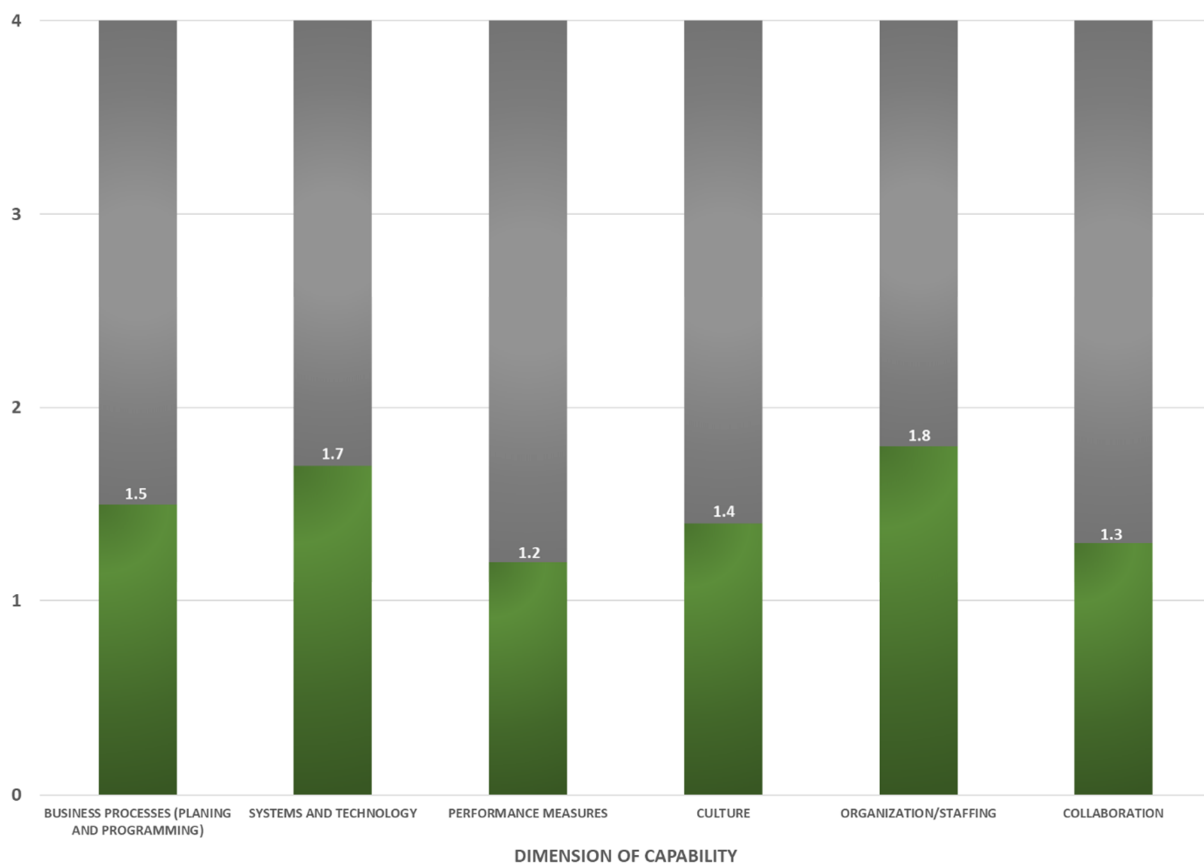

Figure 9: Results of the CMMA

Business Process: Average Rank 1.5

Current at Level 1 - Performed

- Each jurisdiction doing its own thing according to individual priorities and capabilities

Next level is Level 2 - Managed

- Consensus regional approach developed regarding ITS Objectives, deficiencies, B/C, networks, strategies, and common priorities

Action items to get to Level 2:

Several suggestions were made to elevate the ITS business process to a level 2. As with other items in the CMMA, it was suggested that all of VTrans must be engaged to understand the ITS program and follow that with the engagement of the RPCs, major municipalities, and multimodal agencies to reach a common vision and plan for ITS. The stakeholder engagement and meetings in the ITS Management Plan have started that effort, but more is needed.

The actual business processes and responsibilities of the ITS Program need to be clearly defined and will help the Agency obtain funding for ITS related efforts. Policies and procedures that consider ITS in capital projects and maintenance work should be developed. Ultimately, the ITS Program would like technological solutions to be integrated into the Agency's Mission and Goals.

Action item to get beyond Level 2:

Because the ITS Program relies on unique technology that is fundamentally different from traditional transportation infrastructure, it requires thinking differently about procurement and contracting. Consideration should be made to revising the business process for funding ITS projects to be more consistent with FHWA practices for these devices.

A policy to consider and engage all users when incorporating new technology would be an improvement to the business process. Engaging end users (in most cases maintenance personnel) into the planning stages of ITS projects will increase effectiveness and efficiency of new equipment locations. Giving personnel who maintain the ITS equipment the ability to buy replacement parts would improve the business process.

Systems and Technology: Average Rank 1.7

Current at Level 1 - Performed

- Ad hoc approaches to system implementation without consideration of systems engineering and appropriate procurement processes

Next level is Level 2 - Managed

- Regional concept of operations and architectures developed and documented with costs included and appropriate procurement process employed

Action items to get to Level 2:

Several actions were identified to bring the ITS Program to the next level in terms of systems and technology. Efforts included in this ITS Management Plan must continue to be updated in regard to the Statewide ITS Architecture. The ITS Program should prepare a masterplan for statewide ITS deployments.

The ITS Program will need to create an ITS section for the Standards Specifications for Construction and develop a template for developing Concept of Operations documents for ITS devices that are meaningful and scaled to each project. As applications are added, they will need to be integrated into the system.

Action item to get beyond Level 2:

As the ITS Program moves beyond level 2, it will need to ensure that new devices communicate with the TMC. Contracts will need to be maintained and not allowed to expire. Moving forward, all attempts should be made to implement new technology located where permanent power and communications can be accessed. The ITS Program should create blueprints for system implementation (CMS, RWIS, CCTV, Signals, etc.) so configuring devices in the ATMS are seamless. Finally, training staff in ITS Architecture (ARC-IT, RAD-IT, and maybe SET-IT) would advance the program.

Performance Measurement: Average Rank 1.2

Current at Level 1 - Performed

- Some outputs measured and reported by some jurisdictions

Next level is Level 2 - Managed

- Output data used directly for after action debriefings and improvements; data easily available and dash boarded

Action items to get to Level 2:

The action items required to advance to level 2 in performance measurements requires that the ITS Program better utilizes the tools and equipment it already has and develops standard reporting practices, criteria, and dates for pertinent information. Once the data is being gathered and reported, a dashboard should be created to share that information with decision-makers to support funding requests and ultimately create different levels of data sharing with Agency personnel and ultimately the public.

Action item to get beyond Level 2:

Once the existing data is more consistently collected, reported, and shared as appropriate, there are additional requirements to continue moving the program forward beyond the Managed level. To begin with, this data should be evaluated with purpose to support Agency initiatives. The ITS Program will need to establish objectives and corresponding performance targets that are measurable and actionable. One action identified as a specific need is to commit resources to better manage the Automated Vehicle Location systems and their reporting interfaces.

Culture: Rank 1.4

Current at Level 1 - Performed

- Individual staff champions promote ITS – varying among jurisdictions

Next level is Level 2 - Managed

- Jurisdictions' senior management understands ITS business case and educates decision makers/public

Action items to get to Level 2:

To advance, the ITS Program needs to develop public relations materials and Objectives to ensure that the greater Agency, and specifically leadership, understands what ITS is and how it can influence and affect transportation. As a part of the ITS Management Plan, an initial public relations piece has been developed and distributed to stakeholders.

The ITS Program needs to identify ITS champions in other groups at VTrans and encourage information sharing regarding the benefits of the ITS program, as it is most convincing when someone in your same position sees and shares value in what ITS provides.

Finally, the ITS Program should document and communicate ITS needs so that those needs can be included in the early stages of Agency projects. This ITS Management Plan is the first step in that documentation.

Action item to get beyond Level 2:

To get beyond level 2 in culture, a public outreach campaign should be developed whenever there are new devices and configurations, informing stakeholders about the changes and benefits anticipated. Training should follow in the maintenance and use of the new devices.

It was identified that the ITS Program should develop work ticket and ITS applications that better streamline field operations and reduce redundant systems and business processes.

Organization and Staffing: Average Rank 1.8

Current at Level 1 - Performed

- ITS added on to units within existing structure and staffing – dependent on technical champions

Next level is Level 2 - Managed

- ITS-specific organizational concept developed within/among jurisdictions with core capability needs identified, collaboration takes place

Action items to get to Level 2:

To advance to level 2 in organization and staffing, the ITS Program needs to develop a clear strategy to increase the availability of the skill sets needed to construct and maintain technology products and systems. Job specifications for positions in ITS/Systems Engineering, ITS

Maintenance, and TMC Operator should be developed that reflect the unique knowledge and skills needed. The ITS Program should identify appropriate staffing requirements based on equipment level of service or FHWA staffing recommendations where available.

The roles and responsibilities for each position in the ITS Program should be better defined and shared with leadership so they understand the limitation of the Program at different staffing levels. Update resourcing models to include field ITS applications and technology.

Action item to get beyond Level 2:

To move to level 2, the ITS Program must continue to work with Contract Administration to incorporate the types of contracts that are required, and allowed by FHWA, for these technologies. To enhance collaboration with other groups, the Program must work with staff in ADS to streamline ITS workflows and get assistance with trouble-shooting longstanding connectivity and security concerns. Another staffing item connected to other groups is to continue working with maintenance staff to ensure they have the computer skills necessary to address ITS maintenance needs. When new ITS tools are introduced, the ITS Program needs to train appropriate staff to install, maintain, or use information resulting from those tools.

Collaboration: Average Rank 1.3

Current at Level 1 - Performed

- Relationships are ad-hoc and on personal basis

Next level is Level 2 - Managed

- Objectives, strategies, and performance measures aligned among key players with after-action briefing

Action items to get to Level 2:

To move the ITS Program from collaboration performed to managed, the program first needs to identify organizations and jurisdictions for closer collaboration. This includes other parts of the Agency and the State and beyond. The process to complete this ITS Management Plan included identifying groups to target for developing a collaborative relationship.

Once identified, the ITS Program will need to improve coordination with those groups. Specifically identified were other groups within the Agency, such as Planning and Design personnel, as well as the Agency of Digital Services and Vermont State Police.

The ITS Program must do a better job of documenting and communicating its capabilities for this collaboration to result in improved outcomes. Collaborators will buy in if they understand the ITS Objectives and how they are beneficial. Specifically mentioned was the potential ITS benefit to maintenance districts: some districts may not understand how these devices can help them save person hours and materials. Additionally, better communication with Planning and Design staff will ensure that transportation technologies are considered for projects at initiation, rather than as an add on. After-action communication with Planning and Design folks could provide feedback as to what is working and what is not.

Action item to get beyond Level 2:

To move the Collaboration beyond Level 2, cross-training should be considered between ITS staff and Maintenance personnel. Once Maintenance sees the benefit to ITS devices, they can be empowered to ensure that these devices are giving them the data they need. In addition, the ITS Program should strive to deploy ITS solutions that streamline business processes and add value for field operations/maintenance staff.

5

Potential ITS Projects and Solutions

INTRODUCTION

Based on the needs identified during the development of the Vision, Mission, and Objectives; through the Needs Assessment of the ITS Project Team; and through the Stakeholder input in the CMMA outlined in Chapter 4, potential projects have been identified to address these needs. This section describes existing and potential ITS projects identified by the ITS Project Team to address these needs. In addition, Chapter 5 will connect each existing and potential ITS project to the objective(s) the project will address. Identifying projects and which of the ITS Objectives each address will help with the prioritization and implementation of potential projects.

ITS PROJECT DESCRIPTIONS

The ITS Project Team identified 32 ongoing existing and potential future ITS projects—from ITS device deployment to marketing outreach and education. The appendix includes full descriptions of the projects, including their benefits, estimated installation and maintenance costs and schedule, the ITS Architecture project areas the project addresses, and the geographic scope considered for each project. **Table 2** includes a list of the projects, a brief description, and each project's relation to specific ITS Objectives.

PROJECT COORDINATION AND IMPLEMENTATION

New ITS project implementation is predominantly completed in response to a specific situation, event, or need. For example, in response to the Covid-19 pandemic, changeable message signs (CMS) were rented or redeployed to all border crossings into Vermont. Overall, ITS project implementation in Vermont is focused on addressing extremely specific requests and maintaining existing ITS devices deployed throughout the state.

This plan will identify avenues for implementing potential ITS projects as standalone projects. It will also describe how certain ITS components should be incorporated or maintained in coordination with planned projects, such as paving or bridge replacements. Chapter 6 will prioritize potential standalone ITS projects and define criteria or guidelines for incorporating

ITS components on other planned projects. Chapter 6 will include further insight on project prioritization based on fiscal constraints.

EXISTING AND FUTURE COORDINATION

In-State Coordination

VTrans Coordination

Maintaining and expanding relationships between ITS and other departments within the Agency is crucial to the success of the ITS Management Plan and advancement of ITS throughout the state. The first two objectives identified for the ITS Management Plan are **to establish ITS as an asset to the Agency through education, exposure, and awareness** and to **demonstrate the value with the operations and safety bureau**. Coordination with other VTrans departments should be maintained and expanded to include:

- Executive Team
- Finance and Administration
- Asset Management
- Policy and Planning
- Program Delivery and Project Managers
- Maintenance

Successfully incorporating ITS components on future Agency projects and standalone ITS projects requires awareness, education, and coordination.

Interagency Coordination

Coordination with other entities throughout Vermont is crucial for the advancement of ITS. Coordination will continue to occur with the following agencies on specific projects and initiatives:

- Vermont Department of Public Safety
- Vermont State Police
- Vermont Emergency Management
- Department of Public Health
- Vermont Fire Safety
- Regional Planning Commissions
- Municipalities
- Public Transportation Agencies
- Emergency Services
- Utility companies

For example, continued coordination with the CCRPC is paramount. The CCRPC not only has its own Chittenden County ITS Plan, but it has also partnered with VTrans on several ITS project implementations, including the Advanced Traffic Monitoring System Using Bluetooth Technology Project and the Transit Reporting/Data Management Project.

In addition, there are several potential projects already outlined that would require coordination with these entities.

Neighboring State Coordination

In addition to coordination within VTrans and the state as a whole, continued coordination with neighboring states and provincial transportation agencies is important. Currently Vermont coordinates with the following neighbors:

› New York State Department of Transportation (NYSDOT)
› New Hampshire Department of Transportation (NHDOT)
› Maine Department of Transportation (MaineDOT)
› Massachusetts Department of Transportation (MassDOT)
› Ministry of Transport Quebec (MTQ)

While each entity is responsible for transportation infrastructure and management in its respective geographies, there is some direct collaboration. For example, MaineDOT and NHDOT shared in the development of the Compass ITS software system used to share real-time traveler information to the public.

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Table 2: ITS Project Descriptions

Status	ITS Project	Description	Relation to ITS Vision/Mission/Objectives	Relation to VTrans Vision/Mission/Goals
Ongoing	**Traffic Signals**	Traffic signals allow for the control of traffic in a safe, orderly, and efficient manner providing orderly movement, improved safety, reduced travel times, and increasing intersection capacity. To achieve optimum efficiency traffic signals must be maintained, monitored, and adjusted.	Objectives: 4, 6	Mission, Vision and Goals: 2, 3, 4
Ongoing	**Traffic Signals System Updates**	Traffic signal system upgrades can be an easy, low-cost way to improve traffic flow and mitigate congestion. Signal timing systems can be updated to address current traffic conditions and all other modes of transportation involved, such as pedestrian activity and bicycles.	Objectives: 4, 6	Mission and Goals: 2, 3, 4
Ongoing	**Regional Traffic Signal Management**	Signal coordination has been shown to improve arterial and highway traffic flow through the use of advanced signal systems that are calibrated and coordinated along specific corridors. This effort involves connecting all state-owned and -operated traffic signals to a single server.	Objectives: 4, 5, 6	Goals: 2, 3, 4
Ongoing	**Road Weather Information System (RWIS) Stations**	The RWIS stations measure road surface conditions and temperature, air temperature, humidity, barometric pressure, wind speed and direction, precipitation, and visibility.	Objectives: 4, 5, 6	Goals: 2, 3, 4, 5
Ongoing	**Weigh in Motion (WIM) System**	The WIM station measures the volume, speed, classification, and weight of vehicles. Reductions in dramatically overweight trucks will reduce the damage caused to road surfaces and lengthen the lifespan of pavement on roadways.	Objectives: 1, 3, 4	Goal: 4
Ongoing	**Virtual Weigh in Motion (WIM) Station**	The objective of the virtual weigh station is to employ multiple sensor and communication technologies to enforce weight restriction laws more effectively in real time. This project seeks to improve the effectiveness of commercial vehicle weight enforcement throughout the corridor by establishing cooperative agreements among the states.	Objectives: 1, 3, 4	Goal: 4, 5
Ongoing	**Changeable Message Signs (CMS)**	CMS are used to communicate information to the traveling public. Fixed CMS could be used to provide information to users in a more efficient and cost-effective manner. This project seeks to maintain and expand the fixed CMS coverage throughout the state.	Mission and Objective: 4	Mission, Vision, and Goals: 2, 3
Ongoing	**Portable Changeable Message Signs (PCMS)**	Portable CMS serve the same purpose as fixed Changeable Message Signs, including providing information to travelers about special events, giving travelers information before decision points, and safely directing travelers through a work zone.	Mission and Objective: 4	Mission, Vision, and Goals: 2, 3
Ongoing	**Bluetooth Monitoring Devices**	Bluetooth monitoring deployment will provide opportunity to deliver real-time traffic monitoring and communication), including travel times, average travel speeds, start of congestion, and crash avoidance areas.	Vision and Objectives: 2, 5	Goals 2, 5
Ongoing	**Closed Circuit Television (CCTV) Cameras**	CCTV cameras allow for better monitoring and surveillance of the transportation infrastructure. In addition, CCTV cameras can be placed at rail platforms, on transit and maintenance vehicles, airports, and near critical infrastructure to provide additional coverage or near highway or arterial intersections or areas of recurrent congestion to assist in systems operations.	Vision and Objectives: 2, 5	Goals 2, 4, 5
Planned	**ITS Design Guidelines**	This project would develop design standards in the development and implementation of ITS components in Vermont for use by state and local agencies that have started deploying ITS or are looking to deploy ITS.	Vision and Objectives: 1, 3, 6, 7	Goals 1, 2, 4, 5
Ongoing	**Advanced Transportation Management System (ATMS) New England Compass**	The project is a Tri-State initiative with VT working closely with New Hampshire and Maine DOTs to provide system oversight to the vendor and to share best practices for system operations. Compass consolidates multiple "silos" of various VTrans' ITS devices and transportation management tools into a single user interface allowing for efficient management of ITS devices and traveler information.	Mission and Objectives: 4, 5	Mission, and Goals: 2, 3, 5
Ongoing	**Statewide Advanced Traveler Information Systems – Vermont Alert and 511**	The Vermont Alert and 511 system provides travelers a one-stop-shopping opportunity to find traffic information across the state. Existing traveler information and condition reporting systems are incorporated and expanded to form the base for this statewide traveler information system.	Mission and Objectives: 4, 5	Vision, Mission, and Goals: 2, 3, 5
Ongoing	**Vermont State Emergency and Operation (SEOC) TMC Integrations Center**	The Vermont SEOC provides transportation information and support in case of emergencies. The Vermont SEOC is equipped with communications equipment and computer systems needed to provide these services during disaster operations. The SEOC is integrated with the TMC by way of an AOT Duty Officer assigned to the SEOC during Emergencies. An AOT Duty Officer is also assigned to the TMC, creating a direct line of communication between the SEOC and the TMC during emergency activation of AOT's ICS structure.	Objectives: 1, 2, 3, 6, 7	Mission and Goals: 1, 4, 5
Planned	**Integrated Transportation Corridors**	Coordinated ITS can be deployed along selected high-priority corridors to the benefit of all travelers. A corridor would be chosen based on accidents, congestion, travel patterns, availability of alternate routes, and interest of local participants. Specific recommendations for corridors would be developed to address the needs of that corridor and incorporate the systems already in place.	Objectives: 2,6,7	Goals: 2, 4
Ongoing	**Emergency Vehicle Traffic Signal Preemption**	Through the installation of sensors on traffic signals at intersections, emergency vehicles with special emitters can trigger the signal controller to alter the intersection timing and phasing. This gives the emergency vehicle's approach a green indication and all other approaches a red indication, giving priority flow to the emergency vehicle approach reducing emergency response time.	Objectives: 2,5	Vision and Goals: 3, 4, 5

Table 2: ITS Project Descriptions (Continued)

Status	ITS Project	Description	Relation to ITS Vision/Mission/Objectives	Relation to VTrans Vision/Mission/Goals
Planned	**Obtain Third-Party In-Vehicle Traffic Probe Data**	This strategy would allow for better collection of data on arterial routes and interstates in rural areas. Data already gathered on some routes would be enhanced by this new stream of data to provide better information, while this system would also provide data on routes where higher-cost detection systems are not deployed.	Objectives: 4, 5	Goals: 4, 5
Ongoing	**Maintenance Automated Vehicle Location (AVL)**	AVL technology has been implemented in maintenance vehicles to reduce costs and improve performance by planning and operating maintenance activities more efficiently and provide real-time maintenance information to the public.	Mission and Objectives: 1, 2, 5, 6	Mission and Goals: 3, 4, 5
Planned	**Vermont State Police (VSP) Computer Aided Dispatch (CAD) and Transportation Management Center (TMC) Integration**	VSP CAD systems are used to track and retain information provided to VSP dispatchers during an event. In addition to the information being used by emergency response dispatchers, this information can be used by the TMC. TMC access to VSP CAD information would increase efficiency in getting pertinent maintenance and travel information disseminated among VTrans maintenance staff and the traveling public. Integration with the ATMS adds a level of functionality and potentially eliminates a line of communication.	Objectives: 2, 5	Goal: 5
Ongoing	**Smart Work Zones**	Work zones are a major point for congestion and for crashes. Some initiatives may include queue detection, dynamic merge systems, portable traffic management systems, and travel times through work zones.	Mission and Objectives: 1, 2, 4, 5	Mission and Goals: 1, 5
Planned	**Backbone Communications Infrastructure**	This communication system typically transmits two-way data to and from the TMC. Once a fiber optic backbone is installed, sites can be linked by installing short distances of fiber optic cable and associated equipment or wireless transmissions can be used to send and receive information between a local center and a processor connected to the backbone.	Objectives: 1, 3, 6, 7	Goals: 4, 5
Ongoing	**Enhanced Communication Links to Field Devices**	Depending on the importance of various field devices and the age of the devices and their communications connections, outdated connections/conduits should be upgraded to provide more reliable device operation.	Objectives: 1, 3, 6, 7	Goals: 1, 4, 5
Planned	**ITS Outreach/Public Education**	ITS outreach and education would seek to spread greater knowledge of the benefits ITS can provide and how it can be used in different areas such as transportation planning and programming, construction, transit, or law enforcement.	Objectives: 1, 2, 3	Goals: 1, 5
Ongoing	**Traffic Data Archive**	This data can be archived for future analysis of traffic patterns and to measure the effects of changes to the transportation system.	Objective: 4	Goals: 4, 5
Planned	**Training**	Operations personnel need training to effectively use the resources they have available to fit the needs of different circumstances.	Objectives: 1, 7	Goals: 1, 5
Planned	**Emergency Vehicle Trail Crossing Safety Systems[1]**	Many existing active warning systems for grade crossings provide valuable information that can be easily imported into a computer-aided dispatch system. The information would be used to alert emergency vehicle dispatch centers of approaching trains so that they may identify the best routes for emergency response vehicles to follow.	Objectives: 2, 5	Vision and Goals: 3, 4, 5
Ongoing	**Automated Weather Observing System (AWOS)**	AWOS collects and broadcasts continuous, real-time information and reports of weather conditions at their locations on a minute-by-minute basis and are a vital tool for pilot decision making and planning.	Objectives: 4, 5, 6	Goals: 2, 3, 4, 5
Ongoing	**Transit Automated Vehicle Location (AVL)[1]**	AVL technology has been implemented in transit vehicles to reduce costs and improve performance by planning and operating transit activities more efficiently and provide real-time maintenance information to the public.	Mission and Objectives: 1, 2, 5, 6	Mission and Goals: 3, 4, 5
Planned	**Update Transit Scheduling and Dispatch through Mobility on Demand (MOD) and Mobility as a Service (MaaS)[1]**	Transit CAD is a software that connects transit routes, schedules, trips, and vehicles assignments in one system to allow dispatchers more insight and control over the transit fleet. Transit CAD can be used to assist with scheduling demand response or on-demand service. Transit scheduling software utilizes a route optimization module that maximizes the transit vehicle resources and efficiencies using Geo Map technology. Mobility on Demand (MOD) and Mobility as a Service (MaaS) integration with Transit CAD would improve efficiency and expand rider usage and coverage.	Mission and Objectives: 4, 5	Mission and Goals: 4, 5
Planned	**Regional Demand Response[1]**	Demand response service can be greatly increased by sharing AVL information for on-demand routing. Transit CAD/AVL systems allow transit agencies to fulfill ride requests within the same day, making transit a much more attractive option for prospective riders.	Mission and Objectives: 4, 5	Vision, Mission and Goals: 2, 3
Planned	**Complete Trips[1]**	The mobility of Vermonters has been a continuous focus of the Go Vermont program and assisting people with their first and last mile connections. The complete trip would incorporate first mile/last mile, GTFS-Flex, AVL and ITS systems to create expanded mobility knowledge.	Mission and Objectives: 4, 5	Mission, Vision and Goals: 2, 3
Planned	**Connected Vehicles[1]**	CV allows the transfer of crucial transportation information between vehicles, the road itself, traffic signals, and more creating opportunities for improvements in safety, mobility, and the environment.	Objectives: 4, 5, 7	Mission, Vision and Goals: 2, 3
Planned	**Upgrade Land Mobile Radio (LMR) Architecture to Digital System[1]**	Due to deficiencies in the Agency's current tactical VHF/UHF communications, the existing land mobile radio (LMR) architecture should be replaced with a digital system that is P25 Standards compliant. Upgrading the system as whole, opposed to repairing the existing system, will allow the new system to integrate into a larger framework. The upgraded system will integrate with many data nodes including ITS components such as RWIS, ATMS, and more.	Objectives: 1, 3, 6, 7	Goals: 1, 4, 5

1. Project is or has major ITS components therefore it is incorporated into the ITS Management Plan, however, implementation and maintenance the project will not be sole sourced by ITS specific funding.

6

Project Priorities, Funding, and Project Considerations and Criteria

INTRODUCTION

To address the needs recognized during the CMMA outlined in Chapter 4, existing and potential ITS projects were identified in by the ITS Project Team in Chapter 5. This section identifies the status of each of these projects, prioritizes the projects to determine in what order implementation should occur, and defines the potential project implementation timeline. Chapter 6 outlines and describes three potential funding scenarios for maintaining and expanding ITS based on a light investment, asset management, and optimal funding scenario. This section also provides guidance for incorporating ITS components on future state projects such as paving, interchange, and bridge and bridge deck replacements.

ITS PROJECT PRIORITIZATION

The ITS Project Team identified 32 ongoing existing and potential future ITS projects, which are listed in **Table 2**. The ITS Project Team reviewed the projects and provided a project status: each is designated as ongoing or planned. In addition, the ITS Project Team prioritized the projects to define the order in which each should be implemented. **Table 3** includes the list of the projects, a brief description, the project status, and the project prioritization.

ITS FUNDING SCENARIOS

This section will provide insight on project prioritization based on fiscal constraints and various potential ITS funding scenarios.

Scenario 1 – Asset Management (Fiscally Constrained)

Scenario 1 considers an asset management approach to ITS investment. Scenario 1 assumes that ITS has been established as an asset to the Agency and is recognized as a key component of

Vermont's transportation system warranting sufficient funding to maintain its existing ITS infrastructure. With the asset management approach, sufficient funding would be provided to maintain equipment within its useful life, however, there will be no additional funding for ITS expansion. This scenario considers a fiscally constrained approach focusing solely on preservation. The outcomes achieved under Scenario 1 are listed below.

Outcomes

Maintenance and Preservation:

- Replace all ITS devices as life cycles end without having to prioritize locations
  - 10 traffic signal locations per year includes:
    - 5 traffic signal upgrades
    - 5 traffic signal cabinets replaced
  - 3-4 RWIS station replacements per year
  - RWIS sensor and processor repair and replacement
  - WIM maintenance
  - CMS and PCMS maintenance contract
- Maintain ATMS New England Compass
- Maintain Vermont Alert and 511

Expansion:

- No expansion

Staffing:

- Maintain existing staffing
  - 14 full-time equivalents
- Hire 2-person ITS device maintenance crew

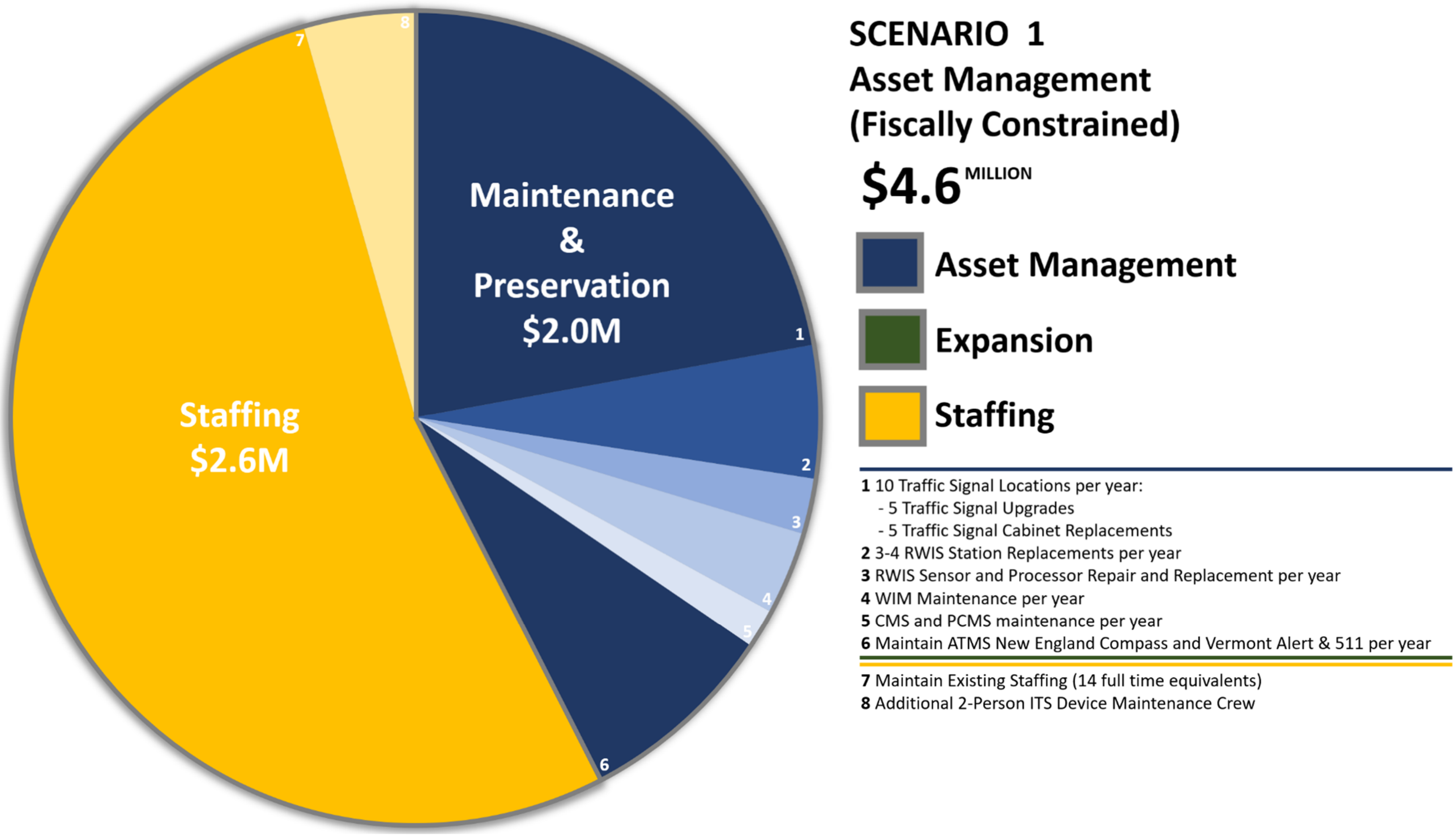


Figure 10: Scenario 1 – Asset Management Funding

Scenario 2 – Light Investment

Scenario 2 considers an ITS investment plan or funding scheme like the current 2021 level. In this scenario, the capital investment remains at its current level and fiscal constraints require focus to remain on maintaining equipment until its useful life cycle and little on expansion. In Scenario 2, ITS will continue to allocate most of the funding to upgrade and replace existing equipment as it reaches the end of its life cycle. Existing funding may not be sufficient to complete necessary equipment upgrades based on life cycle alone but allows upgrades and repairs to be implemented strategically to ensure the ITS system can continue operating as intended. Strategic preservation of existing ITS infrastructure allows for the allocation of a portion of the budget to expansions through the installation of new equipment and devices based on need or demand. The outcomes achieved under Scenario 2 are listed below.

Outcomes

Maintenance and Preservation:

- 25-30 traffic signal locations per year includes:
  - 10-15 traffic signal upgrades*
  - 15 traffic signal cabinets replaced*
- 2-3 new traffic signals per year**
- 3-4 RWIS station replacements per year
- RWIS sensor and processor repair and replacement
- WIM maintenance
- CMS and PCMS maintenance contract
- Maintain ATMS New England Compass
- Maintain Vermont Alert and 511

Expansion:

- 4 new message boards with sensors and cameras per year
- 3-4 new RWIS stations per year
- 2-3 new or upgraded WIMs stations

Staffing:

- Maintain existing staffing
  - 14 full time equivalents

* Provides a healthier life cycle maintenance strategy than that included in Scenario 1
** New traffic signals are typically added as a part of the capital program through project delivery

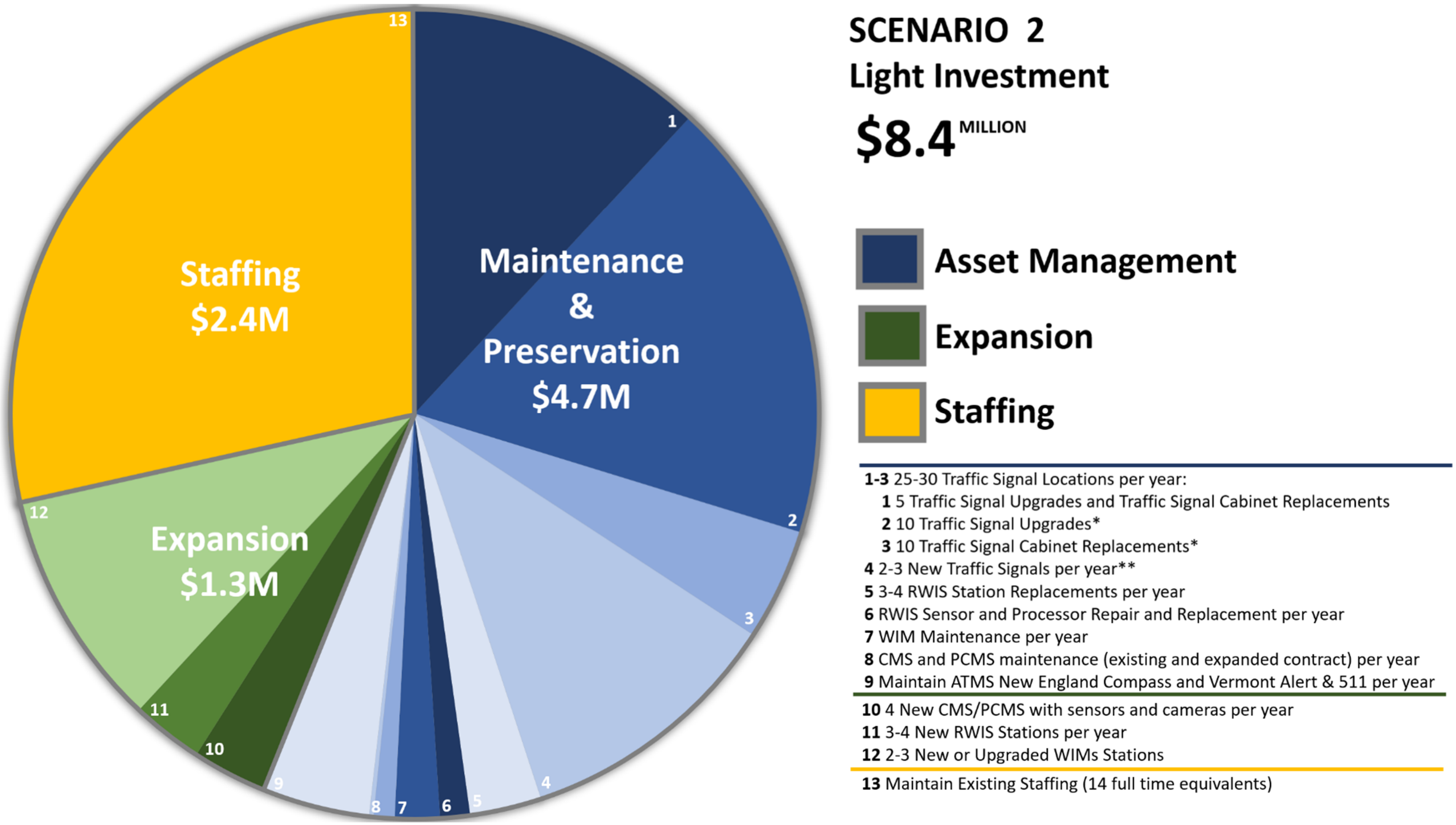


Figure 11: Scenario 2 – Light Investment Funding

* Provides a healthier life cycle maintenance strategy than that included in Scenario 1
** Traffic signals are added as needed to maintain safe and efficient movement throughout the state but not to increase ITS capacity

Scenario 3 – Optimal Funding

Scenario 3 considers an optimal funding situation where ITS investment is highly integrated and optimized within the Agency. This assumes a major shift within the Agency to incorporate the maintenance and expansion of ITS infrastructure and devices as a component of other planned State projects, including bridge rehabilitation and replacement, roadway resurfacing and restoration, and interchange projects. The incorporation of ITS infrastructure and devices in State projects is described in greater detail in a later section and considerations/criteria are listed in **Table 4**. Some planned upgrades to existing ITS infrastructure based on life cycle and installation of new ITS infrastructure based on need would be absorbed by these State projects. This would include updates and installations of static structures within the confines of the project area, including RWIS, CMS, WIM, traffic signals, and communications. With some basic maintenance and expansion rolled into State projects, the available funding focus can shift from preservation to expansion and future technology. In addition, Scenario 3 assumes a significant increase in funding over that assumed in Scenarios 1 or 2. The additional funding can be used to facilitate more of the large-scale projects in **Table 3** such as purchasing statewide probe data, investing in strengthening communication links to field devices, or establishing a communication backbone along the interstate.

Outcomes

Maintenance and Preservation:

- 25-30 traffic signal locations per year includes:
  - 10-15 traffic signal upgrades*
  - 15 traffic signal cabinets replaced*
- 2-3 new traffic signals per year**
- 3-4 RWIS station replacements per year
- RWIS sensor and processor repair and replacement
- WIM maintenance
- CMS and PCMS maintenance contract
- Maintain ATMS New England Compass
- Maintain Vermont Alert and 511

Expansion:

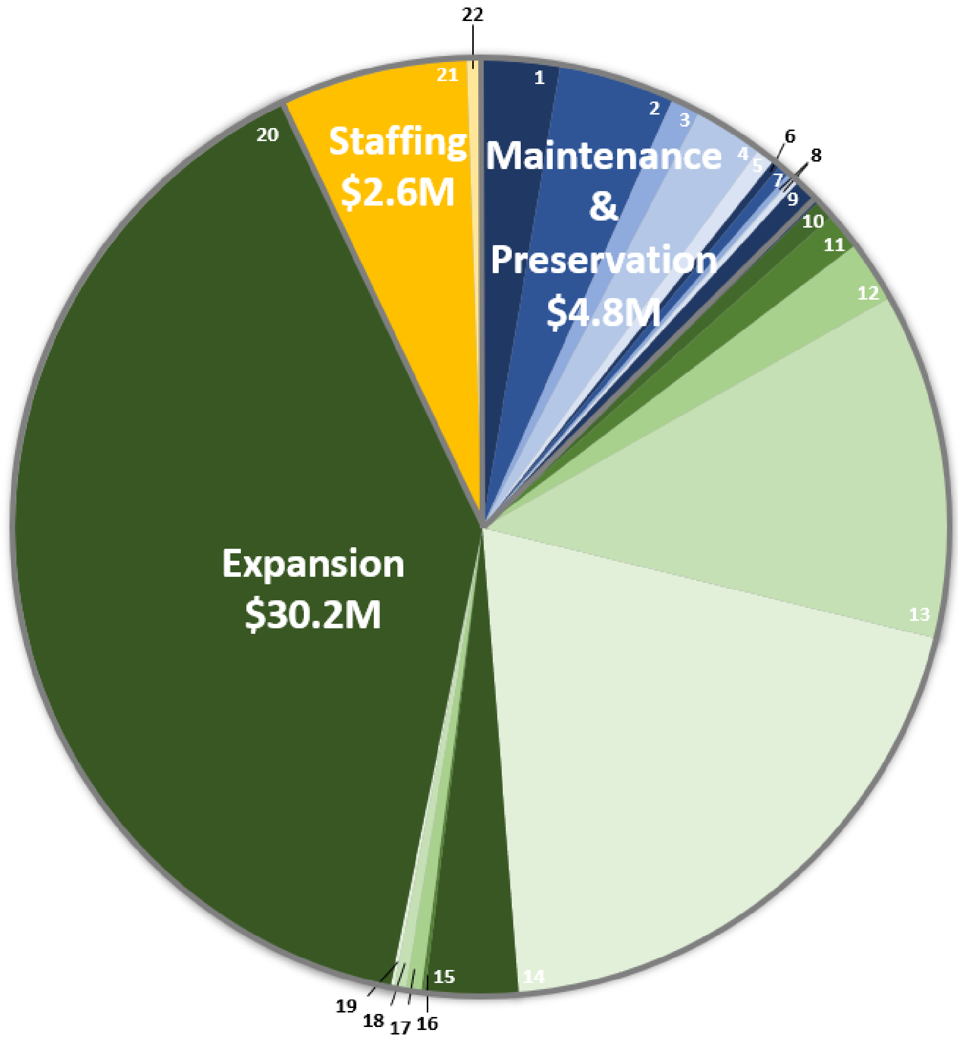
- 4 new message boards with sensors and camera per year
- 8 new RWIS stations per year
- 2-3 new or upgraded WIMs stations
- Modernize Traffic Signals along specific corridors:
  - 4-5 traffic signal locations to be modernized per corridor
- 100 new Changeable Message Signs (with sensors and camera) at key locations and corridors including:

* Provides a healthier life cycle maintenance strategy than that included in Scenario 1
** Traffic signals are added as needed to maintain safe and efficient movement throughout the state but not to increase ITS capacity

  - Waterbury
  - Chittenden County Interchanges
  - Freight Corridors and interchanges: US Routes 2, 4, and 7; VT Routes 9, 22A, and 103; and Interstates 89, 91, and 93
- Expand ITS system further throughout the state implementing more projects in **Table 3** prioritizing the following:
  - ITS Outreach and Public Education
  - ITS Design Guidelines
  - Obtain Third-Party In-Vehicle Traffic Probe Data
  - Virtual WIMs (2 locations)
  - Staff Training
  - Fiber Backbone Communications Infrastructure from Montpelier to Colchester

Staffing:

- Maintain existing staffing
  - 14 full time equivalents
- Hire 2-person ITS device maintenance crew



SCENARIO 3
Optimal Funding
$37.6 MILLION

Asset Management
Expansion
Staffing

1-3 25-30 Traffic Signal Locations per year:
- **1** 5 Traffic Signal Upgrades and 5 Traffic Signal Cabinet Replacements
- **2** 10 Traffic Signal Upgrades*
- **3** 10 Traffic Signal Cabinet Replacements*

4 2-3 New Traffic Signals per year**
5 3-4 RWIS Station Replacements per year
6 RWIS Sensor and Processor Repair and Replacement per year
7 WIM Maintenance per year
8 CMS and PCMS maintenance (existing and expanded contract) per year
9 Maintain ATMS New England Compass and Vermont Alert & 511 per year

10 4 New CMS/PCMS with sensors and cameras per year
11 8 New RWIS Stations per year
12 2-3 New or Upgraded WIMs Stations

13 New Traffic Signals along Selected Corridors
14 100 New Message Boards
15 New Virtual WIM Stations
16 Public Outreach and Education
17 ITS Design Guidelines
18 Obtain Probe Data
19 Staff Training
20 Fiber Optic Connection Montpelier to Colchester

21 Maintain Existing Staffing (14 full time equivalents)
22 Additional 2-Person ITS Device Maintenance Crew

Figure 12: Scenario 3 – Optimal Funding

* Provides a healthier life cycle maintenance strategy than that included in Scenario 1
** Traffic signals are added as needed to maintain safe and efficient movement throughout the state but not to increase ITS capacity

Table 3: ITS Project Status and Prioritization

Priority Rank	Status	ITS Project	Description	Relation to VTrans Vision/Mission/Goals	Project Timeline
1	Ongoing	**Traffic Signals**	Traffic signals allow for the control of traffic in a safe, orderly, and efficient manner providing orderly movement, improved safety, reduced travel times, and increasing intersection capacity. To achieve optimum efficiency traffic signals must be maintained, monitored, and adjusted.	Objectives: 4, 6	Immediate
2	Ongoing	**Road Weather Information System (RWIS) Stations**	The RWIS stations measure road surface conditions and temperature, air temperature, humidity, barometric pressure, wind speed and direction, precipitation, and visibility.	Objectives: 4, 5, 6	2 years
3	Planned	**ITS Outreach/Public Education**	ITS outreach and education would seek to spread greater knowledge of the benefits ITS can provide and how it can be used in different areas such as transportation planning and programming, construction, transit, or law enforcement.	Objectives: 1, 2, 3	Immediate
4	Ongoing	**Portable Changeable Message Signs (PCMS)**	Portable CMS serve the same purpose as fixed Changeable Message Signs, including providing information to travelers about special events, giving travelers information before decision points, and safely directing travelers through a work zone.	Mission and Objective 4	2 years
5	Ongoing	**Changeable Message Signs (CMS)**	CMS are used to communicate information to the traveling public. Fixed CMS could be used to provide information to users in a more efficient and cost-effective manner. This project seeks to maintain and expand the fixed CMS coverage throughout the state.	Mission and Objective 4	2 years
6	Ongoing	**Smart Work Zones**	Work zones are a major point for congestion and for crashes. Some initiatives may include queue detection, dynamic merge systems, portable traffic management systems, and travel times through work zones.	Mission and Objectives: 1, 2, 4, 5	1 year
7	Ongoing	**Maintenance Automated Vehicle Location (AVL)**	AVL technology has been implemented in maintenance vehicles to reduce costs and improve performance by planning and operating maintenance activities more efficiently and provide real-time maintenance information to the public.	Mission and Objectives: 1, 2, 5, 6	1 years
8	Ongoing	**Traffic Signal System Upgrades**	Traffic signal system upgrades can be an easy, low-cost way to improve traffic flow and mitigate congestion. Signal timing systems can be updated to address current traffic conditions and all other modes of transportation involved, such as pedestrian activity and bicycles.	Objectives: 4, 6	1 years
9	Ongoing	**Advanced Transportation Management System (ATMS) New English Compass**	The project is a Tri-State initiative with VT working closely with New Hampshire and Maine DOTs to provide system oversight to the vendor and to share best practices for system operations. Compass consolidates multiple "silos" of various VTrans' ITS devices and transportation management tools into a single user interface allowing for efficient management of ITS devices and traveler information.	Mission and Objectives: 4, 5	1 year
10	Planned	**ITS Design Guidelines**	This project would develop design standards in the development and implementation of ITS components in Vermont for use by state and local agencies that have started deploying ITS or are looking to deploy ITS.	Vision and Objectives: 1, 3, 6, 7	2 years
11	Ongoing	**Weigh in Motion (WIM) System**	The WIM station measures the volume, speed, classification, and weight of vehicles. Reductions in dramatically overweight trucks will reduce the damage caused to road surfaces and lengthen the lifespan of pavement on roadways.	Objectives: 1, 3, 4	2 years
12	Ongoing	**Emergency Vehicle Traffic Signal Preemption**	Through the installation of sensors on traffic signals at intersections, emergency vehicles with special emitters can trigger the signal controller to alter the intersection timing and phasing. This gives the emergency vehicle's approach a green indication and all other approaches a red indication, giving priority flow to the emergency vehicle approach reducing emergency response time.	Objectives: 2, 5	2 years
13	Planned	**Obtain Third-Party In-Vehicle Traffic Probe Data**	This strategy would allow for better collection of data on arterial routes and interstates in rural areas. Data already gathered on some routes would be enhanced by this new stream of data to provide better information, while this system would also provide data on routes where higher-cost detection systems are not deployed.	Objectives: 4, 5	2 years
14	Ongoing	**Closed Circuit Television (CCTV) Cameras**	CCTV cameras allow for better monitoring and surveillance of the transportation infrastructure. In addition, CCTV cameras can be placed at rail platforms, on transit and maintenance vehicles, airports, and near critical infrastructure to provide additional coverage or near highway or arterial intersections or areas of recurrent congestion to assist in systems operations.	Vision and Objectives: 2, 5	3 years
15	Planned	**Vermont State Police (VSP) Computer Aided Dispatch (CAD) and Transportation Management Center (TMC) Integration**	VSP CAD systems are used to track and retain information provided to VSP dispatchers during an event. In addition to the information being used by emergency response dispatchers, this information can be used by the TMC. TMC access to VSP CAD information would increase efficiency in getting pertinent maintenance and travel information disseminated among VTrans maintenance staff and the traveling public. Integration with the ATMS adds a level of functionality and potentially eliminates a line of communication.	Objectives: 2, 5	3 years
16	Planned	**Training**	Operations personnel need training to effectively use the resources available to fit the needs of different circumstances.	Objectives: 1, 7	3 years

1. Project is or has major ITS components therefore it is incorporated into the ITS Management Plan, however, implementation and maintenance the project will not be sole sourced by ITS specific funding.

Table 3: ITS Project Status and Prioritization (Continued)

Priority Rank	Status	ITS Project	Description	Relation to VTrans Vision/Mission/Goals	Project Timeline
17	Ongoing	Virtual Weigh in Motion (WIM) Station	The objective of the virtual weigh station is to employ multiple sensor and communication technologies to enforce weight restriction laws more effectively in real time. This project also seeks to improve the effectiveness of commercial vehicle weight enforcement throughout the corridor by establishing cooperative agreements among the states.	Objectives: 1, 3, 4	2 years
18	Planned	Upgrade Land Mobile Radio (LMR) Architecture to Digital System[1]	Due to deficiencies in the Agency's current tactical VHF/UHF communications, the existing land mobile radio (LMR) architecture should be replaced with a digital system that is P25 Standards compliant. Upgrading the system as whole, opposed to repairing the existing system, will allow the new system to integrate into a larger framework. The upgraded system will integrate with many data nodes including ITS components such as RWIS, ATMS, and more.	Objectives: 1, 3, 6, 7	7 years
19	Ongoing	Statewide Advanced Traveler Information Systems – Vermont Alert 511	The Vermont Alert and 511 system provides travelers a one-stop-shopping opportunity to find traffic information across the state. Existing traveler information and condition reporting systems are incorporated and expanded to form the base for this statewide traveler information system.	Mission and Objectives: 4, 5	2 years
20	Ongoing	Enhanced Communication Links to Field Devices	Depending on the importance of various field devices and the age of the devices and their communications connections, outdated connections/conduits should be upgraded to provide more reliable device operation.	Objectives: 1, 3, 6, 7	4 years
21	Planned	Connected Vehicles[1]	CV allows the transfer of crucial transportation information between vehicles, the road itself, traffic signals, and more creating opportunities for improvements in safety, mobility, and the environment.	Objectives: 4, 5, 7	4 years
22	Ongoing	Traffic Data Archive	This data can be archived for future analysis of traffic patterns and to measure the effects of changes to the transportation system.	Objectives: 4	6 years
23	Ongoing	Regional Traffic Signal Management	Signal coordination has been shown to improve arterial and highway traffic flow using advanced signal systems that are calibrated and coordinated along specific corridors. This effort involves connecting all state owned and operated traffic signals to a single server.	Objectives: 4, 5, 6	7 years
24	Ongoing	Automated Weather Observing System (AWOS)	AWOS collects and broadcasts continuous, real-time information and reports of weather conditions at their locations on a minute-by-minute basis and are a vital tool for pilot decision making and planning.	Objectives: 4, 5, 6	7 years
25	Ongoing	Transit Automated Vehicle Location (AVL)[1]	AVL technology has been implemented in transit vehicles to reduce costs and improve performance by planning and operating transit activities more efficiently and provide real-time maintenance information to the public.	Mission and Objectives: 1, 2, 5, 6	5 years
26	Planned	Update Transit Scheduling and Dispatch through Mobility on Demand (MOD) and Mobility as a Service (MaaS)[1]	Transit CAD is a software that connects transit routes, schedules, trips, and vehicles assignments in one system to allow dispatchers more insight and control over the transit fleet. Transit CAD can be used to assist with scheduling demand response or on-demand service. Transit scheduling software utilizes a route optimization module that maximizes the transit vehicle resources and efficiencies using Geo Map technology. Mobility on Demand (MOD) and Mobility as a Service (MaaS) integration with Transit CAD would improve efficiency and expand rider usage and coverage.	Mission and Objectives: 4, 5	5 years
27	Planned	Regional Demand Response[1]	Demand response service can be greatly increased by sharing AVL information for on-demand routing. Transit CAD/AVL systems allow transit agencies to fulfill ride requests within the same day, making transit a much more attractive option for prospective riders.	Mission and Objectives: 4, 5	7 years
28	Planned	Backbone Communications Infrastructure	This communication system typically transmits two-way data to and from the TMC. Once a fiber optic backbone is installed, sites can be linked by installing short distances of fiber optic cable and associated equipment or wireless transmissions can be used to send and receive information between a local center and a processor connected to the backbone.	Objectives: 1, 3, 6, 7	10 years
29	Planned	Complete Trips	The mobility of Vermonters has been a continuous focus of the Go Vermont program and assisting people with their first and last mile connections. The complete trip would incorporate first mile/last mile, GTFS-Flex, AVL and ITS systems to create expanded mobility knowledge.	Mission and Objectives: 4, 5	7 years
30	Planned	Emergency Vehicle Rail Crossing Safety Systems[1]	Many active warning systems for grade crossings provide valuable information that can be easily imported into a computer aided dispatch system. The information would be used to alert emergency vehicle dispatch centers of approaching trains so that they may identify the best routes for emergency response vehicles to follow.	Objectives: 2, 5	6 years
31	Planned	Integrated Transportation Corridors	Coordinated ITS can be deployed along selected high-priority corridors to the benefit of all travelers. A corridor would be chosen based on accidents, congestion, travel patterns, availability of alternate routes, and interest of local participants. Specific recommendations for corridors would be developed to address the needs of that corridor and incorporate the systems already in place.	Objectives: 2, 6, 7	7 years
32	Ongoing	Vermont State Emergency and Operation (SEOC) TMC Integrations Center	The Vermont SEOC provides transportation information and support in case of emergencies. The Vermont SEOC is equipped with communications equipment and computer systems needed to provide these services during disaster operations. The SEOC is integrated with the TMC by way of an AOT Duty Officer assigned to the SEOC during Emergencies. An AOT Duty Officer is also assigned to the TMC, creating a direct line of communication between the SEOC and the TMC during emergency activation of AOT's ICS structure.	Objectives: 1, 2, 3, 6, 7	5 years
33	Ongoing	Bluetooth Monitoring Devices	Bluetooth monitoring deployment will provide opportunity to deliver real time traffic monitoring and communication including travel times, average travel speeds, start of congestion, and crash avoidance areas.	Vision and Objectives: 2, 5	1 year

1. Project is or has major ITS components therefore it is incorporated into the ITS Management Plan, however, implementation and maintenance the project will not be sole sourced by ITS specific funding.

ITS PROJECT INCORPORATION CRITERIA AND CONSIDERATION

This section will provide guidance and criteria for the determining which ITS components/projects should be considered for inclusion on planned projects such as paving, interchange, or bridge and bridge deck replacements.

Project Considerations and Criteria

ITS components that should be considered for incorporation of planned projects are listed below in **Table 4**. Some of these considerations are specific for certain projects types, while others are more universal. Example graphics of the ITS considerations at an interchange, and at a bridge over a highway, are provided in **Figure 13** and **Figure 14** respectively. Each consideration should be evaluated for inclusion based on the criteria described in the chart below. A standard form is required to determine whether the project meets the criteria for the potential incorporation of ITS components.

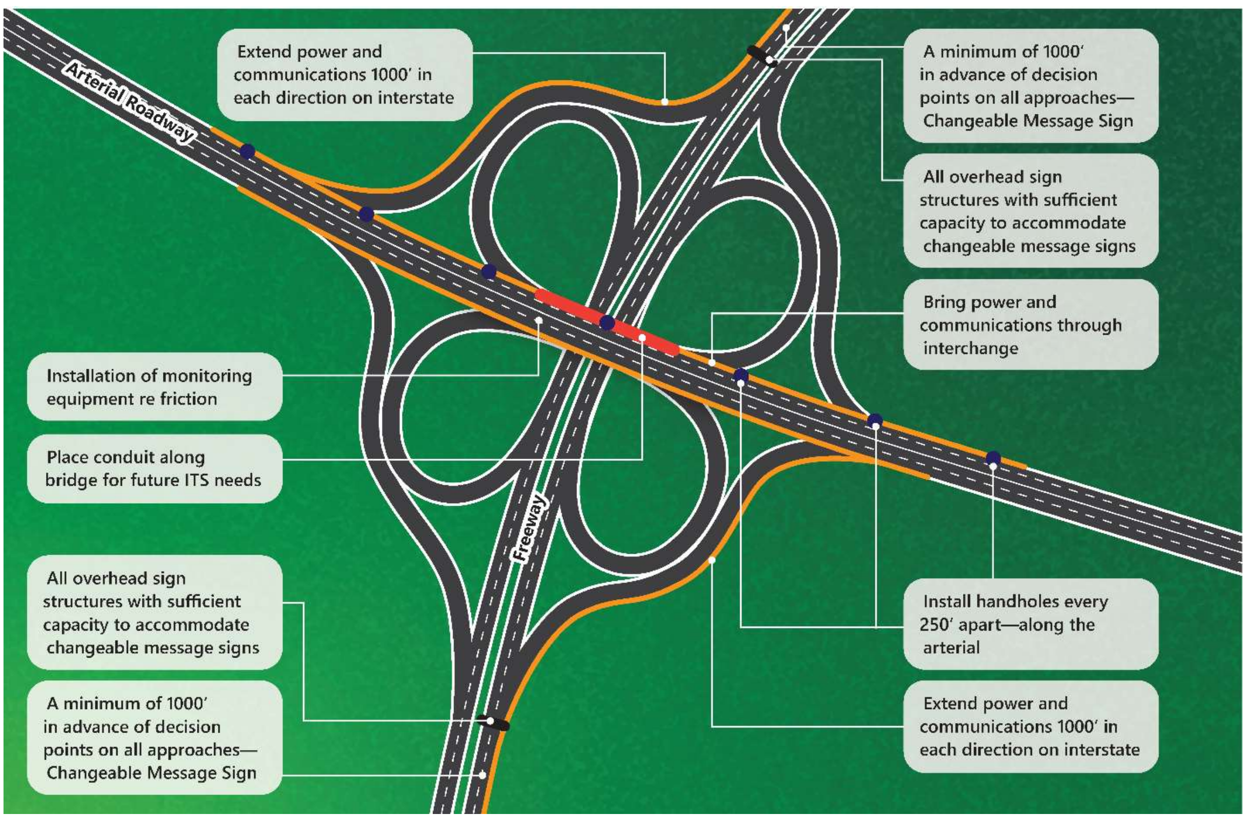


Figure 13: ITS Considerations at an Interchange

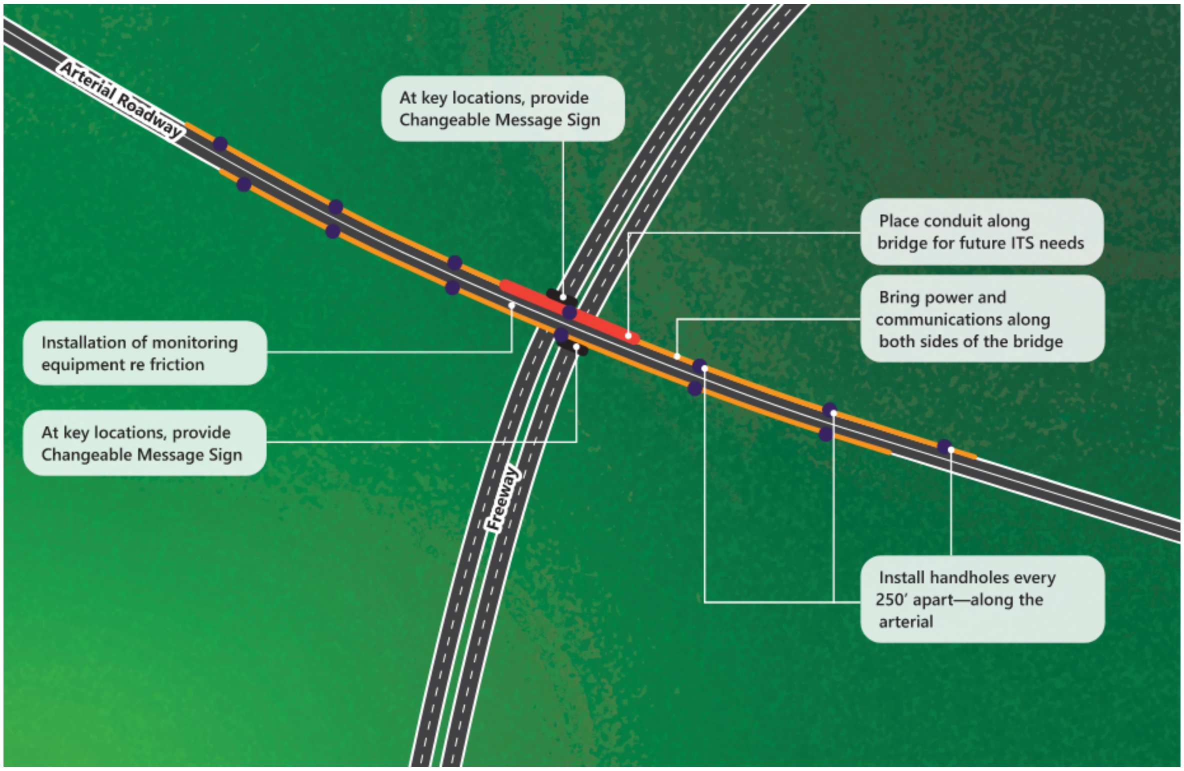


Figure 14: ITS Considerations at a Bridge Over a Highway

Table 4: ITS Project Considerations and Criteria

Considerations	Criteria
The following should be evaluated on <u>all types</u>[1] of state projects:	
Rebuild, upgrade, or maintain existing ITS devices	› All planned ITS equipment upgrades in the vicinity based on life cycle, including (but not limited to) traffic signals, RWIS, WIMs, CMS, PCMS, CCTV, monitoring devices, and their components[1]
Install new planned ITS equipment in the vicinity	› All planned ITS equipment in the vicinity, including (but not limited to) traffic signals, RWIS, WIMs, CMS, PCMS, CCTV, and monitoring devices[2]
Installation of site-specific ITS equipment, including (but not limited to) signage, cameras, high water sensors, and pavement sensors	› Locations of unique geographic locations or roadways prone to weather-related incidents
Application of Smart Work Zone	› As dictated by the current version of the Agency's Work Zone Safety Guidance
Installation of changeable message signs (permanent and/or portable)	› Along any roadway with: • An AADT of 15,000 vehicles or more • An ADDT of 30,000 vehicles or more (TT[3] only) • 8% heavy truck traffic and 10,000 AADT (TT[3]) • An interstate, national or critical truck/freight corridor, or ITS critical corridor[4] designation (TT[3]) • A high crash location(s) or high crash segment(s) • A bridge requiring deck monitoring (see guidance below) • At all interchanges (see guidance above) • A unique geographic locations or other roadways that are prone to weather-related incidents • Critical decision points, including state or international border crossings • Seasonal backups onto interstate (TT[3])
Rebuild or reclaim existing lateral conduit along roadway for future connectivity needs	› Along any roadway with existing or planned ITS components
Install new lateral conduit along roadway for future connectivity needs	› Along any roadway with existing or planned ITS components
Install future fiber optic or power utilities	› Fiber optic: all projects along a roadway with limited access right of way (Limited Access ROW Map) › Future power utilities: along any roadway with existing or planned ITS components

1. All types of projects including paving, interchange, bridge, and bridge deck replacements, etc.
2. ITS equipment is funded by project, but installation will be completed internally by Transportation System Management and Operations Bureau (Intelligent Transportation Systems Unit)
3. Travel time
4. ITS critical corridors includes US Routes 2, 4, and 7; Vermont Routes 9, 22A, and 103; and Interstates 89, 91, and 93

Table 4: ITS Project Considerations and Criteria (Continued)

Considerations	Criteria
The following should be evaluated on bridge replacement projects:	
Installation of conduit (4" fiber glass/steel conduit with 1.25" sleave innerducts per spec) along bridge for future ITS needs	› The bridge is an interstate, national or critical truck/freight corridor, or ITS critical corridor[4] bridge › The project includes a full bridge or full deck replacement
Installation of deck monitoring equipment to calculate friction coefficient	› The bridge is an interstate, national or critical truck/freight corridor, or ITS critical corridor[4] bridge › the project includes a full bridge or full deck replacement
Installation of deicing equipment including power and communication	› The bridge is an interstate bridge › The project includes a full bridge or full deck replacement
The following should be evaluated on interchange projects:	
Install vault or handholes for future ITS needs	› All interchange projects and widening projects on roadways with AADT of at least 15,000 vehicles per day
Install overhead sign structure with sufficient capacity to include new ITS hardware such as changeable message signs (10' to 20' in width, 6' to 8' in height)	› All planned overhead sign structures should be considered for future ITS hardware if: • The structure has a design life exceeding 50 years, or • The roadway has an AADT of 30,000 vehicles or more (TT[3])

1. All types of projects including to paving, interchange, bridge, and bridge deck replacements, etc.
2. ITS equipment is funded by project, but installation will be completed internally by Transportation System Management and Operations Bureau (Intelligent Transportation Systems Unit)
3. Travel time
4. ITS critical corridors includes US Routes 2, 4, and 7; Vermont Routes 9, 22A, and 103; and Interstates 89, 91, and 93

Appendix A

Vision, Mission and Objectives Memo

Memorandum

To: Derek Lyman, PE, VTrans

Date: May 27, 2021

Project #: 57985.03

From: Jennifer Conley, PE, PTOE

Re: Vermont ITS Management Plan
Vision, Mission, Objectives

A strategic plan will achieve greater success if it provides a clear purpose and a clear direction through its mission and vision. The mission statement will define what ITS is and what ITS does while the vision statement will focus on what ITS will be and the role it will play in the future. A strategic plan that aligns with the agency's broader mission, vision, and goals is crucial for its success.

VHB conducted best practices research into the mission, vision, and goals used by others states for their ITS Strategic and Management Plans which were introduced to the ITS Project Team. The ITS Project Team developed the ITS mission, vision, and objectives throughout the process of creating the ITS Management Plan. The current mission, vision, and goals/objectives of the ITS Program and the Vermont Agency of Transportation will be described below:

MISSION

The ITS Project Team developed the ITS Program Mission outlined below. As shown, it is consistent with and supportive of the larger VTrans Mission.

VTrans Mission

Through excellent customer service, provide for the safe and efficient movement of people and goods.

ITS Mission

Implement transportation technologies to support the VTrans Mission to provide excellent customer service and ensure the safe and efficient movement of people and goods.

VISION

As indicated above, the ITS Project Team worked to develop the ITS Program Vision to identify what the ITS Program strives to be and its role in the future. As ITS is an integral piece of the larger Vermont Agency of Transportation organization, it is important that the vision for the ITS Program is cohesive with that of the greater organization. The VTrans and ITS Vision statements are described below.

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VTrans Vision

A safe, reliable, and multimodal transportation system that grows the economy, is affordable to use and operate, and serves vulnerable populations.

ITS Vision

Through Intelligent Transportation Systems, to support the VTrans Vision and Mission by providing relevant, actionable real time traffic information to the public and state agencies, and an archive of historic data for use by decision makers to allow for a safer and more efficient transportation system for all modes throughout Vermont.

GOALS AND OBJECTIVES

In addition to a clear and defined mission and vision, ITS Program Objectives were developed that will support that Mission and provide steps toward achieving the Vision of the ITS Program. These Objectives also connect to the Goals that have been identified for the overall Agency of Transportation.

VTrans Goals

1. Promote organizational excellence by attracting, developing, and retaining a talent, diverse, and engaged workforce.
2. Grow Vermont's economy by providing safe, reliable, and efficient transportation system in a state of good repair.
3. Make Vermont more affordable and serve the vulnerable by providing accessible, convenient, and affordable travel choices.
4. Transition to an energy efficient, advanced technology transportation system.
5. Modernize and improve government efficiency through innovation, continuous improvement, and quality customer service.

ITS Objectives

1. Establish ITS as an asset to the Agency and other stakeholders and improve inter-Agency coordination and communication through education, exposure, and awareness of ITS existing and future capabilities and resources;
2. Demonstrate the value of the intelligent transportation systems within the operations and safety bureau;
3. Integrate the information provided by the following systems (traveler information, traffic management, public transportation management, maintenance and construction management, and emergency management systems) through asset management. With the goal of providing timely information to the public for safe travel and maintenance of our roadways;
4. Collect and communicate real time, relevant, and reliable traveler information, weather conditions, and roadway incidents that impact travel to the public, first responders, and the Vermont maintenance districts through the TMC;

5. Strategically maintain, upgrade, and expand existing ITS infrastructure through the management of assets;
6. Invest in ITS infrastructure that strengthens the Agency's ability to adapt and utilize ever changing intelligent transportation technologies and engage in transportation innovation;
7. Establish institutional mechanisms and clear project parameters to promote the development and deployment of ITS projects and the incorporation of ITS infrastructure in future Agency planning projects.

Coordination of ITS Objectives with VTrans Goals

It is integral that the ITS Objectives support the overall Goals of the Agency. The Project Team was cognizant of goals of the Agency while determining the ITS Objectives. **Figure 1** highlights the overlap between the ITS Objectives and Agency's Goals.

Figure 1: Comparison of VTrans Goals and ITS Objectives

		VTrans Goals				
		Promote organizational excellence by attracting, developing, and retaining a talent, diverse, and engaged workforce.	Grow Vermont's economy by providing safe, reliable, and efficient transportation system in a state of good repair.	Make Vermont more affordable and serve the vulnerable by providing accessible, convenient, and affordable travel choices.	Transition to an energy efficient, advanced technology transportation system.	Modernize and improve government efficiency through innovation, continuous improvement, and quality customer service.
ITS Objectives	Establish ITS as an asset to the Agency and other stakeholders and improve inter-Agency coordination and communication through education, exposure, and awareness of ITS existing and future capabilities and resources;					
	Demonstrate the value of the intelligent transportation systems within the operations and safety bureau					
	Integrate the information provided by the following systems (traveler information, traffic management, public transportation management, maintenance and construction management, and emergency management systems) through asset management. With the goal of providing timely information to the public for safe travel and maintenance of our roadways;					
	Collect and communicate real time, relevant, and reliable traveler information, weather conditions, and roadway incidents that impact travel to the public, first responders, and the Vermont maintenance districts through the TMC;					
	Strategically maintain, upgrade, and expand existing ITS infrastructure through the management of assets;					
	Invest in ITS infrastructure that strengthens the Agency's ability to adapt and utilize ever changing intelligent transportation technologies and engage in transportation innovation;					
	Establish institutional mechanisms and clear project parameters to promote the development and deployment of ITS projects and the incorporation of ITS infrastructure in future Agency planning projects.					

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Appendix B

Existing Conditions Memo

Memorandum

To:	Derek Lyman, PE Vermont Agency of Transportation	Date:	January 14, 2021
		Project #:	57985.03
From:	Jennifer Conley, PE, PTOE Annabelle Dally	Re:	Vermont ITS Architecture Existing Conditions Report Update

INTRODUCTION

With assistance from the Project Team and key stakeholders, VHB completed a review of the Agency's ITS program, the purpose of ITS, and its relationship to the wider transportation system. A summary of the Agency's program and infrastructure and the evolution and development of the system is provided.

The following memorandum documents updates to the Vermont ITS Architecture Update report[1] completed by Cambridge Systematics Inc. for the Vermont Agency of Transportation (VTrans). This memorandum documents and describes updates that have taken place since the report was completed in 2016 and the process to continue updating the State of Vermont ITS Architecture for the remainder of the 2016-2026 term.

What is ITS?

Intelligent Transportation Systems or ITS are defined by the US Department of Transportation as "the integration of advanced communication technologies into the transportation technologies and vehicles. Intelligent transportation systems (ITS) encompass a broad range of wireless and wire line communications-based information and electronics technologies."[2]

ITS is the planning, design, and implementation of technology on transportation infrastructure and services to provide better services to users and reduce negative externalities on the environment. These technologies encompass all transportation modes from pedestrian and bicycles activities to vehicles to transit operations to freight movement. The goal is to allow for a safer and more efficient transportation system for all modes and to ensure the safe and efficient movement of people and good throughout Vermont.

What is an ITS Architecture?

ITS Architecture provides a definitive and consistent framework to guide the planning and deployment of ITS throughout a State or region. The ITS framework is created through the collaboration of a range of stakeholders including Federal agencies, State and regional agencies, local municipalities, and advocacy groups.

ITS Architecture Update Objectives

The objective of this memorandum is to update the State of Vermont ITS Architecture report that was drafted in 2016 which contained updates to the State of Vermont ITS Architecture report drafted in 2005 and updated in 2008. While there is always a need to update and consider new projects and technologies in response to the State's current and anticipated transportation needs regularly, this update is in response to the creation of the State's ITS Management Plan.

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Document Overview

This memorandum will consist of the following 5 sections:

- Introduction
- Background
- Status of System
- ITS Strategic Plan

ITS Architecture Compliance

The following report follows the USDOT National ITS Architecture conformity rule (23 CFR Part 940, and the FTA National Architecture Policy on Transit Projects). This rule requires that ITS Architectures be completed for regionally significant ITS projects, if the projects are to be eligible for Federal transportation funding. Today, developing, documenting and using the ITS Architecture is considered a best practice in the transportation/ITS industry.

1. Vermont ITS Architecture Update and Strategic Plan, Cambridge Systematics, October 2016.
2. Definition obtained from the US DOT Intelligent Transportation Systems Joint Program Office. http://www.its.dot.gov/faqs.htm

BACKGROUND

Previous ITS Architecture

The first Architecture was completed in 2005. In 2008, VTrans partnered with ConSysTec to develop the Vermont Statewide ITS Architecture which included updates to the 2005 Architecture. The updated ITS Architecture presented the framework the deployment and integration of ITS statewide over the next 15 year period. The 2005 Architecture was updated to reflect minor changes in the Architecture vision and stakeholders involved. Furthermore, the 2005 Architecture was updated to Version 6.0 of the US National ITS Architecture format. In 2016, VTrans, with the assistance of Cambridge Systematics, undertook the ITS Architecture Update and Strategic Plan. This existing conditions memorandum is an update of the VTrans ITS Architecture including upgrading the ITS Architecture to Version 9.0 of the US National ITS Architecture format.

Chittenden ITS Architecture

The 2016 ITS Architecture Update and Strategic Plan included information presented in the latest ITS Architecture prepared by for Chittenden County which was approved by the Chittenden County Regional Planning Commission in January of 2016. The Chittenden County ITS Architecture and Strategic Plan incorporated many state wide products and included input from VTrans and other State agencies.

Methodology

This existing conditions memorandum describes the review of the 2016 ITS Architecture Update and Strategic Plan and collection of current data to update the State of Vermont ITS Architecture. The following methodology was used:

- Compare and update the stakeholder list in the Architecture document.
- Obtain information from VTrans regarding the most current inventory.
- Update project list with inputs collected from the ITS Management Plan Committee and others as directed by the Committee.
- Update the 2016 Vermont ITS Architecture Turbo file to develop the Vermont ITS Architecture file using the most current software various. The new Turbo file will consider all the stakeholders, inventory, and projects presented in this report.

STATUS OF THE SYSTEM

This section presents an introduction to current ITS conditions in Vermont and includes the following subsections:

1. A description of the current State and County boundaries and general population information.
2. A description of the current stakeholders involved with the State's ITS.
3. A description of the current ITS equipment.

State of Vermont

Vermont is a State in New England, located in the northeastern region of the United States. The State of Vermont shares a border to the North with the Canadian province of Quebec; to the East with the State of New Hampshire; in the South with the Commonwealth of Massachusetts; and to the West with the State of New York and Lake Champlain. Within its boundaries, the State contains 14 counties:

- Addison
- Bennington
- Caledonia
- Chittenden
- Essex
- Franklin
- Grand Isle
- Lamoille
- Orange
- Orleans
- Rutland
- Washington
- Windham
- Windsor

Figure 1 shows the location of the State of Vermont and its 14 counties.

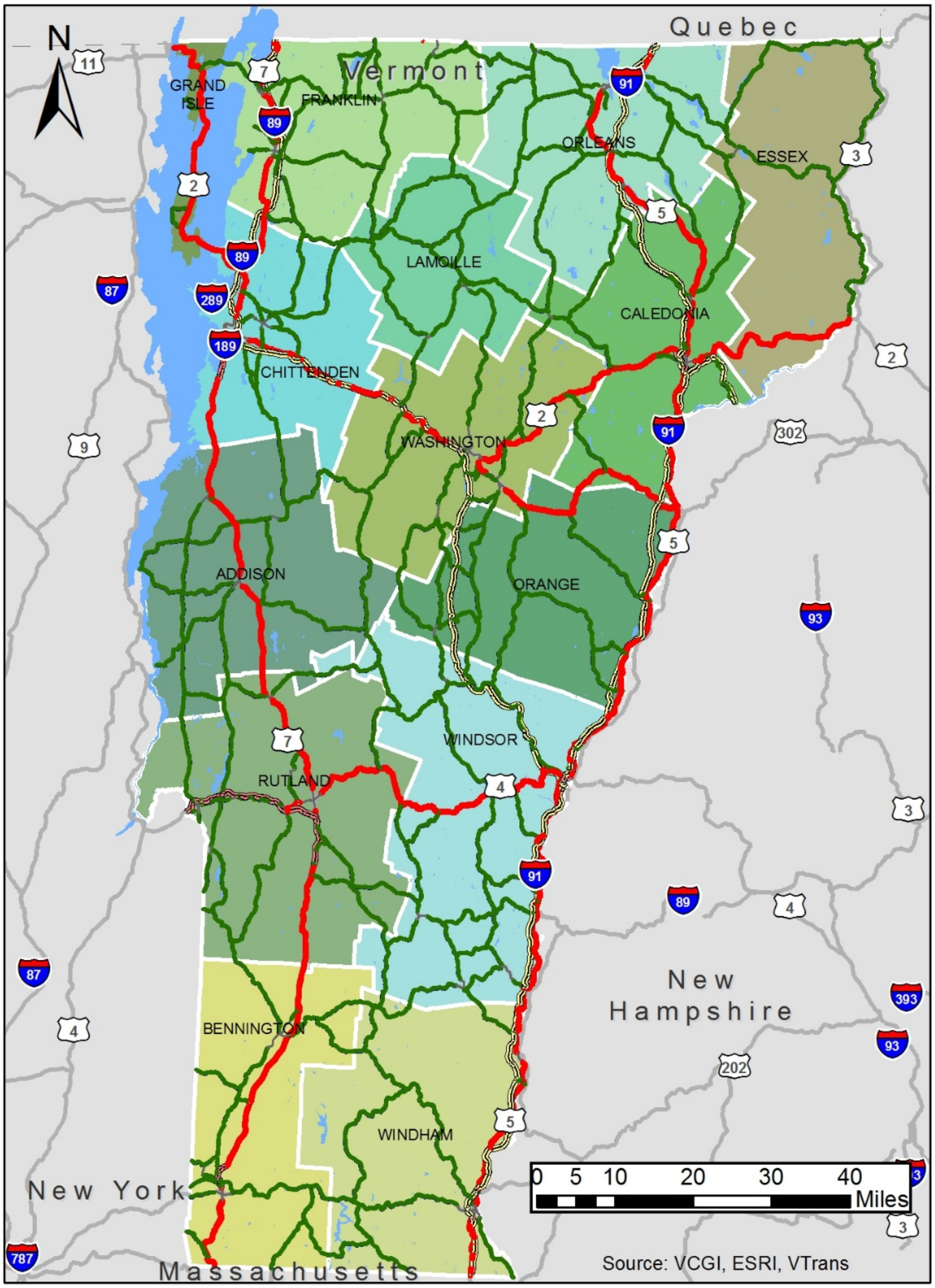
According to estimates based on 2010 US Census information, Vermont has a population of 623,989 habitants, in approximately 9,217 square miles. The State has nine incorporated cities whose populations according to estimates based on 2010 US Census information are shown in Table 1.

Table 1 – Cities of Vermont

City	Population
Burlington	42,819
South Burlington	19,509
Rutland	15,074
Barre	8,528
Montpelier	7,372
Winooski	7,333
St. Albans	6,801
Newport	5,005*
Vergennes	2,741*

*Source 2010 US Census

Figure 1 – State of Vermont



Stakeholders

Current Stakeholders

The 2008 Vermont ITS Architecture defined 66 stakeholders involved in the State's ITS operations. In 2016, the stakeholder list was reviewed and modified to include an additional 11 stakeholders. The list of stakeholders from the 2016 Vermont ITS Architecture was considered as a starting point to develop the current full list of stakeholders, as seen in the Appendix.

Analyzing the current list of stakeholders, the following were identified as key players in the State's ITS system:

Vermont Agency of Transportation

VTrans is the State of Vermont's agency responsible for managing, operating, and/or maintaining state-owned transportation infrastructure (roads, transit, airports, railways), including the Interstate system and many of the major arterials in the State. VTrans owns the following State airports: Franklin County, Middlebury, Rutland, Bennington, Springfield and Newport. In addition, VTrans owns rail right of way. VTrans is also responsible for maintaining and updating the Vermont Statewide ITS Architecture.

Neighboring State/Provincial Transportation Agencies

This group of stakeholders refers to the transportation agencies of Vermont's neighbors, New York State Department of Transportation (NYSDOT), New Hampshire Department of Transportation (NHDOT), Massachusetts Department of Transportation (MassDOT), and the Ministry of Transport Quebec. Each of these entities are responsible for transportation infrastructure and management in their respective geographies. In addition the Maine DOT (ME DOT) shared in the development of the COMPASS ITS software system with VTrans and NHDOT.

State of Vermont Public Safety Department

The State of Vermont Public Safety Department is responsible for public safety and managing emergency operations. The Vermont State Police, Vermont Emergency Management, and Vermont Fire Safety are part of this agency. There are also municipal public safety departments included in this group. This group represents municipalities' police and fire departments, as well as private entity's police, fire, and/or other public safety agencies, including Sheriff's Departments.

State of Vermont Department of Motor Vehicles (DMV)

Vermont's DMV is responsible for vehicle licensing and registration, including the Commercial Vehicle Information System Network (CVISN) program. DMV also provides commercial vehicle and carrier enforcement.

Federal Government Entities

Given the location of the State of Vermont, it is important to consider and involve Federal agencies involved in ITS operations. In addition to the U.S. Department of Transportation Federal Highway Administration (FHWA) this group includes the US Customs and Border Protection (USCBP), US Immigration and Customs Enforcement (USICE) and the Federal Emergency Management Agency (FEMA), all of which are part of the US Department of Homeland Security (USDHS).

Chittenden County Regional Planning Commission (CCRPC)

CCRPC is the regional Metropolitan Planning Organization (MPO) for the State's only metropolitan area including 18 municipalities in Chittenden County. It is the only MPO in the State and the main forum for planning, policy, and community development in the region. It is responsible for developing the Metropolitan Transportation Plan (MTP), the Transportation Improvement Program (TIP), and the Unified Planning Work Program (UPWP).

Public Transportation Agencies

There are 7 public transit agencies throughout Vermont. While not all towns are served by fixed transit service, all towns receive demand response service for eligible clients and/or trips. In FY 2019, over 5 million trips were provided, with about half of those occurring in the Burlington region.

City of Burlington

Burlington is the largest urban municipality in the State of Vermont, with an approximate population of 42,000. It is the owner and operator of traffic signals in their geographic jurisdiction.

Other Municipal Governments

The remaining group of municipal governments are grouped as one main stakeholder. Municipal governments may own and operate ITS inventory, such as traffic lights. Municipal governments also provide safety services.

New Stakeholders Considered

Stakeholders currently in the 2016 ITS Architecture Turbo file that were not included in the 2016 ITS Architecture Update and Strategic Plan the need to be added include:

- Academic Institutions: Institutions (educational and other) that contract with CCTA for transit services.

Stakeholders currently in the 2016 ITS Architecture Turbo file and/or the 2016 ITS Architecture Update and Strategic Plan that need to be updated include:

- Northern Vermont University Meteorological Department: formerly Lyndon State College Meteorological Department
- Agency of Commerce and Community Development: formerly Vermont Department of Economic Development and formerly the Vermont Department of Tourism and Marketing
- Agency of Digital Services: formerly Vermont Department of Information and Innovation

Additional stakeholders found neither the 2016 ITS Architecture Turbo file and/or the 2016 ITS Architecture Update and Strategic Plan that need to be included:

- VTrans
    - Operations and Maintenance Staff

- Executive Team
- Office of the Secretary
- Finance and Administration
- Program Development
- Asset Management
- Policy and Planning
- Project Managers

- Federal Government Agencies
  - Federal Aviation Administration (FAA)
  - Federal Railroad Administration (FRA)
  - Federal Transit Administration (FTA)
  - USDOT
- Department of Public Services: Facilitates with Utility and Telecom providers (power and communications)
- Consultants and Designers: Partner or system user bringing additional skills and expertise to the development and design of ITS at the Agency
- Contractors: Responsible for ITS procurement/construction
- Neighboring State Police: group of stakeholders referring to the State Police agencies of Vermont's neighbors responsible for the public safety and emergency management operations of their respective state including New Hampshire, Maine, Massachusetts, and New York
- Public Transportation Agencies
  - Addison County Transit Resource, Stagecoach Transportation Services, etc.
  - Champlain Islanders Developing Essential Resources, Inc. (CIDER): Transit demand service in Grand Isle County for elders and persons with disabilities
- General Traveling Public: End user who using ITS information to plan and execute travel in Vermont

Current Architecture Inventory

The current list of ITS inventory includes 587 items, assigned to the different stakeholders involved. Of these existing elements, 321 are owned by VTrans, and 266 are owned by a third party including municipalities, planning commissions, adjacent state Agencies, or leased through a private company. Each element consists of a name, a stakeholder, a status (whether it is an existing element or planned), and a brief description.

Analyzing the current list of stakeholders, the following were identified as key elements in the State's ITS system:

Traffic Signals

The State of Vermont operates 164 traffic signals throughout the state with 2 additional signals being constructed. Of the 164 traffic signals operated by the State only 1 is owned by a municipality. Four additional state owned and operated signals are planned for deployment in the near-future. There are an additional 175 traffic signals throughout the state that are owned and operated by the municipalities. Over the next few years, 4 of the state owned and operated traffic signals (2 signals in Waterbury and 2 signals in Hartford) will be turned over to the municipalities. Figure 2 – Locations of Traffic Signals – Statewide shows the locations of the existing traffic signals throughout the state. More detailed maps of the traffic signal locations are provided for Chittenden County (Figure 3), Rutland County (Figure 4), and Washington County (Figure 5).

Serval corridors are equipped with some form of interconnect via twisted pair copper hardwire, serial wireless radios, or GPS clocks. Coordinated traffic signals cover important segments of many major arterials throughout the state, such as US 2, US 5, US 7, US 302, VT 7A, VT 15, and VT 100. Concurrently, there are 76 signals that have remote connectivity statewide. Two corridors in Waterbury and Essex utilize the InSync adaptive signal control system.

Figure 2 – Locations of Traffic Signals – Statewide

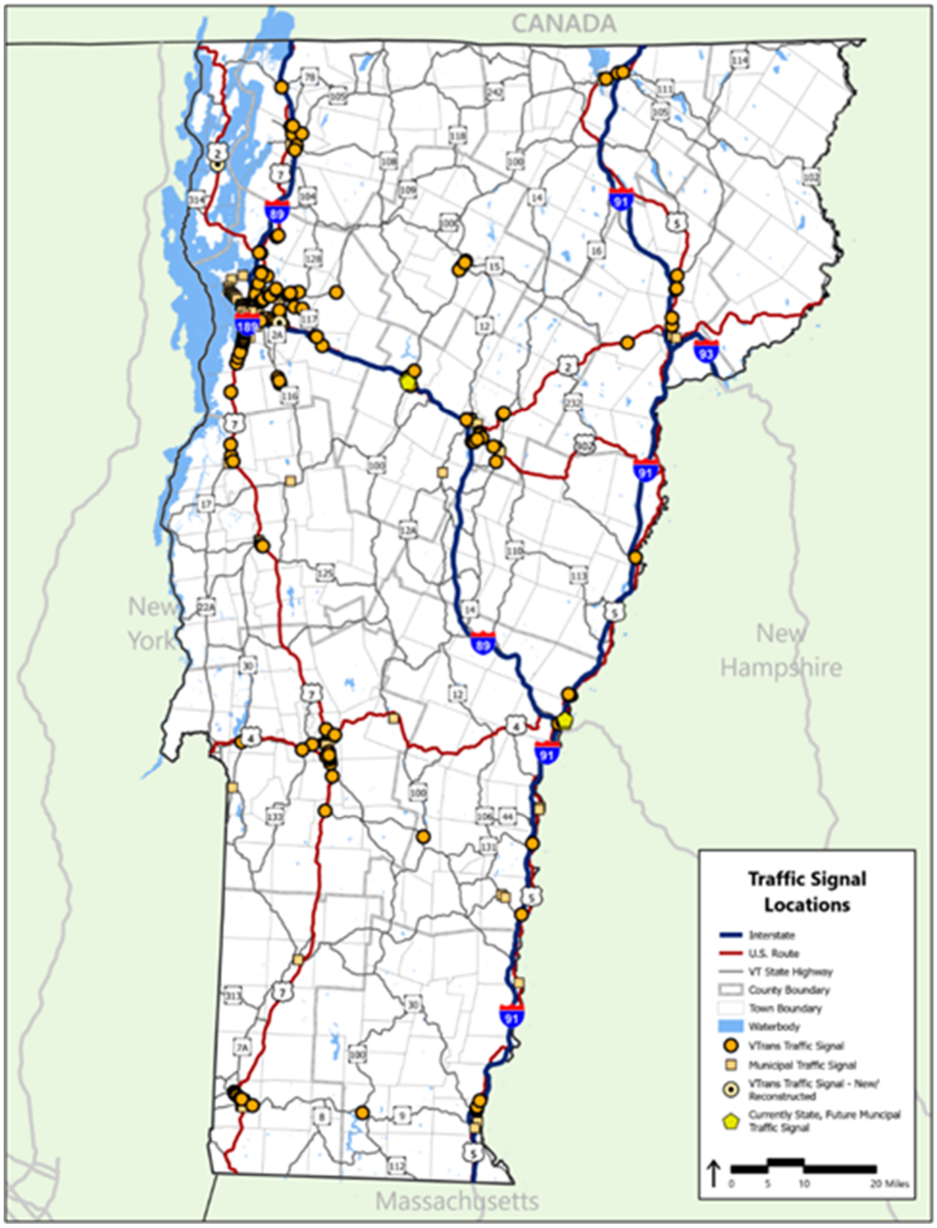


Figure 3 – Locations of Traffic Signals – Chittenden County

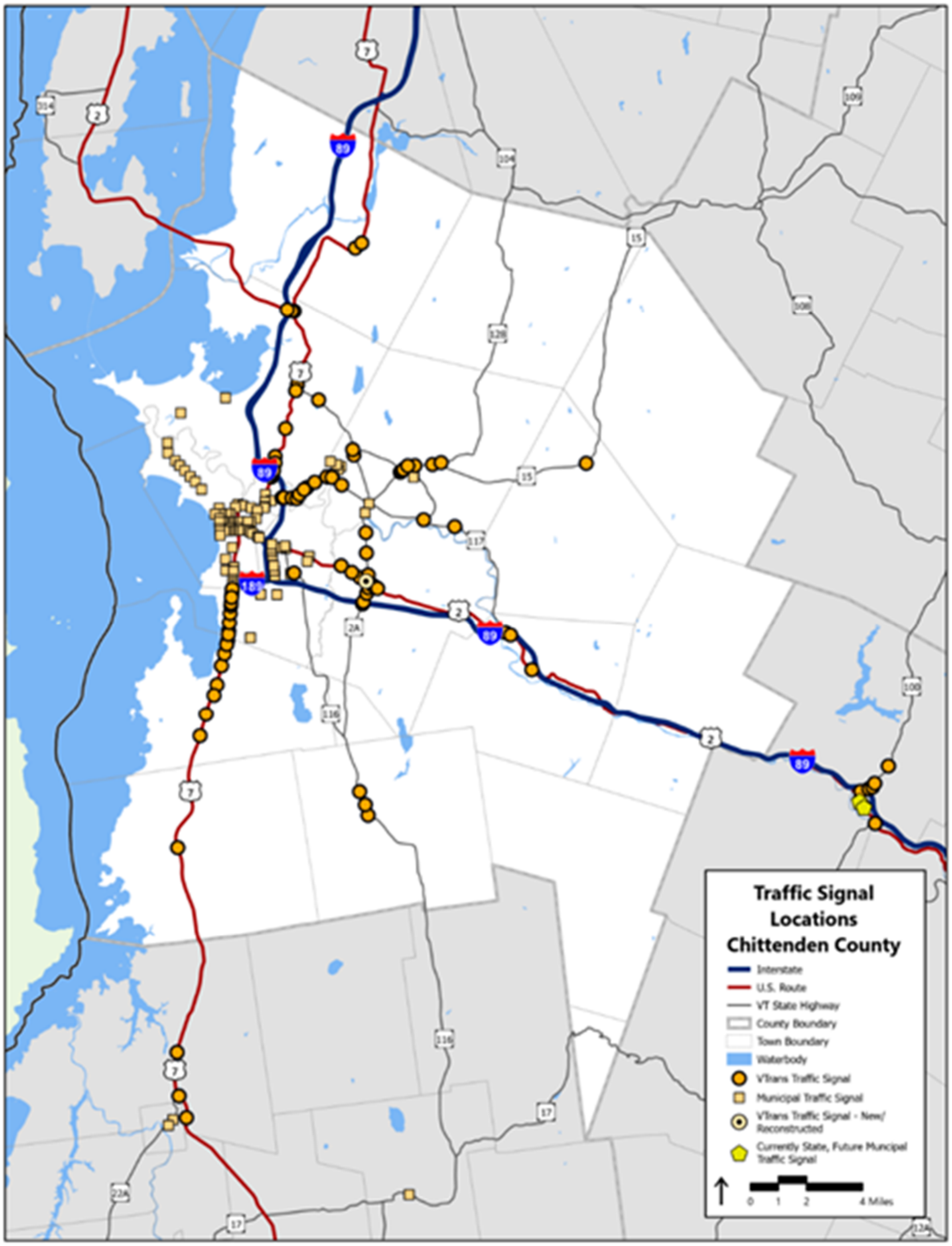


Figure 4 – Locations of Traffic Signals – Rutland County

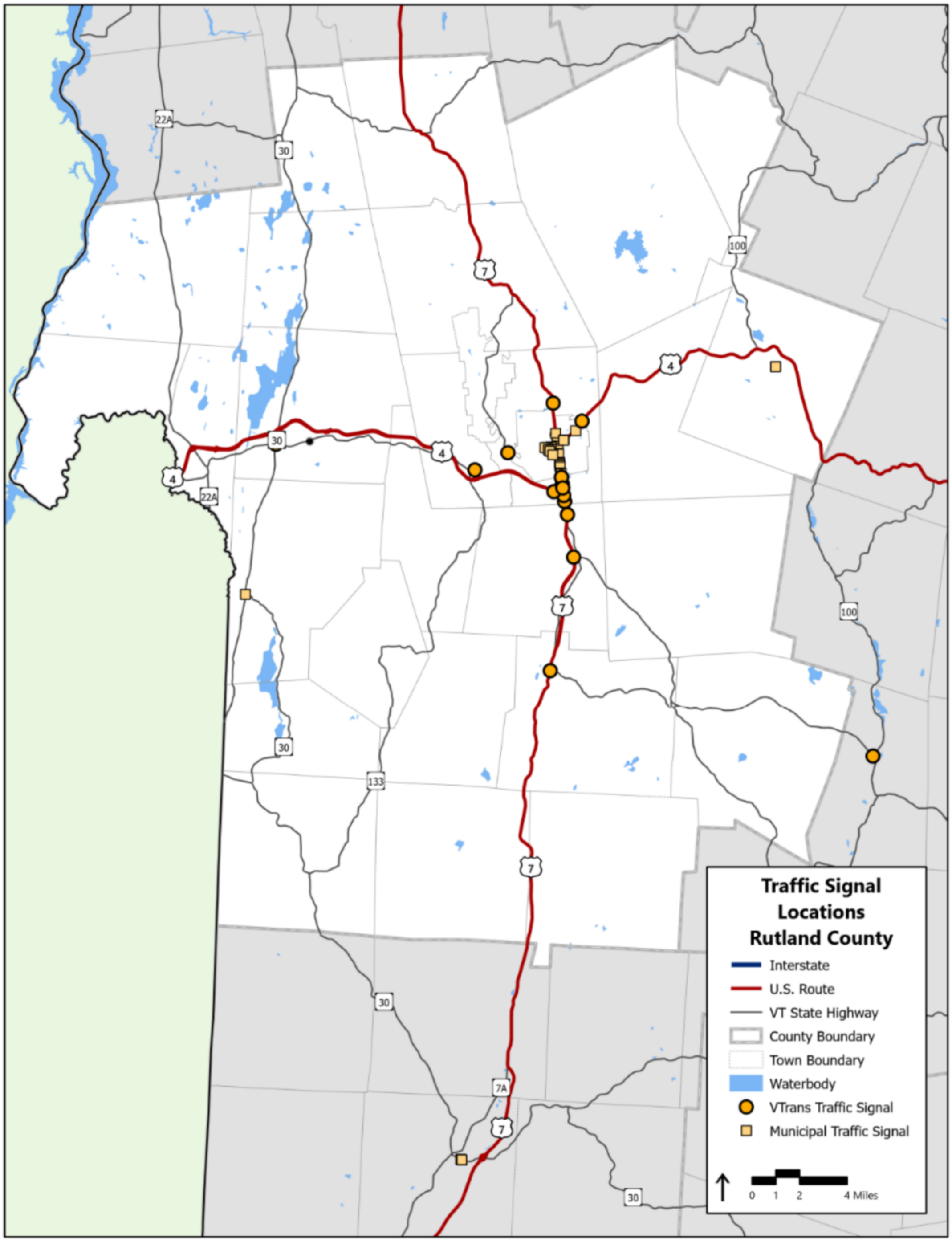
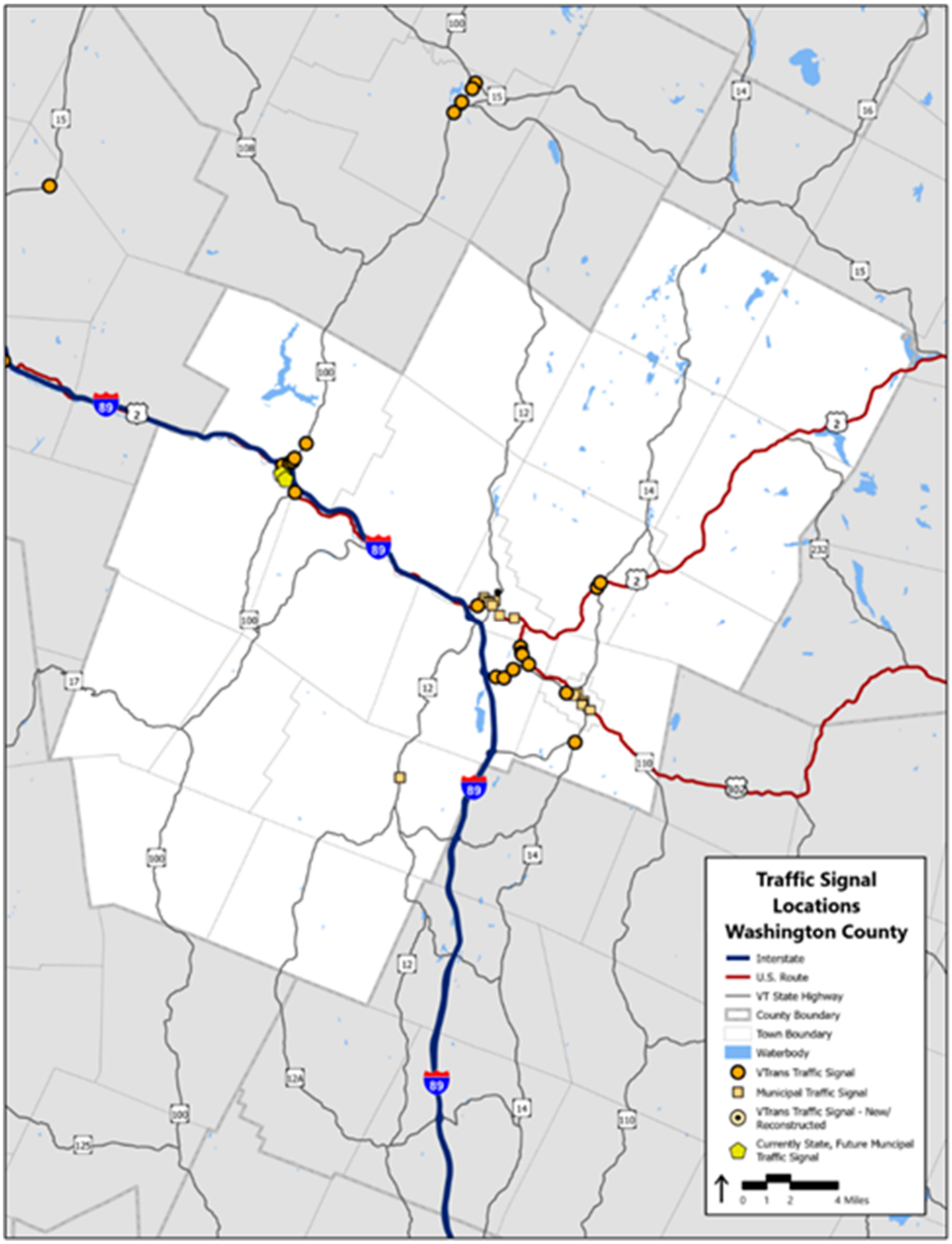


Figure 5 - Locations of Traffic Signals – Washington County

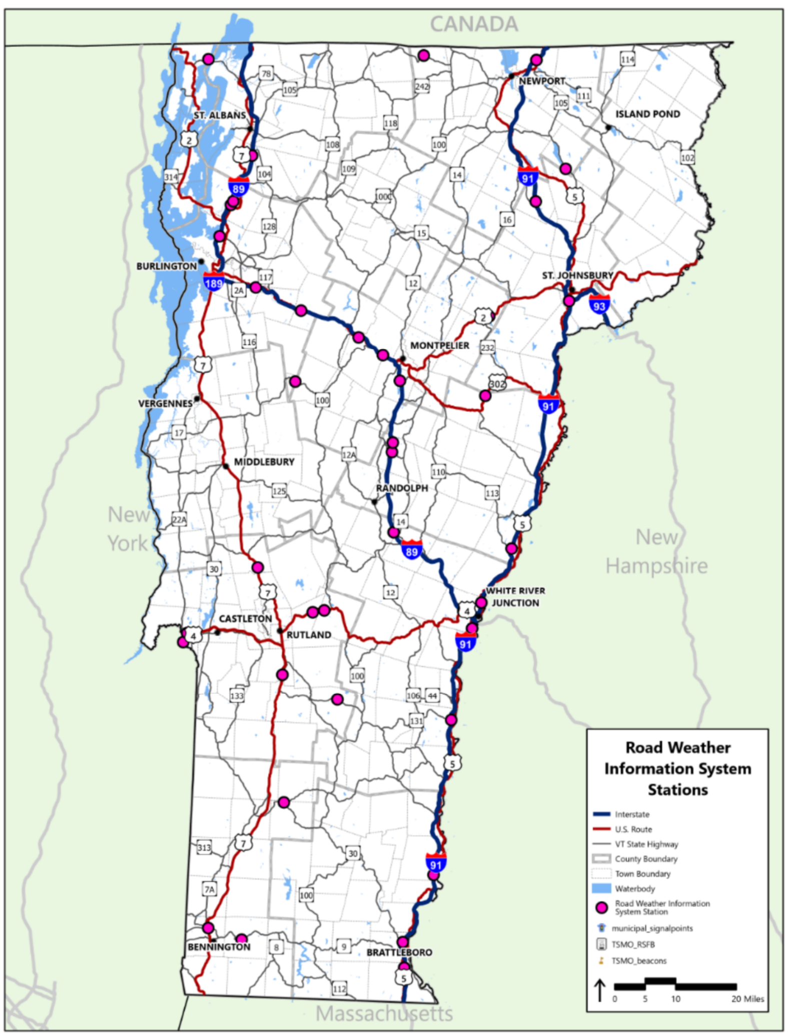


Road Weather Information System (RWIS) Stations

A RWIS consists of a physical sensor station to collect environmental data located in the field, a communication component to transfer the data collected by the sensor, and a central system that collects and analyzes the collected data. The RWIS stations measure road surface conditions and temperature, air temperature, humidity, barometric pressure, wind speed and direction, precipitation, and visibility. The Agency uses the data collected from the RWIS stations to operate and maintain Vermont's road system. The Agency has access to data collected from 85 RWIS stations throughout New England. Of these, 41 RWIS stations are in the state of Vermont. The locations of the existing RWIS stations in the state of Vermont can be found in Figure 6.

As part of the *Advanced Transportation Congestion Management Technology Deployment Initiative*.

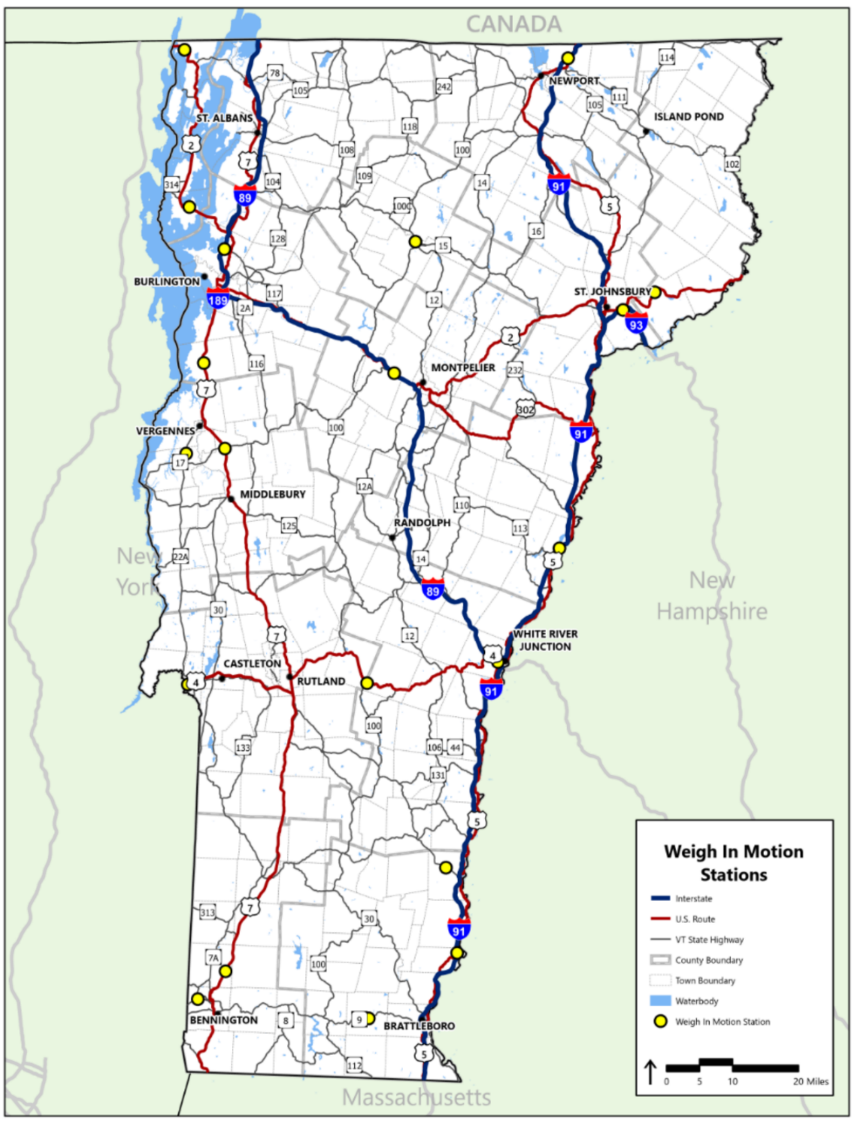
Figure 6 - Location of RWIS Stations - Statewide



Weigh In Motion (WIM) System

A WIM system consists of an in-pavement scale and a detection device which is connected to a central system. The WIM station measures the volume, speed, classification, and weight of vehicles. WIM stations can be used to increase the efficiency of commercial vehicle enforcement by providing real-time information to enforcement officers to help determine which vehicles are worth inspecting. There are 21 WIM stations throughout the state of Vermont as shown in Figure 7. The Vermont Department of Motor Vehicles is installing a virtual WIM station in Williston as part of the *Advanced Transportation Congestion Management Technology Deployment Initiative*.

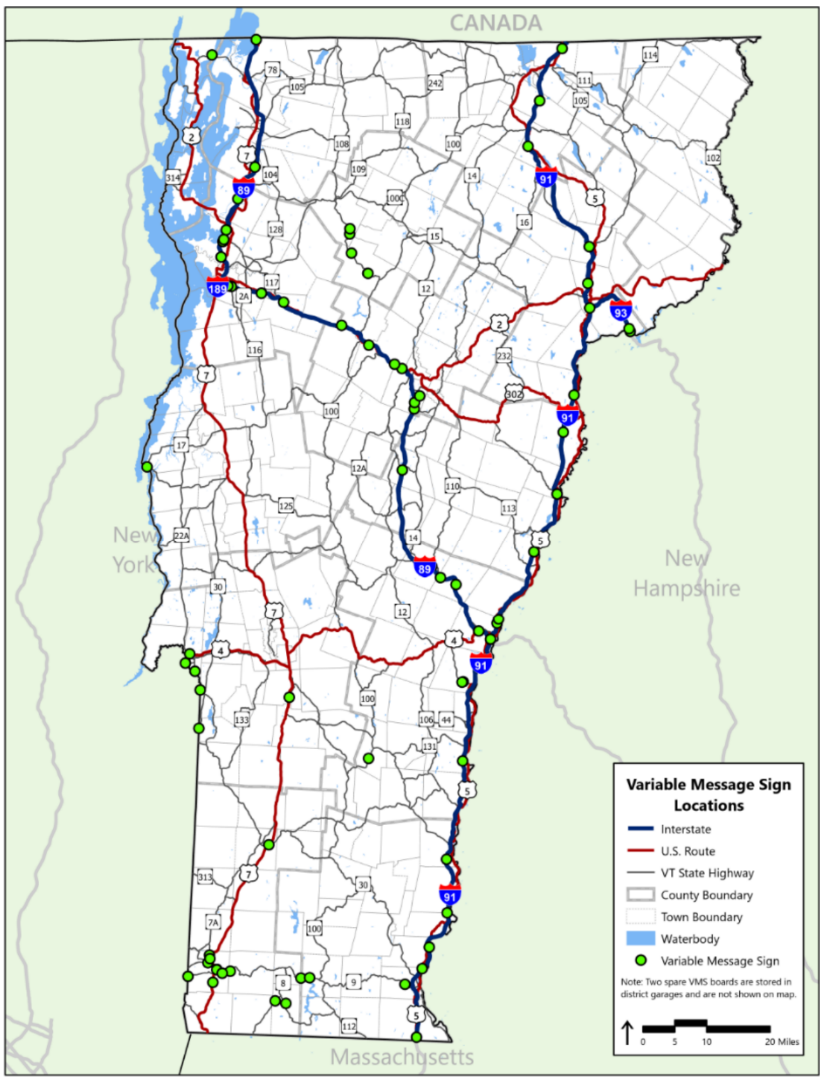
Figure 7 – Locations of WIM Stations - Statewide



Dynamic Message Signs (DMS)

VTrans uses both fixed and portable DMS to communicate information to the traveling public. These DMS include information regarding construction activities, road conditions, traffic incidents, safety, travel, and more. There are 84 existing DMS throughout the state that are owned and operated by the Agency. The DMS are primarily on the two major interstate highways in the state, I-89 and I-91, however, DMS are deployed on major US and VT state routes. Locations of the deployed DMS throughout the state can be found in Figure 8 with the exception of the two spare DMS which are storage in VTrans District garages.

Figure 8 – Locations of DMS – Statewide



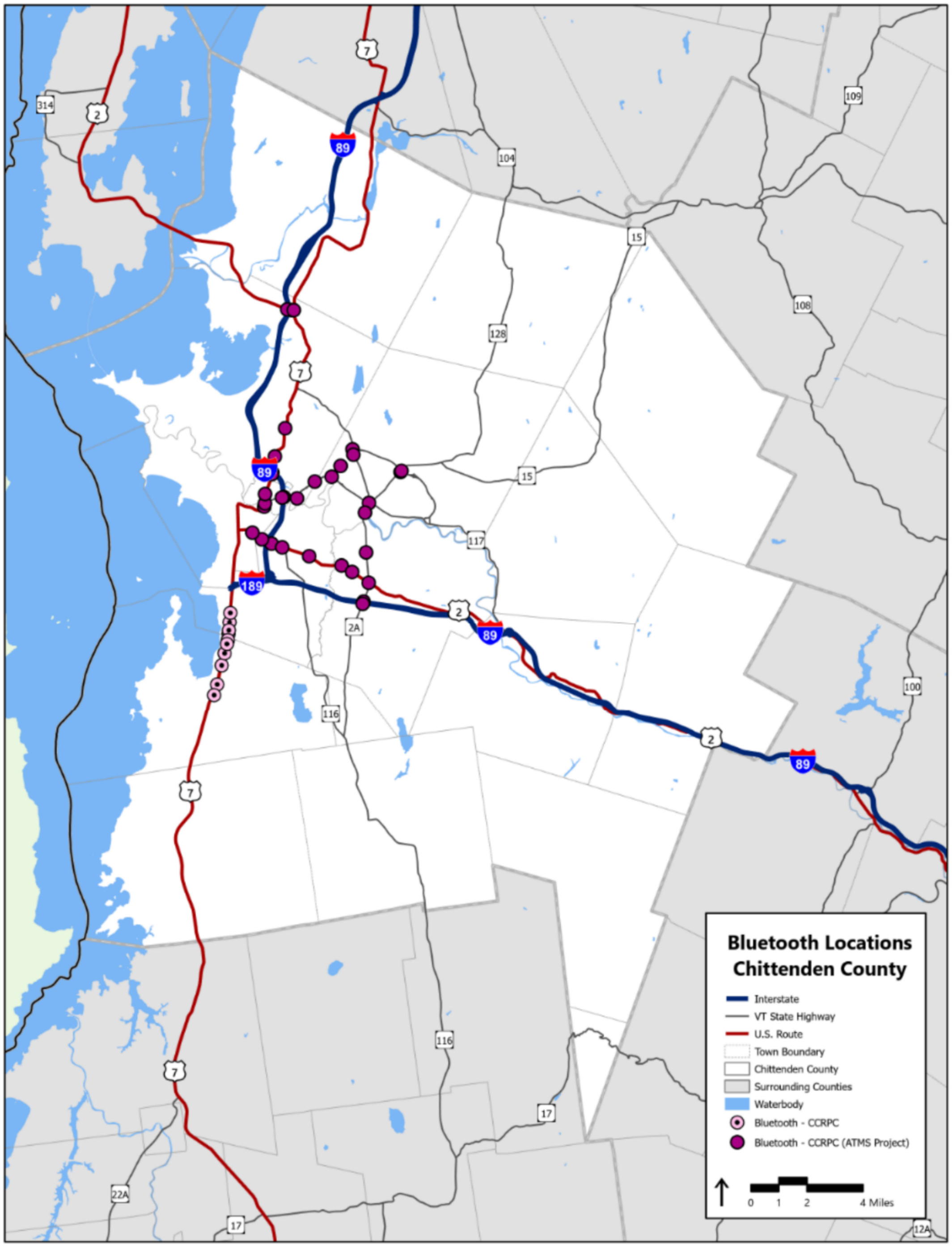
Bluetooth Monitoring Devices

In 2016, CCRPC in coordination with VTrans implemented the first advanced traffic monitoring installation in Vermont through the Accelerated Innovation Deployment (AID) Demonstration program. A total of 33 Bluetooth devices are installed along five congested corridors in Chittenden County which establish real time traffic monitoring and management systems information utilized by the VTrans ATMS and Traveler Information System for 511 through the State Traffic Operations Center. The Bluetooth devices are installed along the following corridors:

- Interstate 89, from Exit 14 to US 2. This corridor includes the intersections on Williston Rd/Main St – from Industrial Ave to University Heights
- VT-289/Susie Wilson Rd/VT-15, from VT-289 to VT-15
- Exit 12/VT-2/VT-2A. These corridors include Essex Rd, from (and including) Essex Junction to (and including) Interstate 89. The study area also includes Williston Rd, from Industrial Ave to Essex Rd
- Interstate 89, Exit 17. This corridor considers the three intersections present on US-2 – from Roosevelt Hwy to US-7
- Interstate 89, Exit 16. This corridor considers US-2, from Severance Rd to the Winooski River

In addition, the CCRPC has 10 Bluetooth devices along Route 7 in Chittenden County. The 43 Bluetooth devices are shown in Figure 9.

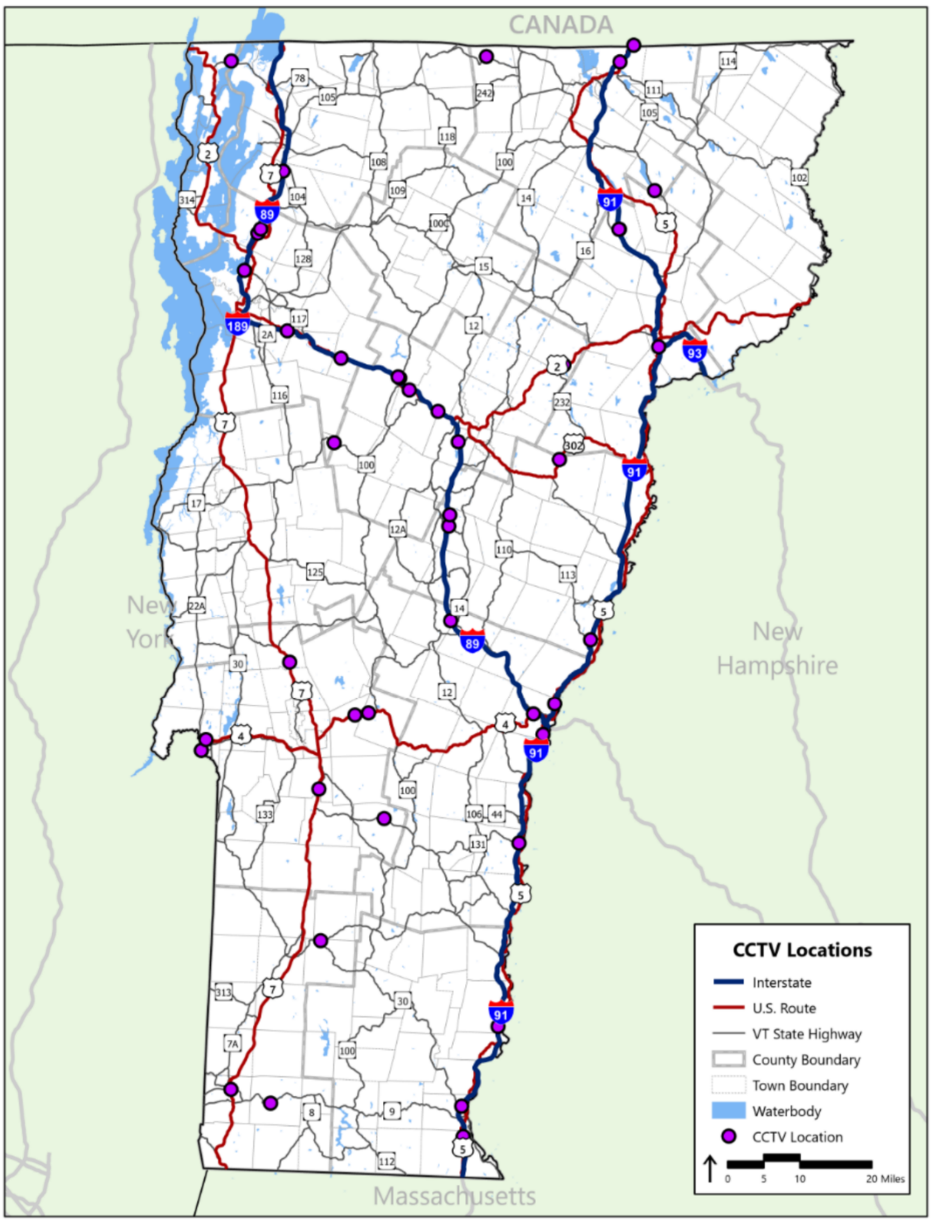
Figure 9 – Locations of Bluetoad Bluetooth Devices – Chittenden County



CCTV

There are 45 CCTV locations throughout Vermont. The locations of the existing CCTV locations in the state can be found in Figure 10.

Figure 10 – CCTV Locations - Statewide



New Inventory Being Considered

- VTrans
  - CAV Infrastructure (planned element)
  - Asset Management Platform (planned element)
- GMT
  - On-Board Cameras (existing element)
  - Routematch dispatch and scheduling software for demand response trips – Medicaid, the Elderly, and Persons with Disabilities Program (planned element)
  - Tablets for RouteMatch software (planned element)
  - Go Vermont Trip Planner and statewide Automated Vehicle Locator service (Transit App) – requiring the development and maintenance of General Transit Feed Specifications (GTFS-Flex) and additional Modules are tracking on-time performance for improved information and route planning (planned element)
  - Microtransit software and hardware for on-demand transit service to the community (planned element)
  - Automated passenger count systems (existing element)
- Regional Integrated Transportation Information System (RITIS)
- Amtrak
  - AMTRAK Operations (existing element)
  - Positive Train Control (planned element?)

Additional ITS inventory elements could be included or modified in the updated Architecture upon request.

ITS STRATEGIC PLAN

This section describes the list of projects considered for the ITS Architecture update. The first section provides a brief description of projects that were previously considered as part of the 2016 ITS Architecture update and are being carried forward in this update. The second part of this report describes a number of additional projects that are being considered.

2016 ITS Architecture Projects Imported to 2021 ITS Architecture Update

The projects mentioned in

Table 2 show the complete list of projects imported and incorporated in the State of Vermont ITS Architecture from the previous document.

Table 2: Projects considered for the 2021 ITS Architecture Update from the 2016 ITS Architecture

Project Type	Project ID	Project Name
Highway/Arterial Projects	1	VTrans Advanced Transportation Management System (ATMS)
	2	I-89 Integrated Corridor Management
	3	Adaptive Signal Control (ASC) on Selected Corridors
	4	Updating Signal Timings
	5	Advanced Traffic Monitoring System using Bluetooth Technology
	6	CCTV Implementation
	7	Permanent Variable Message Signs (VMS)
Transit Projects	8	Automatic Vehicle Location (AVL) on Transit Vehicles
	9	Transit Computer Aided Dispatch (CAD)
	10	Smart Cards
	11	Automatic Passenger Counters (APC)
	12	Transit Networking and Communication
	13	Transit Reporting/Data Management
	14	Improve Paratransit Services
Other Modes of Transportation	15	Weigh-In-Motion (WIM)
	16	Airport Real-Time Information
	17	Plow Services
	18	Automatic Vehicle Location (AVL) on Maintenance Vehicles
	19	Vermont Vacations
Data Management Projects	20	Web-based Data Portal
	21	RITIS Implementation
Emergency/ Weather Management Projects	22	RWIS
	23	National Weather Service
	24	Vermont Alert and 511
	25	University of Vermont Medical Center
	26	Asset Management Performance Board
Vanguard Projects	27	Connected Vehicles
	28	Unmanned Aerial Vehicles

Project Descriptions

1. *VTrans Advanced Transportation Management System (ATMS)*

VTrans' Advanced Transportation Management System (ATMS) called New England Compass was adopted in 2016, conforming with the federal requirements of 23 CFR 511 and Rule 1201 (Real-Time System Management Information Program) – a federal mandate to provide timely travel information to the public. New England Compass is a two part program consisting of an administration user interface and a Traveler Information System (TIS). Inputs from Transportation Management Center (TMC) Operators are displayed as travel information to the public via https://www.newengland511.org/. The project is a Tri-State initiative with VT working closely with New Hampshire and Maine DOTs to ensure the application runs smoothly and as expected. Compass consolidates multiple "silos" of various VTrans' ITS devices and transportation management tools into a single user interface allowing for efficient management of ITS devices and traveler information.

Examples of ATMS functionality in use:

- Road Weather Information Station (RWIS) Information
- Dynamic Message Sign utilization and management
- Road Condition Driving information
- Emergency announcements
- Event Information such as construction projects, planned road closures, unplanned road closures, amber alerts, blue alerts, flooding, motor vehicle crashes, abnormal congestion, and more.
- Real time test message and email alerts for emerging incidents

Examples of future ATMS use:

- Traffic Speed Heat Map by way of Blue Toad sensors
- Automated travel time message boards
- Event Response Plans
- Alerts and Alarms for traffic incidents

While the structure of the ATMS can integrate traffic signals, this is not functionality that is being considered at this time.

NE Compass is currently transitioning from a 'Thick Client' application to a 'Thin Client' application – giving the Tri-States greater flexibility to run the program in different browsers (Thick Client only runs in Internet Explorer) and enhanced security.

The next major enhancement to NE Compass and the TIS is the integration of ESRI based mapping tools – allowing for full feature class functionality. This enhancement allows for grater data sharing capabilities into and out of the ATMS and provides the Tri-States the ability to manage the application more autonomously.

2. *I-89 Integrated Corridor Management*

   The Vermont Agency of Transportation (VTrans) is proposing deployment and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment. The technologies will be implemented in the context of an Integrated Corridor Management (ICM) plan covering a 75-mile corridor following Interstate Route 89 (I-89) between the state capital in Montpelier and the US-Canada international border. The project considers the following action items of which some have already been implemented:

   - Engaging stakeholders in the development of an Integrated Corridor Management Plan.
   - Installing fiber infrastructure (conduits and fiber) connecting all signals at interchanges and all ITS devices (existing and proposed) in the corridor.
   - Installing Weigh-in-Motion Systems (WIMS) with DOT plate readers, Road Weather Information Systems (RWIS).
   - Installing a virtual WIM with DOT plate readers at two new RWIS stations in Bolton and Williston.
   - Installing Wavetronix traffic sensors, Bluetooth and CAV Infrastructure technology at yet to be determined locations.
   - Evaluating and identifying optimum sensor locations.
   - Utilizing Advance Traffic Management Systems (ATMS) and Vermont's Transportation Management Center for monitoring, data capture, analysis and reporting system operations.

3. *Adaptive Signal Control (ASC) on Selected Corridors*

   This project aimed to improve mobility conditions in corridors with recurrent congestion, which are located primarily in Chittenden County. By implementing ASC technology, corridors would be better coordinated, and delays would reduce. In addition, these corridors could be integrated into the State's ATMS system for a better operations strategy. In 2016, VTrans began upgrading existing signal equipment operating pre-timed to full adaptive control. These upgrades included the on/off ramp intersections of Route 289 and 2A which originally comprised the sole location where ASC had been implemented in the state until the state expanded ASC through the implementation of the additional four signals in Waterbury. In 2016, ASC was being evaluated at 19 intersections in Williston and Essex along US 2, Route 15, and Route 2A. Funding has been secured to install ASC at those locations, however, VTrans has moved away from ASC due to changes in considerations for the implementation of ASC at the national level. The most notable changes include the condition that traffic volumes vary significantly throughout the day or season and that all traditional measures to mitigate operational deficiencies have been exhausted. Overall Vermont's arterials provide consistent and predictable traffic volumes; therefore, good basic service can be provided through traditional methods and proper detection eliminating the need for ASC implementation in most cases. VTrans is focusing on Automated Traffic Signal Performance Management (ATSPM) throughout the state, but ASC could still be considered in specific situations where traffic volumes vary and are dependent on factors other than normal commuting patterns. VTrans is responsible for the maintenance and operation of the existing ASC locations, however, it is unlikely there will be any new ASC locations implemented in the near future.

4. *Updating Signal Timings*

VTrans reviews signal timing on a four-year cycle, or sooner if problems exist. Updated signal timings should address current traffic conditions, and all other modes of transportation involved, such as pedestrian activity and bicycles. This way, signals would operate better, and maintenance costs would be reduced. A regional program was proposed for Chittenden County as part of the CCRPC ITS Architecture, which could be carried out in partnership with VTrans.

Automated Traffic Signal Performance Management (ATSPM) is one method for remote monitoring of signal effectiveness. This utilizes software to perform automated signal performance measures on the connected signals. VTrans plans to collect this data along US 7 (Shelburne Road) in South Burlington and Shelburne. The project includes the installation of new traffic signal controllers, advanced vehicle detection, and Bluetooth travel time devices and will establish remote communications utilizing ethernet radios to collect ATSPMs at 17 intersections along Shelburne Road. The equipment needed to collect ATSPMs will be installed as part of the construction project in 2020 and 2021. Upon completion of the project, VTrans will be able to start collecting ATSPMs to optimize the performance of the signals and improve the flow of traffic along the corridor. The benefits will be measured utilizing the output of the following ATSPM reports; Purdue Coordination Diagram, Flow Rate, Cycle Length, Green Times, and Split Failures for vehicle delay, arrivals on green, etc. It is proposed to equip 10+ signals per year with remote connection to allow ATSPM.

5. *Advanced Traffic Monitoring System using Bluetooth Technology*

Advanced Traffic Monitoring System using Bluetooth Technology – Currently, there is a plan to implement corridor level advanced traffic monitoring of travel times and vehicle speeds by anonymously tracking Bluetooth devices on up to 5 different corridors in the CCRPC region:

Corridor 1 - Interstate 89, from Exit 14 to US 2. This corridor includes the intersections on Williston Rd/Main St – from Industrial Ave to University Heights

Corridor 2 - VT-289/Susie Wilson Rd/VT-15, from VT-289 to VT-15

Corridor 3 - Exit 12/VT-2/VT-2A. These corridors include Essex Rd, from (and including) Essex Junction to (and including) Interstate 89. The study area also includes Williston Rd, from Industrial Ave to Essex Rd

Corridor 4 - Interstate 89, Exit 17. This corridor considers the three intersections present on US-2 – from Roosevelt Hwy to US-7

Corridor 5 - Interstate 89, Exit 16. This corridor considers US-2, from Severance Rd to the Winooski River

VTrans' has worked closely with the Chittenden County Regional Planning Commission and secured a grant to implement the above-mentioned technology. VTrans and CCRPC is currently in the process of configured Blue Tooth devices in New England Compass to transition this data on to the TIS for public consumption.

This project is "designed to advance traffic monitoring in high volume roadway corridors where safety, commuter congestion, and construction activity are paramount issues". As an addition to the project, VTrans could look to purchase private probe vehicle data. Real-time information is currently being collected by private and public entities that allow agencies to have better information at the time it is needed. Entities such as NPRMDS (Here), Inrix, TomTom, among others provide these services and could be considered as a data source to complement the data collected via Bluetooth. Early returns on the Blue Tooth technology prove there are challenges maintaining connectivity within the ITS infrastructure. The debate between Blue Tooth technology at a local level versus purchasing this data from other entities is an ongoing debate within the agency.

6. *CCTV Implementation*

   CCTV allows for better monitoring and surveillance of the transportation infrastructure, particularly on busier portions of I-89. There are 45 CCTV locations in Vermont. Additional corridors should be evaluated and included in a CCTV deployment plan where further deployment is feasible. The implementing agency would be VTrans.

7. *Permanent Variable Message Signs (VMS)*

   This project seeks to implement permanent VMS to replace portable ones. New permanent VMS could be considered to provide information to users in a more efficient and cost-effective manner. The implementing agency would be VTrans. Currently, there are 84 VMS throughout the state (as shown in Figure 8) with plans to develop a long-term implementation plan and life-cycle replacement schedule.

8. *Automatic Vehicle Location (AVL) on Transit Vehicles*

   Operations for transit services were improved by implementing AVL technology on GMT and MooVER/SEVT buses. AVL technology coverage was increased and provides real-time information to improve the transit service in general throughout Chittenden County. Other transit agencies should consider deployment to track their vehicles as well. VTrans could support the expansion of this effort by setting standards or by helping smaller agencies to combine their resources for joint purchasing.

9. *Transit Computer Aided Dispatch (CAD)*

   CAD is deployed to further improve transit services and take advantage of existing AVL implementation. This allows transit authorities to have better control over the service, improve its reliability, and makes the service more attractive. VTrans could support the expansion of this effort by setting standards or by helping smaller agencies to combine their resources for joint purchasing.

10. *Smart Card*

    A more flexible payment method would help transit services be more competitive with other modes of transportation, taking advantage of potential integration with other transit services and transportation modes. This project could lead to evaluate new fare payment options, like mobile phone technology applications, along with future developments in this area. Smart cards or mobile ticketing could enhance the service and improve the service accountability. The initial implementation of smart card technology was through GMT. GMT offers universal passes and riders can pay via a web application. This could be expanded upon to include MooVER/DEVT and other transit agencies with support from VTrans.

11. *Automatic Passenger Counters (APC)*

    APC was implemented by GMT in September 2020. APC allows be better boarding and alighting information and is integrated with the AVL system. Other fixed-route transit agencies could consider this equipment with support from VTrans.

12. *Transit Networking and Communication*

    Enabling communication among users and between vehicles could present considerable benefit for the users as well as the transit authority. By enabling, expanding, and improving WiFi communication, the service becomes more competitive. While the project has not been completed, strides have been made to improve the communication as much of the transit service area now has wifi and/or cellular reception. The implementing agency would be GMT, but other transit agencies may want to consider this system.

13. *Transit Reporting/Data Management*

    There was a lack of coordination and integration across the different data sources, and its management and uses among different stakeholders which was largely addressed through the project outlined above. The project provides opportunities to manage the data sets available and integrate streamlined reporting. This project could be benefit from the ATMS Bluetooth project. The implementing agency is GMT, in coordination with CCRPC, and Vermont's ATMS.

14. *Improve Paratransit Services*

    Paratransit services are enhanced by implementing AVL/CAD dispatch, and providing an on-demand and real-time scheduling and dispatch system. All paratransit service providers are currently using the RouteMatch software. Many transit providers have begun implementing tablets with RouteMatch software on-board transit vehicles to facilitate on-demand and real-time scheduling, however, it is not utilized in every transit vehicle. The microtransit pilot project in Montpelier is working toward providing this on-demand, real-time service, and rider information to all members of the public. The implementing agency would be Vermont transit agencies, in coordination with different paratransit service providers and VTrans.

15. *Weigh-In-Motion (WIM)*

    In order to better understand commercial vehicle activities, control and pavement maintenance, deployment of Weigh-In-Motion technology would allow the Vermont DMV have better enforcement over commercial vehicles. The implementing agency would be VTrans. VTrans could support the expansion of this effort by setting standards or by helping smaller agencies to combine their resources for joint purchasing. Currently, there are 21 WIM stations throughout the state as shown in Figure 7.

16. *Airport Real-Time Information*

Among the needs identified during the stakeholders meeting, workshops, and focus groups, a need for improved information on the Burlington International Airport parking facilities was identified. Burlington Airport serves the needs of a large portion of the State. ITS technology would allow the airport users to find parking faster and more easily. The implementing agency would be the City of Burlington, in coordination with Burlington International Airport.

17. *Plow Services*

Given Vermont's winter weather conditions, plow vehicles services are of great importance. VTrans currently offers public AVL portals for plow and maintenance fleets through its VTransparency website allowing the public to view real-time information on recently plowed roadways throughout the state. This is currently implemented by VTrans and future expansion in coordination with local municipalities and private plow services itself to include local roadways could be considered. While predictive and automated spreader technologies have been marketed to increase efficiency of maintenance operations such as plowing there are far too many field variables currently preventing AVL from making plowing itself operationally efficient.

18. *Automatic Vehicle Location (AVL) on Maintenance Vehicles*

This project involves updating technology in VTrans' maintenance vehicles, to be able to reduce costs and improve performance by planning and operating maintenance activities more efficiently and provide real-time maintenance information to the public. Technology will also reduce the impact these activities have on regular traffic conditions. Currently, crews can use AVL to update their work status and job conditions year round. This data is currently used to provide real-time plowing information in the winter and could be expanded to provide real-time flagging and lane closure information throughout the year. The potential to expand the use of AVL to reduce costs and improve efficiency of planning and operating maintenance activities using automatic spreader technologies and for maintenance management systems allowing strategic network deployment should be considered.

19. *Vermont Vacations*

The Vermont Department of Tourism and Marketing is considering the implementation of a new Traveler Information System, targeted specifically to stakeholders involved in tourism activities. This project considers the implementation of the 511 system to a new information system, ultimately providing better information and instruction to tourists during incidents or emergencies.

20. *Web-based Data Portal*

Making an easy and accessible data portal allows users to get involved with the service. This would allow easier access to information to users and other stakeholders interested in knowing more about the transportation services available in the region. The implementing agency would be VTrans. COMPASS and RITIS would serve as the basis for this; additional information on local/regional roads, transit and non-motorized modes could be added.

21. *RITIS Implementation*

The Regional Integrated Transportation Information System (RITIS) is an automated data sharing, dissemination, and archiving system that includes many performance measure, dashboard, and visual analytics tools that help agencies to gain situational awareness, measure performance, and communicate information between agencies and to the public. RITIS requires the procurement of probe data. The implementation of RITIS and the procurement of the required probe data should be considered.

22. *RWIS*

Road Weather Information Systems provide valuable information on the effect of weather on the transportation infrastructure. Currently, VTrans has access to 85 RWIS stations throughout New England of which 41 are located throughout the state as shown in Figure 6. Additional potential locations should be evaluated. An automated tie to VMS for off-hours should be considered. The implementation agency would be VTrans.

23. *National Weather Service*

Having an accurate weather service is an important consideration in transportation services. ITS can help communicate weather events to users to change travel patterns accordingly and provide transportation services with resilience to weather conditions. The implementation agency would be Northern Vermont University Meteorological Department in coordination with the National Weather Service. These will provide detailed weather forecasts to VTrans which will be included on the COMPASS system and disseminated to participants.

24. *Vermont Alert and 511*

One of the most important uses of transportation services is during emergencies. Having an operational and efficient alert system can be the difference between an unusual event and a disaster. This project involves the incorporation of alert systems with the transportation stakeholders to have planned protocols in place when these unfortunate events occur. The implementing agency would be Vermont State Emergency Operations Center (SEOC) in coordination with VTrans and the different stakeholders identified.

25. *University of Vermont Medical Center*

An important regional and state transportation node is the University of Vermont Medical Center. This project aims to upgrade hospital's vehicles, considering the implementation of AVL and CAD, to improve emergency vehicles performance measures. The implementing agency would be the University of Vermont Medical Center.

26. *Asset Management Performance Board*

To improve VTrans' operations, this project considers the implementation of an asset management platform which would allow the agency to monitor and assess the performance of its assets in a robust and efficient manner. The project considers monitoring infrastructure in real-time, through the multiple sensors and data collection systems planned and currently installed and develop a platform that could analyze these data and report accordingly. The Vermont Asset Management Information System (VAMIS) could distribute work orders to maintenance vehicles and maintenance crew devices through AVL/ITS.

27. *Connected Vehicles*

One of the most important ITS technologies currently being developed are Connected Vehicles (CV). CV enables communication across vehicle (V2V) and infrastructure (V2I), opening windows of opportunities for safety improvements, operational enhancements, among many other transportation issues. Furthermore, VTrans has kicked off a series of discussions with Maine and New Hampshire for a regional Tri-State Concept of Operations for the US DOT Pilot Deployment of Connected Vehicle Road Weather Application Solicitation. UVM is also currently researching CV technology and its application in the region. Further research would allow public and private entities understand the possible benefits of this application and accelerate its deployment. The lead agency for this project would be VTrans, with support from UVM.

28. *Unmanned Aerial Vehicles*

With the successful deployment of Unmanned Aerial Vehicles (UAV), their use in transportation has been researched and its application on data collection and enforcement is being researched across different institutions, UVM included. VTrans Rail and Aviation Bureau has been working to expand their UAV capabilities which has 5 drones with equipment and 6 FAA certified pilots. UAV is currently being used to rail and aviation mapping, but could be used to map short roadway corridors or trail segments. UAV has been used to map short segments of roadway to assist in project specific traffic and emergency management. Additional technology could allow UAV to be used to complete survey and volumetric estimates. UAV is currently been used for emergency response for flooding events. VTrans and the VSP expanding their services to include search and rescue capabilities using infra-red technology. This technology can be used to complete real-time monitoring, however, limited cellular coverage throughout the State of Vermont hinders this function. This technology should continue to be expanded and utilized by VTrans and others.

Projects Added to the ITS Architecture

In addition to the projects mentioned in

Table 2, a number of new state-wide projects related to ITS operations are being considered. The following projects are being included in the ITS Architecture Update:

Integrated Transportation Corridors Management

The Vermont Agency of Transportation (VTrans) is considering deployment and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment along major corridors throughout the state. In addition to Interstate Route 89 (I-89) which is part of its own project, the I-89 Integrated Corridor Management, other major corridors are being considered including, but not limited to Vermont Route 9 (VT-9), Vermont Route 100 (VT-100), and US Route 4 (US-4). Similar action items to those outlined in the I-89 Integrated Corridor Management project are being considered including:

- Engaging stakeholders in the development of an Integrated Corridor Management Plan.
- Installing fiber infrastructure (conduits and fiber) connecting all signals at interchanges and all ITS devices (existing and proposed) in the corridor.

- Installing Weigh-in-Motion Systems (WIMS) with DOT plate readers, Road Weather Information Systems (RWIS).
- Installing a virtual WIM with DOT plate readers at two new RWIS stations in Bolton and Williston.
- Installing Wavetronix traffic sensors, Bluetooth and CAV Infrastructure technology at yet to be determined locations.
- Evaluating and identifying optimum sensor locations.
- Utilizing Advance Traffic Management Systems (ATMS) and Vermont's Transportation Management Center for monitoring, data capture, analysis and reporting system operations

Expand Go Vermont Trip Planner and Automated Vehicle Locator Service

Incorporate additional modes into the Go Vermont Trip planner. Currently, the trip planner reveals transit, carpool, vanpools and Transportation Network Companies (such as Uber/Lyft). Stakeholders would like to add our 700,000 demand response trips to this planner so transit can partially fill the empty seats with more members of the community. Stakeholders also need to add a "book it" or payment feature so a rider can schedule and pay in advance for any trip chosen. The implementation would require the development and maintenance of General Transit Specifications (GTFS-Flex). Additional modules could include tracking on-time performance for improved operations and rider information and route planning. This would be implemented by transit providers and transportation network companies in coordination with VTrans.

On-Board Transit Vehicle Cameras

As part of a statewide safety protocol, cameras have been implemented on-board all transit vehicles with the exception of private volunteer-based transit vehicles (ie some demand service vehicles). On-board cameras can be used to capture traffic incidents, monitoring driver behavior, and GPS tracking. The GPS tracking allows for real time information to be captured and utilized. This is implemented by transit providers in coordination with VTrans.

On-Demand and Microtransit Services Project

Microtransit and on-demand transit services can improve rider experience and expand existing transit service network's geographic and demographic reach. A pilot project in Montpelier slated for January 2021 will test the use of microtransit software and hardware for on-demand transit service to the greater Montpelier community. The pilot program is being implemented by GMT via the MyRide program. If successful, GMT should consider implementing the pilot program permanently and expanding this service to other locations that would benefit. In addition, other transit agencies may want to consider this service program.

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Appendix C

CMMA and Strategies Memo

Memorandum

To: Derek Lyman, PE, VTrans

Date: December 1, 2020

Project #: 57985.03

From: Jennifer Conley, PE, PTOE

Re: Vermont ITS Management Plan
CMMA Findings

The ITS Committee has undertaken a Capability and Maturity Model Assessment (CMMA) for the VTrans ITS program. The CMMA involved engaging a group of stakeholders to assess the processes of the ITS program. A meeting was held to introduce the ITS program and the CMMA to the attendees. The assessment seeks to understand how the stakeholders believe the ITS program is operating. Stakeholders ranked a number of criteria with a 1 through 4 based on their knowledge of the ITS program and provide some comments as what the stakeholder sees as the strengths and weaknesses of the program and any action items that they would identify to improve the program. VHB summarized the resulting average scores in each category and listed the strengths, weaknesses and action items identified by all participants.

The ITS committee and stakeholders met for a workshop where the resulting scores were discussed as well as each of the strengths and weaknesses. Finally, the identified action items were each discussed. The committee and stakeholders then discussed if other action items should be listed.

After the workshop, VHB reviewed the information and determined the action items required to bring VTrans to the next level in each category. That information is provided below starting with performance measurement which had received the lowest average score:

Performance Measurement – at 1.2

Current at Level 1 Performed: Some outputs measured and reported by some jurisdictions

Next level is Level 2 Managed: Output data used directly for after action debriefings and improvements; data easily available and dash boarded.

Action items to get to that level:

1. Develop clearly defined reporting criteria and reporting dates for pertinent information.
2. Develop standardized reporting practices that can be shared with all Agency personnel as well as external customers
3. Improve data access (read only) to all Agency personnel
4. Create dashboard
5. Develop annual reporting to be shared with leadership to justify funding requests.
6. Investigate if we can better utilize the tools and equipment we already have.

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Beyond level 2

7. Commit resources to better manage AVL systems and their reporting interfaces
8. Establish performance targets that are measurable and actionable through the determination of goals of the ITS system. Break into two:
   a. Determine goals of the ITS system
   b. Establish performance targets that are measurable and actionable
9. Evaluate information with a purpose

Collaboration – at 1.3

Current at Level 1 Performed: Relationships are ad-hoc and on personal basis

Next level is Level 2 Managed: Objectives, strategies, and performance measures aligned among key players with after-action briefing.

Actions to get to that level:

1. Document and communicate ITS capabilities.
2. Define and target organizations and jurisdictions for closer working relationships.
3. Improve coordination with other parts of the Agency and State (State Police).
4. Document overall goals and get buy-in from stakeholders so that everyone is working toward the same goal then identify and define roles and responsibilities.
5. Engage State IT personnel and get them invested in ITS solutions
6. Collaborate better with Planning and Design to integrate transportation technologies in Construction projects.
7. Develop after action debriefing with planning and design folks – what worked well or did not.

Beyond Level 2

8. Define a clear policy for public utilities that will make them partners in ITS deployments.
9. Deploy ITS solutions that streamline business processes and add value for field operations/maintenance staff.
10. Train district personnel to do some of the more basic maintenance on devices.

Culture – at 1.4

Current at Level 1 Performed: Individual staff champions promote ITS – varying among jurisdictions

Next level is Level 2 Managed: Jurisdictions' senior management understands ITS business case and educates decision makers/public.

Actions to get to that level:

1. VTrans ITS needs some public relations to make it real for everyone.
2. Identify those most knowledgeable about VTrans ITS and encourage them to share that knowledge and excitement/interest in ITS with the rest of the Agency at every opportunity.
3. Request feedback at all levels throughout Agency after installations to call attention to its functionality and benefits
4. Demonstrate the value of ITS to senior leadership down to highway maintenance techs by showing how ITS can influence and affect transportation.
5. Document and communicate ITS needs so they can be included in the early stages of Agency projects.

Beyond Level 2:

6. Public outreach campaign. Be more forth coming with information about individual devices and configurations.
7. Develop work ticket and ITS applications that better streamline field operations and reduce redundant systems and business processes.
8. When new ITS tools and technology are available, roll-out training to top tier stakeholders in use and application.

Business Process – at 1.5

Current at Level 1 Performed: Each jurisdiction doing its own thing according to individual priorities and capabilities

Next level is Level 2 Managed: Consensus regional approach developed regarding ITS goals, deficiencies, B/C, networks, strategies, and common priorities.

Actions to get to that level:

1. Clearly define assignments/responsibilities/processes and planning/programming effort
2. Engage all VTrans into understand the ITS program.
3. Make end users more involved in the planning stage to help maximize effectiveness and efficiency of new equipment locations.
4. Engage all MPOs, major municipalities, and multimodal agencies in a common vision and plan for ITS.
5. Create website to illustrate the who and what of ITS
6. Develop policies and procedures that consider ITS in capital projects and maintenance work.

7. Integrate technology solutions into Agency mission and goals.

Beyond Level 2:

8. Create better documentation and more stable federal funding.
9. Give the people fixing equipment the ability to buy replacement parts.
10. Address funding process shortcomings - training staff in contracts
11. Create process to consider all users when incorporating new technology

Systems and Technology – at 1.7

Current at Level 1 Performed: Ad hoc approaches to system implementation without consideration of systems engineering and appropriate procurement processes

Next level is Level 2 Managed: Regional concept of operations and architectures developed and documented with costs included and appropriate procurement process employed.

Actions to get to that level:

1. Maintain relevant contracts.
2. Make a concerted effort to not just update but to regularly refer to the Statewide Architecture.
3. Develop guidance or even a template for developing ConOps documents that are meaningful and scaled to each project.
4. Establish an ITS section to the Standard Specifications for Construction.
5. Systems integration of various applications
6. Develop masterplan for locating statewide ITS deployments

Beyond Level 2:

7. Standardize communicating new device information to the TMC.
8. Obtain staff training in ARC-IT (National architecture format and structure), RAD-IT (regional architecture tool), and maybe SET-IT (project level architecture tool).
9. Procurement of a Next Generation FWAN network with wayside/micro tower technology.
10. Increase coordination with other jurisdictions.
11. Exhaust all efforts to locate new technology where we can access permanent power and communications.
12. Generate blueprints for system implementation (DMS, RWIS, CCTV, Signals, etc) so configuring devices in the ATMS are seamless.

Organization Staffing – at 1.8

Current at Level 1 Performed: ITS added on to units within existing structure and staffing – dependent on technical champions.

Next level is Level 2 Managed: ITS specific organizational concept developed within/among jurisdictions with core capability needs identified, collaboration takes place.

Actions to get to that level:

1. Need to develop a clear strategy to increase the availability of the skill sets needed to construct and maintain technology products and systems.
2. Update resourcing models to include field ITS applications and technology.
3. Increase number of staff and (maybe) breadth of expertise
4. Develop ITS/Systems Engineering, ITS Maintainer, and TMC Operator job descriptions that reflect the unique knowledge and skills needed for this work.
5. Engage leadership and define roles and responsibilities.
6. Elevate the role of transportation technology within the Agency with closer tie to senior leadership
7. Developing staffing requirements based on equipment level of service or FHWA staffing recommendations if available.

Beyond Level 2:

8. Streamline some ITS workflows and get assistance in trouble shooting long standing connectivity and security concerns (working towards this by adding ADS PM).
9. Work with Contract Administration so that Mark Gerrish is not preparing all budgets and contracts.
10. Train highway maintenance in computer skills necessary to address ITS maintenance needs
11. When introduce new ITS tools, offer training to appropriate staff (to install, maintain, or use resulting information)

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Appendix D

Needs Assessment

Memorandum

To: Derek Lyman, PE, VTrans

Date: January 22, 2020

Project #: 57985.03

From: Jennifer Conley, PE, PTOE
Annabelle Dally

Re: Vermont ITS Management Plan
ITS Projects

This document describes the various projects to be included in the ITS Management Plan including the benefits, estimate installation and maintenance cost and schedule, the program areas the project addresses, and the geographic scope of each.

ITS Device Deployment

A variety of devices can be deployed to gather information and manage traffic on highways or arterials. These separate ITS devices can be deployed individually and integrated with the traffic management center to form the foundation to a traffic management system. These basic ITS devices include:

- Traffic Signals
- Road Weather Information System (RWIS) Stations
- Weight in Motion (WIM) Stations
- Changeable Message Signs (CMS) – fixed and portable
- Bluetooth Monitoring Devices
- Closed Circuit Television (CCTV) Cameras
- Radar Sensors

Over 560 devices are deployed throughout Vermont of which approximately 70 percent are owned and operated by the State of Vermont. The State of Vermont should continue to maintain and expand its coverage of ITS infrastructure throughout Vermont.

- **Benefits**
  - Faster incident detection and response
  - Improved traffic monitoring
  - Increased security surveillance
  - Increased amount of interactive traveler information
  - Reduce congestion and delay
- **Estimated Cost**
  - More detailed estimated costs below by device.
- **Addresses identified program areas:** Traveler Information, Traffic Management, Incident Management, Data Management, Transportation Safety
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

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Traffic Signals

Traffic signals are a vital tool for the safe and efficient movement of all modes of transportation on roadways throughout the state. Traffic signals allow for the control of traffic in a safe, orderly, and efficient manner providing orderly movement, improved safety, reduced travel times, and increasing intersection capacity. There are 339 traffic signals throughout Vermont and additional traffic signals are planned. The State of Vermont operates 164 of the existing traffic signals of which one is owned by a municipality. The remaining 175 traffic signals are owned and operated by municipalities. To achieve optimum efficiency traffic signals must be maintained, monitored, and adjusted.

- **Benefits**
  - Safe and efficient movement of traffic
  - Reduce congestion and delay
- **Estimated Cost**
  - $250,000/new signal installation; $25,000/existing signal cabinet/controller upgrade, $40,000 for vehicle detection replacement
  - $2,000 for annual operations and maintenance per signal, per year
  - 2-3 new signals/year; 10-15 upgrades/year
- **Addresses identified program areas:** Traffic Management, Transportation Safety
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Traffic Signal System Upgrades

Traffic signal system upgrades can be an easy, low-cost way to improve traffic flow and mitigate congestion. Signal timing systems can be updated to address current traffic conditions and all other modes of transportation involved, such as pedestrian activity and bicycles. The State of Vermont reviews and adjusts signal timings at signalized intersections throughout the state on a four year cycle. Signal timings are reviewed and adjusted more frequently as needed. Signal upgrades can decrease congestion at key intersections and signal timing should be coordinated along important routes. The State of Vermont strives to upgrade 10 signalized intersections per year.

- **Benefits**
  - Reduced congestion
- **Estimated Cost**
  - $1,500 to $2,000/ intersection for signal timing review and adjustment
  - $5,000/existing signal controller upgrade
  - $40.000/detection upgrade
  - 10-15 upgrades/year
  - Signal timing reviews and adjustment are made on a four-year cycle
- **Addresses identified program areas:** Traffic Management, Transportation Safety
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Regional Traffic Signal Management

Traffic signal coordination is a key ITS strategy that has been applied extensively throughout the United States for several years. Signal coordination has been shown to improve arterial and highway traffic flow through the use of advanced signal systems that are calibrated and coordinated along specific corridors. This effort involves providing communication links (ie internet connectivity) to all state owned and operated traffic signals to allow connection to the Centracs server. This effort will allow for the remote monitoring and modifications of state owned and operated traffic signals from a single location. The Centracs system is capable of reporting measures of effectiveness for each signal. Signal timings can be modified remotely including changing signal offsets and splits manually or based on certain factors such as time of day, day of the week, or for special events or updating controller configurations and timing plans. Traffic signal coordination ensures appropriate traffic signal progression, which enables motorists to experience less congestion and delay. Signals will need to have compatible signal timing systems and control, so older systems may need to be upgraded to be included.

- **Benefits**
  - Improved travel speeds
  - Increased safety through reduced crash risks
  - Reduced emissions from fewer vehicles idling at intersections
  - Improved transit running times
- **Estimated Cost**
  - $250/year to connect each intersection to the cloud;
  - $1,000/year for communications
- **Addresses identified program areas:** Traffic Management, Incident Management, Interagency Coordination
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Road Weather Information System (RWIS) Stations

Road Weather Information Systems provide valuable information on the effect of weather on transportation infrastructure. A RWIS consists of a physical sensor station to collect environmental data located in the field, a communication component to transfer the data collected by the sensors, and a central system that collects and analyzes the collected data. The RWIS stations measure road surface conditions and temperature, air temperature, humidity, barometric pressure, wind speed and direction, precipitation, and visibility. The Agency has access to 89 RWIS stations throughout New England of which 45 are located in Vermont. The Agency uses the data collected from the RWIS stations to operate and maintain Vermont's road system. The Agency can then communicate hazardous weather conditions to the traveling public in real time. The Agency should continue to maintain its existing RWIS stations and expand its coverage as necessary throughout Vermont. In addition, the Agency should explore the potential of automated weather/roadway conditions between RWIS stations and Changeable Message Signs.

- **Benefits**
  - Improved operations and maintenance of road system
  - Faster and more efficient weather detection and response
  - Potential for communicating weather/roadway conditions to the public
- **Estimated Cost:**
  - $60,000/new station installation; $25,000/existing station upgrade
  - $4,000-5,000 staffing cost per station
  - $2,500 annual operations and maintenance cost per device
  - 3-4 new stations/year; 3-4 upgrades/year
- **Addresses identified program areas:** Traveler Information, Incident Management, Transportation Safety, Construction & Maintenance
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Weigh in Motion (WIM) System

The objective of WIM systems are to monitor the weights of commercial vehicles to ensure compliance and collect weight data essential to design, particularly pavement. A WIM system consists of an in-pavement sensors and a detection device which is connected to a central system. The WIM station measures the volume, speed, classification, and weight of vehicles. Often these WIM systems are deployed on high speed roadways such as interstates as a pre-screening tool for static weigh stations. WIM stations can be used to increase the efficiency of commercial vehicle enforcement by providing real-time information to enforcement officers to help determine where to target enforcement and which vehicles are worth inspecting. Reductions in dramatically overweight trucks will reduce the damage caused to road surfaces and serve to lengthen the lifespan of pavement on roadways. There are 21 WIM stations throughout Vermont. The State of Vermont should continue to maintain its existing WIM stations and construct additional WIM stations throughout the state, as necessary.

- **Benefits**
  - Significantly reduce damage to roads
  - Increase efficiency of commercial vehicle enforcement
- **Estimated Cost**
  - $50,000/location deployment
  - $10,000/year operations and maintenance
- **Addresses identified program areas:** Data Management, Commercial Vehicle Operations, Construction & Maintenance
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Virtual Weigh in Motion (WIM) Station

The objective of the virtual weigh station is to employ multiple sensor and communication technologies to more effectively enforce weight restriction laws in real time. Virtual weigh stations can be used to complement traditional weigh stations by improving weight enforcement capabilities on known or suspected by-pass routes throughout Vermont. By using a series of sensors including a WIM sensors, video cameras, over-height detectors, and even license plate readers all connected via software to the internet, enforcement personnel can screen more vehicles for effective and targeted enforcement. The virtual WIM station has the advantage that it can be deployed in locations that are not likely candidates for a full weigh station with a permanent truck scale. Trucks that are in compliance with vehicle weight restrictions are not delayed but trucks that exceed the legal limits (weight and/or height) can be pulled over for more intensive screening. Virtual weigh in motion stations do not require continuous staffing and can be monitored remotely. Virtual weigh in motion stations allow enforcement officer locations to be more flexible and not confined to a specific WIM station location.

This project also seeks to improve the effectiveness of commercial vehicle weight enforcement throughout the corridor by establishing cooperative agreements among the states. These agreements could take the form of reciprocity agreements allowing one state to take enforcement action on a vehicle identified as overweight, or flagged as a vehicle likely to be overweight, by another state.

The State of Vermont is installing its first virtual WIM station in Williston and considering an additional virtual WIM station in Bolton. The State of Vermont should monitor the results of the virtual WIM station to determine the feasibility of installing virtual WIM stations in other locations throughout the state.

- **Benefits**
  - Significantly reduce damage to roads
  - Reduce delay for compliant truckers
  - Coordination opportunity with neighboring states
- **Estimated Cost**
  - $400,000-$600,000/location deployment
  - $10,000/year operations and maintenance
- **Addresses identified program areas:** Data Management, Commercial Vehicle Operations, Construction & Maintenance
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Changeable Message Signs (CMS) - Fixed

CMS are used to communicate information to the traveling public. CMS are primarily deployed on the two major interstate highways, I-89 and I-91, however, CMS are deployed on major US and VT state routes as well. fixed changeable message signs can be used at locations of importance, such as decision points (i.e. prior to interchanges) or border crossings. Depending on Agency guidelines, CMS technology can be used to address several needs including, but not limited to: giving travelers information before decision points, warning travelers of upcoming roadwork or traffic incidents, maintenance or weather conditions, and providing travelers with real-time travel times. Fixed CMS could be used to provide information to users in a more efficient and cost-effective manner. This project seeks to maintain and expand the fixed CMS coverage throughout the state.

- **Benefits**
  - Provide improved motorist information
  - Improved safety
  - Can be used at several locations
- **Estimated Cost**
  - $35,000-$40,000/new ground mounted board installation;
  - $120,000-$400,000/new overhead board installation dependent on size and mounting structure;
  - $4,000/camera; $6,500/radar sensor; $12,000/other sensors
  - $2,000/sign/year operations & maintenance
- **Addresses identified program areas:** Traveler Information, Traffic Management, Incident Management, Construction & Maintenance, Asset Sharing & Control
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Portable Changeable Message Signs (PCMS)

Similar to fixed CMS, portable CMS are used to communicate information to the traveling public. The value of portable message signs is that they can be deployed and redeployed where needed such as at locations for construction zones or special events. Portable CMS serve the same purpose as fixed Changeable Message Signs, including providing information to travelers about special events, giving travelers information before decision points, and safely directing travelers through a work zone. Due to their portable nature, they can be deployed in both urban and rural areas. ITS use in work zones has a major impact on incident avoidance and mitigation.

- **Benefits**
  - Provide improved motorist information
  - Improved safety
  - Can be used at several locations
  - Manage special events traffic

- **Estimated Cost**
  - $25,000/sign;
  - $1,600/sign/year operations & maintenance
- **Addresses identified service package area:** Traveler Information, Traffic Management, Public Safety, Construction & Maintenance, Data Management, and Support
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Bluetooth Monitoring Devices

Bluetooth monitoring devices can be deployed along corridors throughout the state to monitoring traffic in real time. Bluetooth monitoring deployment will provide opportunity to deliver real time traffic monitoring and communication (through the VTrans TMC, ATMS, and TIS) including travel times, average travel speeds, start of congestion, and crash avoidance areas – enhancing safety, mobility, reducing congestion and congestion-related vehicle emissions in the region.

- **Benefits**
  - Faster incident detection and response
  - Improved traffic monitoring
  - Increased amount of interactive traveler information
  - Reduce congestion and delay
  - Enhanced route planning
- **Estimated Cost**
  - $6,000 per unit
  - $4,500-5,000 per unit per year for hosting and communications.
- **Addresses identified program areas:** Traffic Management, Incident Management
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Closed Circuit Television (CCTV) Cameras

CCTV cameras allow for better monitoring and surveillance of the transportation infrastructure, particularly on busier portions of I-89. VTrans currently has access to 275 CCTV locations throughout New England of which 50 are located within Vermont. The State of Vermont currently uses their CCTV cameras to monitor weather and traffic at various locations throughout the state. Images from the CCTV cameras are also made available for public consumption to allow travelers the ability to view real-time weather and traffic conditions through VTrans website and 511.

In addition, CCTV cameras can be placed at rail platforms, on transit and maintenance vehicles, at airports, and near critical infrastructure to provide additional coverage or near highway or arterial intersections or areas of recurrent congestion to assist in systems operations. CCTV cameras can also be used to prevent incidents by alerting travelers of changes in weather or traffic patterns through the use of CMS or for incident detection and response, but this requires dedicated staff in place to consistently view/monitor the images the cameras provide. Software is available that automatically alerts operators of changes in motion patterns, mitigating the demands for staff time used for surveillance. CCTV cameras can be used at airports to combat terrorism, provide real-time surveillance, and detect suspicious activity and individuals via advanced video analytics. The Agency should continue to maintain its existing CCTV stations and expand its coverage to reduce gaps. The Agency should consider the capabilities of CCTV in incident prevention and detection.

- **Benefits**
  - Potential for faster incident detection and response
  - Improved traffic monitoring
  - Improved weather and roadway conditions monitoring
  - Increased security surveillance

- **Estimated Cost**
  - $4,000 (in-vehicle) - $10,000-20,000 (outdoor)/camera deployment;
  - $2,000/camera/year operations and maintenance
- **Addresses identified program areas:** Incident Management, System Security
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Intelligent Transportation Systems (ITS) Design Guidelines

This project would develop design standards in the development and implementation of ITS components in Vermont for use by state and local agencies that have started deploying ITS or are looking to deploy ITS. These design guidelines would provide some level of standardization for state and local projects which could lead to incorporation of ITS components in other state and local projects including bridge repairs or replacement projects or roadway/pavement rehabilitation projects. The guidelines would assist other agencies or departments within the Agency as they develop design plans for projects that ITS technologies should be incorporated, but have not been in the past due to inexperience. Standard details and specifications would be collected into a single manual to be used by VTrans staff around the state.

- **Benefits**
  - Standardize maintenance and operations
  - Reduce design costs for local agencies
  - Expand understanding of ITS across the state
- **Estimated Cost**
  - $150,000-200,000 for initial deployment, no operations costs (variable depending on focus of guidelines), bulk purchase costs will be dependent on equipment order
- **Addresses identified program areas:** Support, Data Management
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Advanced Transportation Management System (ATMS) New England Compass

Vermont has already established an ATMS called New England Compass in 2016, conforming with the federal requirements of 23 CFR 511 and Rule 1201 (Real-Time System Management Information Program) – a federal mandate to provide timely travel information to the public. New England Compass is a two part program consisting of an administration user interface and a Traveler Information System (TIS). Inputs from Transportation Management Center (TMC) Operators are displayed as travel information to the public via https://www.newengland511.org/. The project is a Tri-State initiative with VT working closely with New Hampshire and Maine DOTs to provide system oversight to the vendor and to share best practices for system operations. Compass consolidates multiple "silos" of various VTrans' ITS devices and transportation management tools into a single user interface allowing for efficient management of ITS devices and traveler information.

Examples of ATMS functionality in use:

- Road Weather Information Station (RWIS) Information
- Changeable Message Sign utilization and management
- Road Condition Driving information
- Emergency announcements
- Event Information such as construction projects, planned road closures, unplanned road closures, amber alerts, blue alerts, flooding, motor vehicle crashes, abnormal congestion, and more.
- Real time test message and email alerts for emerging incidents

Examples of future ATMS use:

- Speed Heat Map by way of BlueTooth sensors
- Automated real-time travel time messaging
- Special Event and Incident Response Plans
- Alerts and Alarms for traffic incidents

The Agency should continue to maintain its ATMS and adapt its capabilities and services adding additional modules to the Compass System (i.e. travel time messaging) to accommodate the ever changing needs of the traveling public. A transition from a Thick Client application to a Thin Client application is underway and expected completion is Fall 2022. The Thin Client includes integration of an ESRI base map, providing the Tri-States added functionality to customize the map views. Full ESRI feature class integration is a goal in the next five years.

- **Benefits**
  - Increased amount of traveler information
  - Traveler information available statewide
  - Reduced future statewide cost of upgrades because of standardization

- **Estimated Cost**
  - $500,000 for Thin Client transition and ESRI base map
  - $200,000 estimated for ESRI Feature Class integration
  - $175,000 per year maintenance costs
- **Addresses identified program areas:** Traveler Information, Traffic Management, Improved Communications, Data Management, Standardization, Performance Measures
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Statewide Advanced Traveler Information Systems – Vermont Alert and 511

VTran's has already developed a Statewide Advanced Traveler Information System called Vermont Alert and 511 is an easy-to-remember traveler information interface that provides a variety of traveler information at the fingertips of all travelers. The system supports a variety of information including construction, weather related road conditions, incidents, and road closures.

The Vermont Alert and 511 system provides travelers a one-stop-shopping opportunity to find traffic information across the state. This source of consolidated information benefits travelers by giving them easy access to a wide range of traveler information and eliminate confusion over where to go for information. Existing traveler information and condition reporting systems are incorporated and expanded to form the base for this statewide traveler information system.

Information from this system's database is distributed through several channels, including Vermont Alerts and 511 website, dynamic message signs, highway advisory radio, personal digital devices, and e-mail alerts. Information that is currently or could be potentially included in this system are:

- Travel conditions/congestion
- Travel times
- Emergency info/weather
- Construction
- AMBER Alert
- Special events
- Surface conditions
- Multi-modal/transit
- Advisories
- Truck route information and temporary weight/size limits
  - **Benefits**
    - Increased amount of traveler information
    - Traveler information available statewide
    - Reduced future statewide cost of upgrades because of standardization

- **Estimated Cost**
  - $40,000 per year hosting fees
  - $50,000 ESRI based 511 development
- **Addresses identified program areas:** Traveler Information, Traffic Management, Improved Communications, Data Management, Standardization
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Vermont State Emergency Operations Center (SEOC) and Transportation Management Center (TMC) Integration

Vermont has already developed a central notification system to address communications during emergencies, the Vermont State Emergency Operations Center. The Vermont SEOC provides transportation information and support in case of emergencies. The Vermont SEOC is equipped with communications equipment and computer systems needed to provide these services during disaster operations. The State of Vermont should continue to maintain the Vermont SEOC and keep staff trained/prepared in the event of an emergency. In addition, that Agency should consider integration of the Vermont SEOC with the TMC. This could include anything from communication protocols to hardware that provides a direct connection from the TMC to the Vermont SEOC.

- **Benefits**
  - Increase security preparedness
  - Improve coordination between transportation and response personnel
- **Estimated Cost**
  - X
- **Addresses identified program areas:** Traveler Information, Traffic Management, Interagency Coordination, Improved Communications, Data Management, System Security, Asset Sharing & Control
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Integrated Transportation Corridors

In order to increase the efficiency and safety of routes inside Vermont, coordinated Intelligent Transportation Systems can be deployed along selected high-priority corridors to the benefit of all travelers. This solution area would include ITS improvements on a major interstate or highway and a parallel route, in either an urban or rural area. Deployment in rural areas may be more expensive because of the lack of existing communications infrastructure and available power sources. A candidate corridor would be chosen based on accidents, congestion, travel patterns, availability of alternate routes, and interest of local participants. Specific recommendations for corridors would be developed to address the needs of that corridor and incorporate the systems already in place. Systems would be integrated to work together in order to maximize benefits to travelers at a corridor-level. Potential action items include:

- Engaging stakeholders in the development of an Integrated Corridor Management Plan.
- Installing fiber infrastructure (conduits and fiber) connecting all signals at interchanges and all ITS devices (existing and proposed) in the corridor.
- Installing Weigh-in-Motion Systems (WIMS) with DOT plate readers, Road Weather Information Systems (RWIS).
- Installing a virtual WIM with DOT plate readers at appropriate locations.
- Installing radar traffic sensors, Bluetooth and CAV Infrastructure technology at yet to be determined locations.
- Evaluating and identifying optimum sensor locations.
- Utilizing Advance Traffic Management Systems (ATMS) and Vermont's Transportation Management Center for monitoring, data capture, analysis and reporting system operations

The State of Vermont is proposing deployment and operation of advanced transportation technologies along 75 miles of I-89 between the state capital in Montpelier and the US-Canada international border as part of the Integrated Corridor Management (ICM) plan. The State of Vermont should consider the deployment and operations of advanced transportation technologies along other major corridors including, but not limited to VT-9, VT-100, and US-7

  - **Benefits**
    - Reduced congestion
    - Increased safety
    - Standardization of systems along corridor
  - **Estimated Cost**
    - Highly variable dependent on corridor and identified needs; sample costs: $200,000 for planning/scoping study; $1Million for deployment; $70,000/year operations
  - **Addresses identified program areas:** Traffic Management, Transportation Safety, Standardization, others variable based on corridor
  - **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Emergency Vehicle Traffic Signal Preemption

Through the installation of sensors on traffic signals at intersections, emergency vehicles with special emitters can trigger the signal controller to alter the intersection timing and phasing. This gives the emergency vehicle's approach a green indication and all other approaches a red indication, giving priority flow to the emergency vehicle approach reducing emergency response time. This technology is predominantly based on optical sensors. When applying these technologies, agencies should consider the inclusion of signal preemption security components to combat the growing prevalence of illegal preemption emitters.

- **Benefits**
  - Reduce emergency response time
  - Reduce intersection collisions
- **Estimated Cost**
  - $10,000/intersection capital cost, $1,000/vehicle for emitting device; $200/intersection/year operations & maintenance (negligible maintenance on emitting device)
- **Addresses identified program areas:** Traffic Management, Incident Management
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Obtain Third-Party In-Vehicle Traffic Probe Data

Mobile technologies located in vehicles are being used to measure travel times. New low-cost methods of gathering this traffic data use technologies previously deployed for other reasons, such as toll transponders and cell phones. These methods are being tested in several parts of the country in public-private partnerships. This strategy would allow for better collection of data on arterial routes and interstates in rural areas. Data already gathered on some routes would be enhanced by this new stream of data to provide better information, while this system would also provide data on routes where higher-cost detection systems are not deployed. The Agency should consider obtaining third party probe data being collected throughout the state of Vermont. Obtained probe data could be used to collect real-time probe data to support real-time travel time data and be archived to use in traffic analyses. The obtained probe data could also be used to determine work zone allowances for future construction projects and be displayed on the 511 website as a traffic heat map.

- **Benefits**
  - More accurate travel time information
  - Travel time information on new routes
  - More effective response to congestion
- **Estimated Cost**
  - $300,000 implementation; or existing devices could be used as probes at no cost to consumers; $125,000/year operations and maintenance (costs would be shared with vendor through public/private partnership)

- **Addresses identified program areas:** Traffic Management, Data Management, Asset Sharing & Control
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Maintenance Automated Vehicle Location (AVL)

AVL uses GPS or other location technologies to manage vehicle fleets. GPS units in vehicles transmit data to a central processor that coordinates the location of all GPS units in the fleet. This enables the dispatch center to locate vehicles and calculate average speeds on a real-time basis.

AVL technology has been implemented in maintenance vehicles to reduce costs and improve performance by planning and operating maintenance activities more efficiently and provide real-time maintenance information to the public. Technology can be used to reduce the impact these activities have on regular traffic conditions. Currently, crews can use AVL to update their work status and job conditions year round. The data is currently used to provide real-time plowing information in the winter, but could be expanded to provide real-time flagging and lane closure information throughout the year. The potential to expand the use of AVL to reduce costs and improve efficiency of planning and operating maintenance activities using automatic spreader technologies and for maintenance management systems allowing strategic network deployment should be considered as part of this project. Enhancements to the current AVL system could include on-board cellular connectivity and hotpots to transmit data, sensors to evaluate and relay atmospheric and road conditions (mobile RWIS), and integration with radio communication technologies for better connectivity between drivers, TMC Operators, and other maintenance personnel.

- **Benefits**
  - Better fleet management
  - Better use of time and resources
  - Better management of resources (salt dropped, vehicle repair/vehicle use)
  - Increase roadway maintenance operational efficiency
  - Better road condition reporting
  - Better predictive road condition modeling
- **Estimated Cost**
  - $15,000/vehicle for equipment and integration, $300,000 for central system; $50/year/unit for operations & maintenance
- **Addresses identified program areas**: Incident Management, Construction & Maintenance
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Vermont State Police (VSP) Computer Aided Dispatch (CAD) and Transportation Management Center (TMC) Integration

VSP CAD systems are used to track and retain information provided to VSP dispatchers during an event. In addition to the information being used by emergency response dispatchers this information can be used by the TMC.

TMC access to VSP CAD information would increase efficiency in getting pertinent maintenance and travel information disseminated among VTrans maintenance staff and the traveling public. Integration with the ATMS adds a level of functionality and potentially eliminates a line of communication.

VSP began modernizing its IT systems in 2019 including the procurement of new statewide CAD software. Integration between the existing VSP CAD system and the TMC would require the procurement of a new module for both VSP's CAD system and the TMC's Advanced Transportation Management System (ATMS).

- **Benefits**
  - Better use of time and resources
  - Reduce distance vehicles travel
  - Improve operational efficiency
  - Improve TMC Performance Measure accuracy
  - Automate TMC notification
- **Estimated Cost Strategic Plan**
  - $250,00 for VSP CAD system module and TMC integration
  - $25,000/year for operations & maintenance
- **Addresses identified program areas**: Incident Management
- **Geographic Scope**: Statewide, NE, NW, SE, SW Regions

Smart Work Zones

Work zones are a major point for congestion and for crashes. Work zone safety continues to be a priority for VTrans. A number of steps can be made to increase work zone safety and make travel through work zones a more pleasant experience for drivers. Some of these initiatives include the following:

- Queue Detection – alerts operators when a line entering a work zone has reached a designated length, signaling that countermeasures should be implemented
- Dynamic Merge Systems – instructs drivers on when to merge to reduce crashes and tension caused by uncontrolled merging
- Portable Traffic Management Systems – uses equipment such as cameras, speed detectors, and message displays to collect traffic data from work zones, display real time traffic information to travelers, and communicate with a central control facility
- Travel Times through Work Zones – displays travel times through a work zone on a changeable message board to inform travelers how long it is taking motorists to travel through the zone

- **Benefits**
  - Increase safety in work zones
  - Increases traveler information as they enter work zone
  - Decreases congestion and pollution at work zones
- **Estimated Cost:**
  - Queue Detection - $26,000/unit, $x annual operations and maintenance
  - Dynamic Merge Systems - $x/unit, $x annual operations and maintenance
  - Portable Traffic Management System - $90,000/unit, $9,000 annual operations and maintenance
- **Addresses identified program areas:** Traveler Information, Traffic Management, Data Management, Commercial Vehicle Operations, Transportation Safety, Construction & Maintenance
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

<u>Backbone Communications Infrastructure</u>

A critical feature of any Intelligent Transportation Systems (ITS) device is its communication system. This communication system typically transmits two-way data to and from the Transportation Management Center (TMC). In order to make many projects truly statewide and to share information between different areas of the state, stable high-speed, high-bandwidth communication links should be established. Vermont needs to work to install and/or share access to a privately owned fiber optic backbone cable along I-89 and other highway segments in the state.

Once a fiber optic backbone is installed, sites can be linked by installing short distances of fiber optic cable and associated equipment or wireless transmissions can be used to send and receive information between a local center and a processor connected to the backbone.

- **Benefits**
  - Share real-time information statewide
  - Allow for deployment of statewide ITS systems
- **Estimated Cost**
  - $100,000-250,000/mile of fiber installation, $20,000-40,000 for integration; $1,000-2,000 per year per mile for maintenance,
  - $8,000 per installation of wireless link, $1,000-2,500 for operations and maintenance
- **Addresses identified program areas:** Traveler Information, Traffic Management, Interagency Coordination, Improved Communications, Data Management, Standardization, Asset Sharing & Control
- **Geographic Scope**: Statewide, NE, NW, SE, SW Regions

Enhanced Communication Links to Field Devices

To ensure operations of traffic management devices, communications links to some field devices need to be enhanced/upgraded and the addition of secure, diverse links need to be explored. Depending on the importance of various field devices and the age of the devices and their communications connections, outdated connections/conduits should be upgraded to provide more reliable device operation. Many of the existing communications links are cellular, which usually have bandwidth limitations.

- **Benefits**
  - Increased reliability of field device operations
  - Increased bandwidth allows for better access to some ITS devices (i.e. streaming video)
  - Reduces long-term maintenance costs
- **Estimated Cost**
  - the cost of this initiative would depend on the type and length of connections needed to devices determined to be of highest priority (e.g., $500- 5,000 for 8 to 15 miles of T1 or T3 communication lines, with $5,000-$60,000 operations and maintenance per year; $500 per month per drop for wireless communications)
- **Addresses identified program areas:** Traffic Management, Incident Management, Improved Communications, Data Management, Transit, Standardization, Asset Sharing & Control
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Intelligent Transportation Systems (ITS) Outreach/Public Education

While ITS is in the process of being mainstreamed into traditional transportation projects, it is still seen as a niche service that may not apply to many transportation activities. ITS outreach and education would seek to spread greater knowledge of the benefits ITS can provide and how it can be used in different areas such as transportation planning and programming, construction, transit, or law enforcement. This strategy would promote the benefits of ITS to a variety of groups, from high-level decision makers to operations staff to the general public. This would make more people aware of ITS resources that may be used to address applicable issues. Possible outreach sources include seminars/workshops, newsletters, public service commercials, or a benefits webpage.

- **Benefits**
  - Promotes cost-effective solutions
  - Expand awareness of potential resources
- **Estimated Cost**
  - $30,000-$200,000 (highly variable, dependent on outreach)
- **Addresses identified program areas:** ITS Outreach/Public Education
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Traffic Data Archive

Agencies collect a large amount of traffic data in their daily operations. This data can be archived for future analysis of traffic patterns and to measure the effects of changes to the transportation system. The Agency provides access to some collected data archives including traffic counts and speed data on the Transportation Data Management System. In addition, the Agency provides access to some of the real-time collected data including plow maps, weather station data, and Closed Circuit Television (CCTV) snapshots of roadway and traffic conditions via New England Compass and the Agency website. In order to maximize the uses of stored data across the state, archival standards should be developed so that data is easily retrieved and used.

- **Benefits**
  - Standardized traveler information format - Easier ability to develop travel time prediction algorithms - Comparison of current versus past travel times
- **Estimated Cost**
  - $70,000-$100,000 for archive standardization; $500,000 for travel-time prediction development, $50,000 for Operations and Maintenance
- **Addresses identified program areas:** Traveler Information, Data Management, Standardization
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Training

Operations personnel need training in order for them to effectively use the resources they have available to fit the needs of different circumstances. Training can be provided to operators to address a number of needs identified. This training can draw on already existing programs and manuals to provide proven, up-to-date information. These different training programs would be offered to appropriate VTrans personnel and other agencies around the state. Areas for training include:

- Train highway maintenance in computer skills as necessary to address ITS maintenance needs.
- Train district personnel to do some of the more basic maintenance on devices.
- ITS staff training in ARC-IT, RAD-IT, and SET-IT.
- Appropriate staff training when introducing new tools (installation, maintenance, resulting information use).
- Funding process shortcomings and contracts training
  - **Benefits**
    - Increase safety and preparedness
    - Reduce secondary accidents
    - Savings on fewer new equipment purchases
    - More consistent maintenance, longer equipment life cycle
    - Improve coordination between transportation and response personnel
  - **Estimated Cost**
    - $3,000-10,000 per training class of 20 individuals; $30,000-$70,000 to develop training

- **Addresses identified program areas:** Traffic Management, Incident Management, Interagency Coordination, Transportation Safety, Standardization, System Security
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Emergency Vehicle Rail Crossing Safety Systems

At-grade railroad crossings present two distinct types of challenges for rural areas. The first challenge relates to the potential for vehicle-train collisions. The second challenge is that presented by long trains passing through rural towns that prevent traffic, including emergency vehicles, from crossing over the rail line. This strategy would focus on the latter challenges. Many existing active warning systems for grade crossings provide valuable information that can be easily imported into a computer aided dispatch system. The information would be used to alert emergency vehicle dispatch centers of approaching trains so that they may identify the best routes for emergency response vehicles to follow. Because of data transmittal costs, this is more cost-effective to deploy in urban areas.

- **Benefits**
  - Decrease response time to incidents
  - Reduce incidents and injuries from train/car crashes
- **Estimated Cost**
  - $20,000-50,000 per intersection for deployment
- **Addresses identified program areas:** Incident Management, Transportation Safety
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Automated Weather Observing System (AWOS)

Automated Weather Observing Systems (AWOS) collects and broadcasts continuous, real-time information and reports of weather conditions at their locations on a minute-by-minute basis. AWOS are a vital tool for pilot decision making and planning. AWOS also provide information to the National Weather Service which is accessible to the media and general public. There are various types of AWOS stations which are capable of reporting varying data types from altitude to precipitation. AWOS stations are managed, maintained, and controlled by the Federal Aviation Association (FAA) or the airport operation organization. Automated Surface Observing System (ASOS) stations are similar to AWOS stations. The major discrepancies between the systems are that ASOS stations broadcast hourly and the stations are primarily operated and controlled by the National Weather Service and the Department of Defense, though the FAA does operate and control some ASOS stations.

Within Vermont all AWOS and ASOS stations are capable of reporting wind, visibility, temperature/dewpoint, altitude, density altitude, and clouds/ceiling information. In addition, several of the AWOS and ASOS stations in Vermont are capable of reporting precipitation type and thunder/lighting information. There are ten AWOS and ASOS stations throughout the State of Vermont which are located at all the state and municipal owned airports with the exception of the John H Boylan State Airport in Island Pond. Six of the AWOS and ASOS stations are managed, maintained, and controlled by the NOAA and the FAA. The remaining four AWOS stations are managed, maintained, and controlled by the State of Vermont and are located at the Franklin County State Airport in Highgate, Northeast Kingdom

International Airport in Newport, Caledonia County Airport in Lyndonville, and the Middlebury State Airport in Middlebury. The Agency should continue to maintain its existing AWOS stations and expand its coverage as necessary throughout Vermont.

- **Benefits**
  - Improved aviation safety
  - Assists pilots in navigating take off and landing
  - Provides weather information to the National Weather Service
  - Provides weather reporting for the media and the public
- **Estimated Cost:**
  - $75,000-125,000/new system installation
  - new station upgrade every 14-20 years
  - $30,000/existing station component upgrade
  - station component upgrade every 7-10 years
  - $5,000 annual operations and maintenance cost per device
- **Addresses identified program areas:** Traveler Information, Incident Management, Transportation Safety, Construction & Maintenance
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Transit Automated Vehicle Location (AVL)

AVL uses GPS or other location technologies to manage vehicle fleets. GPS units in vehicles transmit data to a central processor that coordinates the location of all GPS units in the fleet. This enables the dispatch center to locate vehicles and calculate average speeds on a real-time basis.

AVL technology was first implemented on GMT and MooVER/SEVT buses. AVL coverage was increased and now provides real time information to improve the transit service across all of Vermont's Transit Providers. AVL is used to track their vehicles, gather data on schedule adherence, trip speed, and provides route guidance for on-demand service. AVL helps dispatchers easily find and dispatch the closest vehicle to pick up riders.

- **Benefits**
  - Better fleet management
  - Better use of time and resources
  - Better management of resources (vehicle repair/vehicle use)
  - Increase transit operational efficiency, service, and ridership
- **Estimated Cost**
  - $15,000/vehicle for equipment and integration, $300,000 for central system; $50/year/unit for operations & maintenance, $100,000 for central system to maintenance.
- **Addresses identified program areas:** Incident Management, Transit
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Upgrade Transit Scheduling and Dispatch through Mobility on Demand (MOD) and Mobility as a Service (MaaS)

VTrans has procured and distributed Transit CAD to the transit providers throughout the state. Transit CAD is a software that connects transit routes, schedules, trips, and vehicles assignments in one system to allow dispatchers more insight and control over the transit fleet. Transit CAD provides dispatchers the ability to dispatch transit vehicles more efficiently, maintain a better service, and respond to disruptions such as a vehicle breakdown, road closure, or traffic incident. Transit CAD can be used to assist with scheduling demand response or on-demand service. Transit scheduling software utilizes a route optimization module that maximizes the transit vehicle resources and efficiencies using Geo Map technology. Mobility on Demand (MOD) and Mobility as a Service (MaaS) integration with Transit CAD would improve efficiency and expand rider usage and coverage.

MOD, as defined by the USDOT, is an innovative concept where consumers can access mobility, goods, and services on demand by dispatching or using shared mobility, courier services, and public transportation solutions. MaaS is one application of MOD that focuses on integrating trip planning and scheduling, booking and payment, and real-time service updates on one public facing platform or interface.

- **Benefits**
  - Faster response time
  - Better fleet management
  - Better use of time and resources
  - Reduce distance vehicles travel
  - Improve transit service quality and operational efficiency
- **Estimated Cost Strategic Plan**
  - $500,000 – $1,000,000
- **Addresses identified program areas**: Incident Management, Transit
- **Geographic Scope**: Statewide, NE, NW, SE, SW Regions

Regional Demand Response Coordination

Demand Response service can be greatly increased by sharing AVL information for on-demand routing. Transit CAD/AVL systems allow transit agencies to fulfill ride requests within the same day, making transit a much more attractive option for prospective riders. Small urban and rural transit agencies that have deployed these systems have experienced dramatic growth in ridership. This is an especially valuable service in rural areas where regular transit service routes might not be accessible to residents, as several paratransit services can pool resources to reach their customers. This technology consists of paratransit call intake, scheduling and dispatch software systems, AVL, mobile data terminals, mobile communications, and other components. It has been shown to increase the number of riders that can be served with any given number of vehicles.

- **Benefits**
  - Increase range of service
  - Reduce operations cost through shared dispatch and improved routing.
  - Reduce driver paperwork
  - Improve coordination of inter-agency transit connections
- **Estimated Cost**
  - $500,000 to 1M plus $600/vehicle for system deployment; $150/vehicle/year operations and maintenance
- **Addresses identified program areas:** Interagency Coordination, Transit, Standardization, Asset Sharing & Control
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

<u>Complete Trips</u>

The mobility of Vermonters has been a continuous focus of the Go Vermont program and assisting people with their first and last mile connections. Tools like the Go Vermont Trip Planner and Transit App which rely on Vermont GTFX-Flex transit data and AVL system are important mobility tools. But a person's trip does not end when they get off the bus or out of their car. The trip is completed when the person is sitting at their desk, in the waiting room of their doctor's office or at home. Understanding and assisting with the mobility of a person's complete trip can help address even more barriers to mobility. The complete trip would incorporate first mile/last mile, GTFS-Flex, AVL and ITS systems to create expanded mobility knowledge.

- **Benefits**
  - Improved Mobility
  - Better awareness of complete trip
  - Expand awareness of potential resources
- **Estimated Cost**
  - $200,000-500,000 (highly variable, dependent on integration)
- **Addresses identified program areas:** Transit, Public Mobility,
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

<u>Connected Vehicles</u>

One of the most important ITS technologies currently being developed are Connected Vehicles (CV). CV enables communication across vehicle, infrastructure, and devices. CV allows the transfer of crucial transportation information between vehicles, with nearby pedestrians, with the transportation infrastructure and more, creating opportunities for improvements in safety, mobility, and the environment. CV technology focuses on improving safety through incident prevention by providing warnings to the user of imminent crash situations or deteriorating/dangerous driving conditions. Through data generation on how, when, and where vehicles are traveling, both real-time and historic, CV technology can improve mobility through more efficient travel planning and alternate route usage and increasing the reliability and usability of transit and carpooling. CV technology also has an environmental benefit by reducing idling times and decreasing emissions through signal optimizing and reducing congestion. VTrans has participated in a series of discussions with Maine and New Hampshire for a regional Tri-State Concept of Operations for the US DOT Pilot Deployment of Connected Vehicle Road Weather Application Solicitation. University of Vermont is researching CV technology and its application in the region. Further research will allow public and private entities understand the possible benefits of this application and accelerate its deployment.

- **Benefits**
  - Increased safety and incident prevention
  - Increased mobility for all users including populations that can't currently drive
  - Reduced travel costs
  - Reduced emissions
- **Estimated Cost**
  - TBD
- **Addresses identified program areas**: Traveler Information, Traffic Management, Incident Management, Data Management, Transportation Safety, Improved Communications, Performance Measures, Construction & Maintenance, Transit
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

Upgrade Land Mobile Radio (LMR) Architecture to Digital System

Due to deficiencies in the Agency's current tactical VHF/UHF communications, the existing land mobile radio (LMR) architecture should be replaced with a digital system that is P25 Standards compliant. The system is used during steady state mission execution and emergency response. Upgrading the architecture to address existing deficiencies will ensure a reliable execution and response. Upgrading the system as whole, rather than repairing the existing system, will allow the new system to integrate into a larger framework. The upgraded system will integrate with many data nodes including ITS components such as RWIS, ATMS, and more.

- **Benefits**
  - Improved reliability
  - Higher quality/fidelity voice communications
  - Enhanced safety features
  - Statewide geographic coverage exceeding current capability
- **Estimated Cost**
  - the cost for requisite engineering work to replace the equipment $15-20 million
  - the cost to replace the existing equipment $8-11 million
  - $250,000 per year (annual estimate)
- **Addresses identified program areas:** Traffic Management, Incident Management, Improved Communications, Data Management, Transit, Standardization, Asset Sharing & Control
- **Geographic Scope:** Statewide, NE, NW, SE, SW Regions

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Appendix E

ITS Devices and Equipment Maintenance and Installation Priorities

VTrans Traffic Signal Statewide Rankings

June 2021 Ranking Snapshot (Attached)

Updated Ranking Snapshot (Linked)

VTrans Traffic Signal Assets

MS #	INTERSECTION	TOWN	STRUCTURE INSTALL YEAR	MAST ARMS	NEMA TS2	CONTROLLER	AADT	2014 HCL	Infrastructure Risk Grade	Statewide Ranking
MS 541	VT 15 & CAMP JOHNSON	COLCHESTER	1985	N	N	Econolite ASC/2S-2100	25100	0	19	1
MS 531	US 7 & I-89 EXIT 16 NB RAMPS	COLCHESTER	1993	N	N	Econolite Cobalt	21150	Y	19	2
MS 520	US 7 & BREWER PKWY	SO. BURLINGTON	1971	N	N	Econolite Cobalt	32400	0	18	3
MS 521	US 7 & QUEEN CITY PKWY	SO. BURLINGTON	1989	N	N	Econolite Cobalt	32250	0	18	4
MS 522	US 7 & SWIFT ST	SO. BURLINGTON	1989	N	N	Econolite Cobalt	32100	0	18	5
MS 519	US 7 & BALDWIN AVE	SO. BURLINGTON	1971	N	N	Econolite ASC/3-2100	31900	0	18	6
MS 518	US 7 & MCINTOSH AVE	SO. BURLINGTON	1993	N	N	Econolite ASC/3-2100	31400	0	18	7
MS 540	VT 15 & ST MIKE'S EAST	COLCHESTER	1985	N	N	Econolite ASC/3-2100	25100	0	18	8
MS 542	VT 15 & FORT ETHAN ALLEN	COLCHESTER	1995	N	N	Econolite ASC/3-2100	25000	0	18	9
MS 308	US 7 & COLD RIVER RD	RUTLAND TOWN	1993	N	N	Econolite ASC/3-2100	24950	0	18	10
MS 539	VT 15 & LIME KILN RD	COLCHESTER	1985	N	N	Econolite ASC/3-2100	24000	0	18	11
MS 538	VT 15 & ST MIKE'S WEST	COLCHESTER	1988	N	N	Econolite ASC/3-2100	22900	0	18	12
MS 313	US 7 & HOLIDAY INN	RUTLAND TOWN	1995	N	N	Econolite ASC/3-2100	20300	0	18	13
MS 551	VT 15 & SUSIE WILSON RD	ESSEX TOWN	1993	N	N	Econolite Cobalt	19450	Y	18	14
MS 306	US 7 & US 4	RUTLAND TOWN	1995	N	N	Econolite ASC/3-2100	17650	Y	18	15
MS 569	VT 2A & INDUSTRIAL AVE	WILLISTON	1995	N	N	Econolite ASC/3-2100	15650	Y	18	16
MS 202	US 5 & BRATTLEBORO NO. SHOP. CTR.	BRATTLEBORO	1990	N	N	Naztec 980	15100	0	18	17
MS 203	US 5 & BLACK MTN RD	BRATTLEBORO	1990	N	N	Naztec 980	15100	0	18	18
MS 590	VT 2A & MILL POND RD	COLCHESTER	1991	N	N	Econolite ASC-8000	10300	Y	18	19
MS 534	US 7 & MOUNTAIN VIEW DR	COLCHESTER	1993	N	N	Econolite Cobalt	18650	0	17	20
MS 530	US 7 & I-89 EXIT 16 SB RAMPS	COLCHESTER	1993	N	N	Econolite Cobalt	17650	0	17	21
MS 529	US 7 & SO PARK DR	COLCHESTER	1993	N	N	Econolite ASC/3-2100	15700	0	17	22
MS 532	US 7 & RATHE RD	COLCHESTER	1993	N	N	Econolite ASC/3-2100	15200	0	17	23
MS 566	US 2 & INDUSTRIAL AVE	WILLISTON	1972	N	N	Econolite Cobalt	14700	Y	17	24
MS 505	US 7 & BOSTWICK RD	SHELBURNE	1992	N	N	Naztec 980	13250	0	17	25
MS 411	VT 10A & I-91 EXIT 13 SB RAMPS	NORWICH	1995	N	N	Econolite Cobalt	12300	Y	17	26
MS 405	US 4 & BRIDGE ST/PINE ST	HARTFORD	1968	N	N	Econolite ASC/2-2100	11200	0	17	27
MS 802	US 7 & PRICE CHOPPER	ST. ALBANS	1998	N	N	Econolite ASC/2-2100	15900	0	16	28
MS 201	US 5 & FAIRFIELD PLAZA	BRATTLEBORO	1990	N	Y	Naztec 981	15100	0	16	29
MS 410	VT 10A & I-91 EXIT 13 NB RAMPS	NORWICH	1995	N	N	Econolite Cobalt	13600	0	16	30
MS 537	US 7 & US 2	COLCHESTER	1995	N	N	Econolite Cobalt	12500	0	16	31

MS #	INTERSECTION	TOWN	STRUCTURE INSTALL YEAR	MAST ARMS	NEMA TS2	CONTROLLER	AADT	2014 HCL	Infrastructure Risk Grade	Statewide Ranking
MS 404	US 5 & US 4 & VT 14	HARTFORD	1968	N	Y	Naztec 980	11400	Y	16	32
MS 608	VT 62 & BERLIN MALL RD	BERLIN	1987	N	N	Econolite ASC/2S-2100	9400	0	16	33
MS 612	VT 62 & BERLIN ST	BARRE CITY	1974	N	N	Econolite ASC-8000	9300	0	16	34
MS 205	US 5 & C&S GROCERS	BRATTLEBORO	1988	N	N	Econolite ASC-8000	7050	0	16	35
MS 318	VT 4A & VT 30	CASTLETON	1985	N	N	Naztec 980	5250	Y	16	36
MS 104	VT 7A & ORCHARD RD	BENNINGTON	1998	N	N	Econolite Cobalt	16400	0	15	37
MS 309	US 7 & POST RD	RUTLAND TOWN	1991	N	Y	Econolite Cobalt	15150	0	15	38
MS 500	US 7 & MIDDLE RD	MIDDLEBURY	1998	N	N	Econolite ASC/2S-2100	14500	0	15	39
MS 536	US 7 & SEVERANCE RD	COLCHESTER	1995	N	Y	Econolite Cobalt	11700	Y	15	40
MS 403	US 5 & NO MAIN ST	HARTFORD	1968	N	N	Econolite Cobalt	7400	0	15	41
MS 100	VT 67A & BENNINGTON ACRES	BENNINGTON	1994	N	N	Econolite Cobalt	6900	0	15	42
MS 704	US 5 & VT 25	BRADFORD	1990	N	N	Econolite ASC/3-2100	4600	0	15	43
MS 524	US 7 & LAUREL HILL RD	SO. BURLINGTON	1996	N	Y	Econolite ASC/3-2100	32400	0	14	44
MS 506	US 7 & HARBOR RD	SHELBURNE	2001	N	N	Econolite ASC/3-2100	15600	Y	14	45
MS 533	US 7 & HERCULES DR	COLCHESTER	1993	N	Y	Econolite Cobalt	14900	0	14	46
MS 305	US 7 & WINDCREST RD	RUTLAND TOWN	1995	N	Y	Econolite Cobalt	14800	0	14	47
MS 102	VT 7A & VT 67A	BENNINGTON	1998	N	N	Econolite Cobalt	13300	0	14	48
MS 601	MONTPELIER ST HWY & NATL LIFE	MONTPELIER	1996	N	N	Econolite ASC/3-2100	12900	0	14	49
MS 303	US 7 & NO. SHREWSBURY RD	CLARENDON	1993	N	Y	Econolite ASC/3-2100	12750	0	14	50
MS 310	US 4 BUS & VT 3	CENTER RUTLAND	1981	N	Y	Econolite Cobalt	11400	0	14	51
MS 607	VT 62 & PAINE TPKE	BERLIN	1997	N	N	Econolite Cobalt	11300	0	14	52
MS 312	US 4 & RR CROSSING	RUTLAND TOWN	1995	Y	N	Econolite KMC 400	10600	0	14	53
MS 620	VT 15 & VT 100	MORRISTOWN	1993	N	Y	Econolite ASC/3-2100	9700	Y	14	54
MS 210	US 5 & VT 131	WEATHERSFIELD	1992	N	Y	Econolite ASC/3-2100	9300	Y	14	55
MS 118	VT 9 & VT 100	WILMINGTON	1993	N	Y	Econolite Cobalt	8600	Y	14	56
MS 615	VT 14 & VT 63	BARRE TOWN	1982	N	Y	Econolite Cobalt	8250	Y	14	57
MS 576	US 2 & BRIDGE ST	RICHMOND	1997	N	N	Econolite ASC/3-2100	6350	Y	14	58
MS 710	US 5 & BACK CENTER RD	LYNDON	2005	N	N	Econolite ASC/2S-2100	12400	0	13	59
MS 701	US 5 & I-91 ACCESS RD	ST. JOHNSBURY	1993	N	Y	Econolite Cobalt	6650	0	13	60
MS 901	VT 191 & WESTERN AVE	NEWPORT	1994	N	Y	Econolite Cobalt	5750	0	13	61
MS 813	VT 104 & ST. ALBANS ST. HWY	ST. ALBANS	2002	N	Y	Econolite Cobalt	18000	Y	12	62

VTrans Traffic Signal Assets

MS #	INTERSECTION	TOWN	STRUCTURE INSTALL YEAR	MAST ARMS	NEMA TS2	CONTROLLER	AADT	2014 HCL	Infrastructure Risk Grade	Statewide Ranking
MS 501	US 7 & SHOPPING CTR	MIDDLEBURY	1998	N	Y	Econolite ASC/3-2100	13350	0	12	63
MS 801	US 7 & MILTON SQ	MILTON	1997	N	Y	Econolite ASC/3-2100	12200	0	12	64
MS 101A	VT 67A & VT 279 EB RAMPS	BENNINGTON	2002	N	N	Econolite Cobalt	11000	0	12	65
MS 311	US 4 & HOME DEPOT	RUTLAND TOWN	2001	N	Y	Econolite ASC/2S-2100	14200	0	11	66
MS 604	US 302 & VT SHOPPING CTR	BERLIN	2001	N	Y	Econolite ASC/2S-2100	13400	0	11	67
MS 603	US 302 & BERLIN ST. HWY	BERLIN	2001	N	Y	Econolite ASC/2S-2100	13300	0	11	68
MS 106	US 7 & KOCHER DR	BENNINGTON	1973	Y	Y	Econolite ASC/3-2100	13200	0	11	69
MS 605	US 302 & MCDONALD'S	BERLIN	2001	N	Y	Econolite ASC/2S-2100	13150	0	11	70
MS 606	US 302 & PRICE CHOPPER	BERLIN	2001	N	Y	Econolite ASC/2S-2100	12000	0	11	71
MS 502	US 7 & VT 22A	FERRISBURGH	1996	N	Y	Econolite ASC/3-2100	9550	0	11	72
MS 101	VT 67A & VT 279 WB RAMPS	BENNINGTON	2001	N	N	Econolite Cobalt	9100	0	11	73
MS 572	VT 2A & MARSHALL AVE	WILLISTON	2001	Y	Y	Econolite Cobalt	22050	Y	10	74
MS 105	VT 7A & BENMONT AVE	BENNINGTON	1998	Y	Y	Econolite Cobalt	16400	0	10	75
MS 715	US 5 & VT 114 & VT 122	LYNDON	2005	N	Y	Econolite ASC/2S-2100	8100	0	10	76
MS 517	US 7 & IDX DR	SO. BURLINGTON	2005	Y	Y	Econolite Cobalt	31500	0	9	77
MS 516	US 7 & BARTLETT BAY RD	SO. BURLINGTON	2005	Y	Y	Econolite Cobalt	28750	0	9	78
MS 514	US 7 & HARBORVIEW RD	SO. BURLINGTON	2005	Y	Y	Econolite Cobalt	27000	0	9	79
MS 515	US 7 & ALLEN RD	SO. BURLINGTON	2005	Y	Y	Econolite Cobalt	26050	0	9	80
MS 509	US 7 & PINE HAVEN SHORES	SHELBURNE	2005	Y	Y	Econolite Cobalt	25100	0	9	81
MS 513	US 7 & MARTINDALE RD	SHELBURNE	2005	Y	Y	Econolite Cobalt	25100	0	9	82
MS 512	US 7 & HULLCREST RD	SHELBURNE	2005	Y	Y	Econolite Cobalt	24450	0	9	83
MS 571	VT 2A & I-89 EXIT 12 NB RAMPS	WILLISTON	2002	Y	Y	Econolite Cobalt	23000	0	9	84
MS 508	US 7 & BAY RD	SHELBURNE	2005	Y	Y	Econolite Cobalt	20500	0	9	85
MS 803	US 7 & HIGHGATE SHOPPING CTR	ST. ALBANS	2004	Y	Y	Econolite ASC/2S-2100	16300	0	9	86
MS 568	US 2 & VT 2A	WILLISTON	2002	Y	Y	Econolite Cobalt	15300	Y	9	87
MS 301	US 7 & VT 140	WALLINGFORD	2003	N	Y	Econolite ASC/2S-2100	6150	0	9	88
MS 702	US 5 & GREEN MTN MALL	ST. JOHNSBURY	2003	N	Y	Econolite ASC/2S-2100	4600	0	9	89
MS 573	VT 2A & CONNER WAY	WILLISTON	2001	Y	Y	Econolite Cobalt	17400	0	8	90
MS 511	US 7 & WEBSTER RD	SHELBURNE	2005	Y	Y	Econolite Cobalt	17200	0	8	91
MS 559	VT 15 & OLD STAGE RD	ESSEX TOWN	2004	Y	Y	Econolite Cobalt	15350	0	8	92
MS 828	US 2 & I-89 EXIT 17 NB RAMPS	COLCHESTER	2004	Y	Y	Econolite Cobalt	14400	Y	8	93

MS #	INTERSECTION	TOWN	STRUCTURE INSTALL YEAR	MAST ARMS	NEMA TS2	CONTROLLER	AADT	2014 HCL	Infrastructure Risk Grade	Statewide Ranking
MS 829	US 2 & I-89 EXIT 17 SB RAMPS	COLCHESTER	2004	Y	Y	Econolite Cobalt	13900	Y	8	94
MS 504	US 7 & MONKTON RD	FERRISBURGH	2002	Y	N	Econolite ASC/3-2100	7750	0	8	95
MS 406A	HIGHLAND AVE & HIGH SCHOOL	HARTFORD	2008	N	Y	Naztec 980	4000	0	8	96
MS 570	VT 2A & I-89 EXIT 12 SB RAMPS	WILLISTON	2002	Y	Y	Econolite Cobalt	13850	0	7	97
MS 578	US 2 & SIMONS	WILLISTON	2001	Y	Y	Econolite Cobalt	12450	0	7	98
MS 577	US 2 & SHAWS	WILLISTON	2001	Y	Y	Econolite Cobalt	10600	0	7	99
MS 810	VT 104 & VT 105	ST. ALBANS	2001	Y	Y	Econolite ASC/2S-2100	5100	0	7	100
MS 507	US 7 & LONGMEADOW RD	SHELBURNE	2006	Y	Y	Econolite Cobalt	17200	0	6	101
MS 640	VT 100 & SHAWS	WATERBURY	2006	Y	Y	Econolite Cobalt	15000	0	6	102
MS 523	VT 116 & KENNEDY DR	SO. BURLINGTON	2007	Y	Y	Econolite ASC/2S-2100	14260	0	6	103
MS 408	VT 10A & RIVER RD	NORWICH	2006	Y	Y	Econolite ASC/2S-2100	14200	0	6	104
MS 820	VT 78 & ROBIN HOOD DR	SWANTON	2007	Y	Y	Econolite ASC/2S-2100	10600	0	6	105
MS 302	US 7 & VT 103	CLARENDON	2005	Y	Y	Econolite ASC/3-2100	9650	0	6	106
MS 632	US 2 & VT 100	MORETOWN	2015	N	Y	Naztec 980	5750	0	6	107
MS 543	VT 15 & FANNY ALLEN HAWK	COLCHESTER	2013	Y	Y	Econolite ASC/3-2100	25100	0	5	108
MS 550	VT 15 & ETHAN ALLEN AVE	ESSEX TOWN	2011	Y	Y	Econolite ASC/3-2100	24100	0	5	109
MS 558	VT 15 & VT 128	ESSEX TOWN	2007	Y	Y	Econolite Cobalt	14350	0	5	110
MS 579	VT 2A & ZEPHYR RD	WILLISTON	2006	Y	Y	Econolite Cobalt	13200	0	5	111
MS 581	US 2 & TALCOTT RD	WILLISTON	2007	Y	Y	Econolite Cobalt	12850	0	5	112
MS 636	VT 100 & I-89 EXIT 10 SB RAMPS	WATERBURY	2008	Y	Y	Econolite ASC/3-2100	10900	0	5	113
MS 906	US 5 & QUARRY RD	DERBY	2010	Y	Y	Econolite ASC/3-2100	10400	0	5	114
MS 575	VT 116 & CHARLOTTE RD	HINESBURG	2008	Y	Y	Econolite ASC/3-2100	10350	0	5	115
MS 648	US 2 & VT 14 NORTH	E. MONTPELIER	2010	Y	Y	Econolite Cobalt	10050	0	5	116
MS 910	US 5 & SHATTUCK RD	DERBY	2006	Y	Y	Econolite ASC/2S-2100	10000	0	5	117
MS 406	US 5 & WORCESTER AVE	HARTFORD	2008	Y	Y	Naztec 981	7500	0	5	118
MS 806	US 7 & SEYMOUR RD	ST. ALBANS	2013	Y	Y	Econolite ASC/3-2100	15300	0	4	119
MS 609	VT 62 & FISHER RD	BERLIN	2015	Y	Y	Econolite Cobalt	13200	Y	4	120
MS 804	US 7 & VT 207	ST. ALBANS	2013	Y	Y	Econolite ASC/3-2100	12600	Y	4	121
MS 623	VT 100 & NORTHGATE PLAZA	MORRISTOWN	2011	Y	Y	Naztec 980	11600	0	4	122
MS 585	VT 116 & COMMERCE ST	HINESBURG	2008	Y	Y	Econolite Cobalt	8600	0	4	123
MS 811	VT 104 & VT 36	ST. ALBANS	2008	Y	Y	Econolite ASC/3-2100	8450	0	4	124

VTrans Traffic Signal Assets

MS #	INTERSECTION	TOWN	STRUCTURE INSTALL YEAR	MAST ARMS	NEMA TS2	CONTROLLER	AADT	2014 HCL	Infrastructure Risk Grade	Statewide Ranking
MS 107	VT 9 & VT 279	BENNINGTON	2008	Y	Y	Econolite Cobalt	5500	0	4	125
MS 307	US 7 & SEWARD RD	RUTLAND TOWN	2017	Y	Y	Econolite Cobalt	21900	0	3	126
MS 800	US 7 & CENTRE DR	MILTON	2013	Y	Y	Econolite ASC/3-2100	13300	0	3	127
MS 637	VT 100 & I-89 EXIT 10 NB RAMPS	WATERBURY	2014	Y	Y	Econolite ASC/3-2100	12900	0	3	128
MS 596	VT 2A & JAMES BROWN DR	WILLISTON	2019	Y	Y	Econolite Cobalt	18100	0	2	129
MS 555	VT 15 & BILLY BUTLER DR	ESSEX TOWN	2018	Y	Y	Econolite Cobalt	16400	0	2	130
MS 638	VT 100 & BLUSH HILL	WATERBURY	2019	Y	Y	Econolite Cobalt	15000	0	2	131
MS 503	US 7 & VT F5	CHARLOTTE	2019	Y	Y	Econolite Cobalt	11600	Y	2	132
MS 621	VT 100 ATR & BRIDGE ST	MORRISTOWN	2014	Y	Y	Econolite ASC/3-2100	9200	0	2	133
MS 582	VT 117 & SAND HILL RD	ESSEX TOWN	2013	Y	Y	Econolite ASC/3-2100	8950	0	2	134
MS 584	US 2 & I-89 EXIT 11 SB RAMPS	RICHMOND	2014	Y	Y	Econolite ASC/3-2100	7250	0	2	135
MS 821	VT 207 & I-89 EXIT 20 NB RAMPS	ST. ALBANS	2013	Y	Y	Econolite ASC/3-2100	7150	0	2	136
MS 805	US 7 & WAL-MART	ST. ALBANS	2013	Y	Y	Econolite ASC/3-2100	7000	0	2	137
MS 714	US 2 & PEACHAM RD	DANVILLE	2014	Y	Y	Econolite ASC/3-2100	6250	0	2	138
MS 580	US 2 & VT 117	RICHMOND	2014	Y	Y	Econolite ASC/3-2100	5850	0	2	139
MS 556	VT 15 & ESSEX WAY	ESSEX TOWN	2018	Y	Y	Econolite Cobalt	14300	0	1	140
MS 557	VT 15 & PRICE CHOPPER	ESSEX TOWN	2018	Y	Y	Econolite Cobalt	14300	0	1	141
MS 553	VT 15 & VT 289 EB RAMPS	ESSEX TOWN	2018	Y	Y	Econolite Cobalt	13900	0	1	142
MS 554	VT 15 & VT 289 WB RAMPS	ESSEX TOWN	2018	Y	Y	Econolite Cobalt	13900	0	1	143
MS 563	VT 2A & VT 289 WB RAMP	ESSEX TOWN	2018	Y	Y	Econolite ASC/3-2100	13200	0	1	144
MS 647	US 2 & VT 14 SOUTH	E. MONTPELIER	2018	Y	Y	Econolite Cobalt	13200	0	1	145
MS 711	US 5 & RED VILLAGE RD	LYNDON	2017	Y	Y	Econolite Cobalt	12400	0	1	146
MS 510	US 7 & LITTLE CHICAGO RD	FERRISBURGH	2016	Y	Y	Econolite ASC/3-2100	12300	0	1	147
MS 565	US 2 & HARVEST LANE	WILLISTON	2018	Y	Y	Econolite Cobalt	12300	0	1	148
MS 591	US 7 & CREEK FARM RD	COLCHESTER	2018	Y	Y	Econolite Cobalt	11600	0	1	149
MS 567	US 2 & BROWNELL RD	WILLISTON	2018	Y	Y	Econolite Cobalt	11500	0	1	150
MS 642	VT 100 & GUPTIL RD	WATERBURY	2019	Y	Y	Econolite Cobalt	11200	0	1	151
MS 562	VT 2A & SUSIE WILSON RD	ESSEX TOWN	2018	Y	Y	Econolite ASC/3-2100	11000	0	1	152
MS 316	US 4 BUS & VT 4A	WEST RUTLAND	2020	Y	Y	Econolite Cobalt	10000	0	1	153
MS 574	VT 116 & CVU RD	HINESBURG	2021	Y	N	Econolite ASC/3-2100	8550	Y	1	154
MS 904	US 5 & I-91 NB RAMPS	DERBY	2016	Y	Y	Econolite ASC/3-2100	9600	0	0	155

VTrans Traffic Signal Assets

MS #	INTERSECTION	TOWN	STRUCTURE INSTALL YEAR	MAST ARMS	NEMA TS2	CONTROLLER	AADT	2014 HCL	Infrastructure Risk Grade	Statewide Ranking
MS 208	US 5 & VT 11 & HOLIDAY INN	SPRINGFIELD	2019	Y	Y	Econolite ASC/3-2101	9400	0	0	156
MS 597	VT 15 & BROWNS TRACE	JERICHO	2018	Y	Y	Econolite Cobalt	9200	0	0	157
MS 622	VT 100 ATR & VT 100/BJAMS	MORRISTOWN	2016	Y	Y	Econolite Cobalt	9200	0	0	158
MS 320	VT 103 & VT 100	LUDLOW	2018	Y	Y	Econolite Cobalt	8700	0	0	159
MS 592	US 7 & BAY RD	COLCHESTER	2017	Y	Y	Econolite Cobalt	7850	0	0	160
MS 564	VT 117 & VT 289 EB RAMP	ESSEX TOWN	2019	Y	Y	Econolite Cobalt	7000	0	0	161

VTrans Road Weather Information System Station Rankings

June 2021 Ranking Snapshot (Attached)

Updated Ranking Snapshot (Linked)

VTrans Road Weather Information System Station Assets

Location_ID	Community	Route			Latitude	Longitude	Status	Priority Ranking	Repair, Replace	Notes:
122	ALBURGH ITS PLATFORM	VT-78	West	WEST END OF MISSISQUOI BAY BRIDGE	44975151	-73227072	Device Online			
123	BENNINGTON RWIS	US-7	North	ROUTE 7 WELCOME CENTER	42905120	-73202990	Device Online			
124	BERLIN RWIS	I-89	South	BERLIN .2 MILES SOUTH OF EXIT 7	44212320	-72583380	Device Online			
125	BETHEL RWIS	I-89	North	BETHEL NXT TO CHRISTEN HILL OVERPASS	43852230	-72603450	Device Offline			
126	BOLTON RWIS	I-89	South	BETWEEN BOLTON FLATS NEAR EMERGENCY EXIT	44379480	-72911910	Device Online			
127	BRANDON RWIS	US-7	North	ACROSS ROUTE 7 FROM OTTER VALLY HIGH SCHOOL	43767237	-73050150	Device Offline			
128	BROOKFIELD GUARDIAN	I-89	North	1/2 MILE SOUTH OF THE BROOKFILD RWIS	44042817	-72609457	Device Online			
129	BROOKFIELD RWIS	I-89	North	NEXT TO EMERGENCY EXIT GATE	44065345	-72606547	Device Online			
130	CABOT RWIS	US-2	East	NEXT TO MOLLY'S FALLS POND	44366367	-72287198	Device Online			
131	DERBY RWIS	I-91	South	1 MILE SOUTH OF CANADIAN BORDER	44975052	-72126381	Device Online			
132	FAIR HAVEN RWIS	US-4	East	FAIRHAVEN WELCOME CENTER LAWN	43586410	-73292899	Device Offline			
133	GEORGIA RWIS	I-89	South	SOUTH BOUND REST AREA LAWN	44747065	-73078415	Device Online			
134	GUILFORD RWIS	I-91	North	WELCOME CENTER LAWN	42812763	-72567547	Device Online			
135	HARTFORD RWIS	I-91	North	CLOSED NORTH BOUND REST AREA	43621587	-72345750	Device Online			
136	JAY RWIS	VT-105	West	LONGTRAIL PARKING LOT	44986390	-72504420	Device Online			
137	MENDON RWIS	US-4	East	MENDON AOT GARAGE YARD	43659444	-72868754	Device Online			
138	MILTON RWIS	I-89	North	.1 MILES SOUTH OF THE WEST MILTO OVERPASS	44629548	-73147800	Device Online			
139	MOUNT HOLLY RWIS	VT-103	East	ROUTE 103 MM 4.1 EAST BOUND PULL OFF	43451590	-72786690	Device Offline			
140	NEWBURY RWIS	I-91	South	.2 MILE SOUTH OF ROUTE 302 OVERPASS	44156890	-72091768	Device Online			
141	SHEFFIELD RWIS-1	I-91	North	I91 MEDIAN IN UTURN	44638905	-72130753	Device Offline			
142	ST.JOHNSBURY RWIS	I-91	South	.2 MILES NORTH OF I-93 INTRCHANGE	44402200	-72021460	Device Online			
143	THETFORD RWIS	I-91	North	.1 NORTH OF ROUTE 113 OVERPASS	43813148	-72215439	Device Online			
144	WEATHERSFIELD RWIS	I-91	South	NEXT EXIT 8 SOUTH BOUND ON RAMP	43402698	-72414582	Device Online			
145	WESTMINSTER RWIS	I-91	South	SOUTH BOUND REST AREA LAWN	43033980	-72472530	Device Online			
146	WILLISTON RWIS	I-89	North	AT THE INTERSECTION OF ROUTE 11 and 30	44433885	-73062877	Device Online			
147	WINHALL RWIS	VT-11	West	AT THE INTERSECTION OF ROUTE 11 and 30	43205520	-72959970	Device Online			
148	WOODFORD RWIS	VT-9	East	MM 1.6 EAST BOUND PULL OFF	42877990	-73094390	Device Online			
149	BUELS GORE	VT-17	East	TOP OF APPALACHIAN GAP	44209618	-72930035	Device Online			
150	CLARENDON ITS PLATFORM	US-7	North	100 YARDS SOUTH OF BUMP ROAD	43510494	-72967163	Device Online			
151	FAIR HAVEN ITS PLATFORM	VT-22A	North	1/4 MILE NORTH OF US-4	43608131	-73280273	Device Online			
152	HARTFORD ITS PLATFORM	I-89	South	I-89 MILE MARKER 3.25 SB	43662454	-72374182	Device Online			
567	MILTON BRIDGE RWIS	I-89	North	I-89 MILTON BRIDGE	44638120	-73140010	Device Online			
568	COLCHESTER RWIS	I-89	South	I-89 SB COLCHESTER	44554777	-73184730	Device Online			
569	WATERBURY RWIS	I-89	North	I-89 WATERBURY	44316230	-72720530	Device Online			
570	BRATTLEBORO BRIDGE RWIS	I-91	South	I-91 SB BRATTLEBORO BRIDGE	42873690	-72572250	Device Online			
571	MENDON MOUNTAIN RWIS	US-4	East	US-4 EB MENDON MOUNTAIN	43664080	-72830900	Device Online			
572	WILDER RWIS	I-91	South	I-91 SB WILDER	43682850	-72315380	Device Online			
573	MIDDLESEX RWIS	I-89	North	I-89 NB MIDDLESEX	44273310	-72639890	Device Online			
596	TOPSHAM RWIS	US-302	West	TOPSHAM ROUTE 302 WEST BOUND SHOULDER	44176511	-72300608	Device Online			
597	WESTMORE RWIS	VT-5A	North	WESTMORE ROUTE 5A NORTH BOUND SHOULDER	44716117	-72030289	Device Online			
609	WESTFIELD RWIS	VT-242	North	WESTFIELD ROUTE 242 NORTH BOUND SHOULDER	44912520	-72504290	Device Online			

VTrans Weigh In Motion Station Rankings

June 2021 Ranking Snapshot (Attached)

Updated Ranking Snapshot (Linked)

VTrans Weigh In Motion Station Assets

OID_	Location_ID	Community	Route	Rural_Urban	AADT2018	Priority Ranking	Full Weigh or Historic Data	Safe Pull Off Location?	Simple equipment upgrade or heavier lift?	How is data currently exported or viewed?	A/C Power
18	X073	PUTNEY	I91	R	11800	1	full	yes- both directions	upgrade	FHWA Reporting & MEPDG Data Facilitating	Yes
8	E020	CONCORD	US2	R	2700	2	full	yes- both directions	upgrade	FHWA Reporting & MEPDG Data Facilitating	Yes
21	Y117	BRIDGEWATER	US4	R	4100	3	full	yes- both directions	upgrade	FHWA Reporting & MEPDG Data Facilitating	Yes
14	R001	FAIR HAVEN	US4	R	0	4	full	yes- WB is priority	upgrade	FHWA Reporting & MEPDG Data Facilitating	Yes
5	C015	WATERFORD	I93	R	6900	5	full	yes- NB	upgrade	FHWA Reporting & MEPDG Data Facilitating	Yes
6	D092	COLCHESTER	I89	U	32600	6	full	yes- both directions	upgrade	FHWA Reporting & MEPDG Data Facilitating	Yes
7	D132	CHARLOTTE	US7	R	11200	7	full	yes- both directions	upgrade	FHWA Reporting & MEPDG Data Facilitating	Yes
12	N001	FAIRLEE	I91	R	10200	8	full	yes- NB is priority	upgrade	FHWA Reporting & MEPDG Data Facilitating	Yes
13	P082	DERBY	I91	R	3200	9	full	yes- both directions	upgrade	FHWA Reporting & MEPDG Data Facilitating	Solar
2	A111	ADDISON	VT22A	R	5100	10	full	No	heavier lift	FHWA Reporting & MEPDG Data Facilitating	Yes
16	X009	MARLBORO	VT9	R	4900	11	full	No	heavier lift	FHWA Reporting & MEPDG Data Facilitating	Yes
3	B282	SHAFTSBURY	US7	R	7800	12	full	yes	upgrade	FHWA Reporting & MEPDG Data Facilitating	Yes
19	X249	ROCKINGHAM	VT103	R	6400	13	full	no	heavier lift	FHWA Reporting & MEPDG Data Facilitating	Yes
4	B379	BENNINGTON	VT279	R	7600	14	full	yes	heavier lift	FHWA Reporting & MEPDG Data Facilitating	Yes
17	X071	VERNON	I91	R	18300	15	full	yes	upgrade	FHWA Reporting & MEPDG Data Facilitating	Solar
20	Y085	HARTFORD	I89	U	26000	16	full	no	heavier lift	FHWA Reporting & MEPDG Data Facilitating	Solar
15	W088	MIDDLESEX	I89	R	25200	17	full	no	heavier lift	FHWA Reporting & MEPDG Data Facilitating	Yes
10	G118	ALBURGH	US2	R	4700	18	full	no	heavier lift	FHWA Reporting & MEPDG Data Facilitating	Yes
9	G005	SOUTH HERO	US2	R	8400	19	full	no	heavier lift	FHWA Reporting & MEPDG Data Facilitating	Yes
1	A041	NEW HAVEN	US7	R	6900	20	full	no	heavier lift	FHWA Reporting & MEPDG Data Facilitating	Yes
11	L203	MORRISTOWN	VTA100	R	8800	21	full	no	heavier lift	FHWA Reporting & MEPDG Data Facilitating	Solar

VTrans Changeable Message Sign (Fixed and Portable) Rankings

June 2021 Ranking Snapshot (Attached)

Updated Ranking Snapshot (Linked)

VTrans Changeable Message Sign (Fixed and Portable) Assets

Location_ID	Community	District	Route		MM	Border Location	Fixed or Portable	Priority Ranking	Repair, Replace	Notes:
21454	HIGHGATE	8	I-89	SB	0.00	Y	PORTABLE			
101063	HARTFORD	4	I-89	SB	3.25	N	FIXED			
24723	HARTLAND	4	VT-12	NB	0.00	N	PORTABLE			
27742	ROYALTON	4	I-89	NB	0.00	N	PORTABLE			
19641	SHARON	4	I-89	NB	12.15	N	PORTABLE			
19645	SHARON	4	I-89	SB	15.60	N	PORTABLE			
22282	ROYALTON	4	I-89	SB	20.15	N	PORTABLE			
22297	ROYALTON	4	I-89	NB	20.40	N	PORTABLE			
21806	BROOKFIELD	6	I-89	NB	37.00	N	FIXED			
19638	BERLIN	6	I-89	SB	47.40	N	PORTABLE			
24687	BERLIN	6	I-89	NB	48.45	N	PORTABLE			
19648	MIDDLESEX	6	I-89	SB	54.40	N	PORTABLE			
68390	MIDDLESEX	6	I-89	NB	55.75	N	FIXED			
34535	WATERBURY	6	I-89	NB	61.20	N	FIXED			
24763	WATERBURY	6	I-89	SB	0.00	N	PORTABLE			
24721	RICHMOND	5	I-89	SB	73.80	N	PORTABLE			
19643	RICHMOND	5	I-89	NB	77.20	N	PORTABLE			
34534	WILLISTON	5	I-89	NB	81.35	N	FIXED			
68389	WILLISTON	5	I-89	SB	81.35	N	FIXED			
24688	SOUTH BURLINGTON	5	I-89	SB	86.25	N	PORTABLE			
22299	COLCHESTER	5	I-89	NB	95.00	N	PORTABLE			
34533	COLCHESTER	5	I-89	SB	95.35	N	FIXED			
22286	COLCHESTER	5	I-89	NB	96.90	N	PORTABLE			
24720	MILTON	5	I-89	SB	102.40	N	PORTABLE			
19646	GEORGIA	8	I-89	SB	111.20	N	PORTABLE			
24725	COVENTRY	9	I-91	NB	166.55	N	PORTABLE			
68391	HARTFORD	4	I-91	SB	73.00	N	FIXED			
19637	GUILFORD	2	I-91	NB	0.55	Y	PORTABLE			
22292	DUMMERSTON	2	I-91	NB	16.20	N	PORTABLE			
24001	WESTMINSTER	2	I-91	SB	23.60	N	PORTABLE			
22293	NEWBURY	7	I-91	NB	107.25	N	PORTABLE			
22288	ST JOHNSBURY	7	I-91	NB	128.50	N	PORTABLE			

VTrans Changeable Message Sign (Fixed and Portable) Assets

Location_ID	Community	District	Route		MM	Border Location	Fixed or Portable	Priority Ranking	Repair, Replace	Notes:
22289	ST JOHNSBURY	7	I-91	SB	132.70	N	PORTABLE			
19666	LYNDON	7	I-91	NB	138.85	N	PORTABLE			
22294	BARTON	9	I-91	SB	158.80	N	PORTABLE			
19662	DERBY	9	I-91	SB	176.10	N	PORTABLE			
19644	WATERFORD	7	I-93	NB	0.00	Y	FIXED			
22291	RYEGATE	7	I-91	SB	113.50	N	PORTABLE			
27735	HARTFORD	4			0.00	N	PORTABLE			
62312	CLARENDON	3	US-7	NB	1.10	N	FIXED			
24722	WOODFORD	1	VT-9	WB	0.00	N	PORTABLE			
19639	FERRISBURGH	5	US-7	SB	6.74	N	PORTABLE			
22692	FAIR HAVEN	3	US-4	EB	0.00	N	PORTABLE			
21455	LUDLOW	3	VT-100		3.10	N	PORTABLE			
19640	BERLIN	6	Other		0.00	N	FIXED			
19650	CAMBRIDGE	8	VT-108	EB	2.20	N	PORTABLE			
19649	STOWE	6	VT-108	WB	2.61	N	FIXED			
26966	CAMBRIDGE	8	VT-108	EB	3.30	N	PORTABLE			
26965	STOWE	6	VT-108	WB	7.10	N	PORTABLE			
22296	HARTFORD	4	I-91	NB	0.00	N	PORTABLE			
22298	THETFORD	4	I-91	SB	86.55	N	PORTABLE			
27731	READSBORO	1	VT-100	NB	0.00	N	PORTABLE			
22283	WEATHERSFIELD	2	I-91	NB	48.80	N	PORTABLE			
27747	WILMINGTON	1	VT-9	EB	0.00	N	FIXED			
24724	CASTLETON	3			0.00	N	FIXED			
27745	ADDISON	5	US-7		0.00	N	PORTABLE			
62313	FAIR HAVEN	3	VT-22A	NB	2.75	N	FIXED			
22295	BRADFORD	7	I-91	NB	97.00	N	PORTABLE			
27738	BENNINGTON	1	Other		0.00	N	FIXED			
27739	BENNINGTON	1	Other		0.00	N	FIXED			
No ID	BENNINGTON	1	VT-279	EB	3.35	N	FIXED			
27743	BARRE	7			0.000	N	PORTABLE			
27744	STOWE	6	VT-108			N	PORTABLE			
27746	WELLS	3	VT-31		0.00	Y	PORTABLE			

VTrans Changeable Message Sign (Fixed and Portable) Assets

Location_ID	Community	District	Route		MM	Border Location	Fixed or Portable	Priority Ranking	Repair, Replace	Notes:
22287	MANCHESTER	1	VT-11		0.00	N	PORTABLE			
24719	BENNINGTON	1	US-7	NB	1.70	N	PORTABLE			
24685	HARTLAND	4	VT-12	SB	0.00	Y	PORTABLE			
92456	ALBURGH	8	VT-78	WB	2.95	N	FIXED			
24762	BENNINGTON	1	VT-7A		2.30	N	PORTABLE			
27730	READSBORO	1	Other	NB	0.00	N	PORTABLE			
19665	BRATTLEBORO	2	I-91	SB	12.25	N	PORTABLE			
22284	ROCKINGHAM	2	I-91	NB	32.50	N	PORTABLE			
27732	SEARSBURG	1	VT-9	EB	0.00	N	PORTABLE			
24686	BRATTLEBORO	2	VT-9	WB	4.40	N	PORTABLE			
24718	FAIR HAVEN	3	VT-22A		0.00	Y	PORTABLE			
27733	BENNINGTON	1	US-7	SB	5.71	N	PORTABLE			
27737	COLCHESTER	5	I-89	SB	92.40	N	PORTABLE			
27734	HARTFORD	4			0.00	N	PORTABLE			
22280	POULTNEY	3			0.00	Y	FIXED			
27736	SOUTH BURLINGTON	5	I-89	NB	86.80	N	PORTABLE			
24761	BENNINGTON	1	VT-9	EB	0.00	N	PORTABLE			
NA	WATERFORD	7	I-93	NB	0.50	N	FIXED			
24764	WILMINGTON	1	VT-9	WB	0.00	N	PORTABLE			
	BENNINGTON	1			0.00	N	FIXED			

VTrans CCTV Station Rankings

June 2021 Ranking Snapshot (Attached)

Updated Ranking Snapshot (Linked)

VTrans CCTV Assets

Location_ID	Community	Route	Status	Priority Ranking	Repair, Replace	Notes:
ALBURGH RWIS CCTV	ALBURGH	VT-78 West	Device Online			
BENNINGTON RWIS CCTV	BENNINGTON	US-7 North	Device Online			
BERLIN RWIS CCTV	BERLIN	I-89 South	Device Online			
BETHEL RWIS CCTV	BETHEL	I-89 North	Device Online			
BOLTON RWIS CCTV	BOLTON	I-89 South	Device Online			
BRANDON RWIS CCTV	BRANDON	US-7 North	Device Online			
BROOKFIELD GUARDIAN CCTV	BROOKFIELD	I-89 North	Device Online			
BROOKFIELD RWIS CCTV	BROOKFIELD	I-89 North	Device Online			
CABOT RWIS CCTV	CABOT	US-2 East	Device Online			
DERBY RWIS CCTV	DERBY	I-91 South	Device Online			
FAIR HAVEN RWIS CCTV	FAIR HAVEN	US-4 East	Device Online			
GEORGIA RWIS CCTV	GEORGIA	I-89 South	Device Online			
GUILFORD RWIS CCTV	GUILFORD	I-91 North	Device Online			
HARTFORD RWIS CCTV	HARTFORD	I-91 North	Device Online			
JAY RWIS CCTV	JAY	VT-105 West	Device Online			
MILTON RWIS CCTV	MILTON	I-89 North	Device Online			
MOUNT HOLLY RWIS CCTV	MOUNT HOLLY	VT-103 East	Device Online			
NEWBURY RWIS CCTV	NEWBURY	I-91 South	Device Online			
SHEFFIELD RWIS NB CCTV	SHEFFIELD	I-91 North	Device Online			
SHEFFIELD RWIS SB CCTV	SHEFFIELD	I-91 South	Device Online			
ST.JOHNSBURY RWIS CCTV	ST.JOHNSBURY	I-91 South	Device Online			
THETFORD RWIS CCTV	THETFORD	I-91 North	Device Online			
WEATHERSFIE RWIS CCTV	WEATHERSFIELD	I-91 South	Device Online			
WESTMINSTER RWIS CCTV	WESTMINSTER	I-91 South	Device Online			
WILLISTON RWIS CCTV	WILLISTON	I-89 North	Device Online			
WINHALL RWIS CCTV	WINHALL	VT-11 East	Device Online			
MENDON RWIS CCTV	MENDON	US-4 East	Device Online			
WOODFORD RWIS CCTV	WOODFORD	VT-9 East	Device Online			

VTrans CCTV Assets

Location_ID	Community	Route	Status	Priority Ranking	Repair, Replace	Notes:
BUELS GORE RWIS CCTV	BUELS GORE	VT-17 East	Device Online			
CLARENDON RWIS CCTV	CLARENDON	US-7 North	Device Online			
FAIR HAVEN RWIS CCTV	FAIR HAVEN	VT-22A North	Device Online			
HARTFORD RWIS CCTV	HARTFORD	I-89 South	Device Online			
MIDDLESEX RWIS CCTV	MIDDLESEX	I-89 North	Device Online			
WILDER RWIS CCTV	WILDER	I-91 South	Device Online			
MENDON MOUNTAIN RWIS CCTV	MENDON	US-4 East	Device Online			
BRATTLEBORO BRIDGE RWIS CCTV	BRATTLEBORO	I-91 South	Device Online			
COLCHESTER RWIS CCTV	COLCHESTER	I-89 South	Device Online			
MILTON BRIDGE RWIS CCTV	MILTON	I-89 South	Device Online			
WATERBURY EXIT 10 NB RWIS CCTV	WATERBURY	I-89 North	Device Online			
WATERBURY RWIS CCTV	WATERBURY\	I-89 North	Device Online			
WATERBURY EXIT 10 SB RWIS CCTV	WATERBURY	I-89 South	Device Online			
TOPSHAM RWIS CCTV	TOPSHAM	US-302 West	Device Online			
WESTMORE RWIS CCTV	WESTMORE	VT-5A North	Device Online			
WESTFIELD RWIS CCTV	WESTFIELD	VT-242 North	Device Online			
Stanstead	AUT	I-91 South	Device Online			

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