Accelerated Innovation Deployment (AID) Demonstration Project:

CREATING A BENCHMARK FOR TRAFFIC SIGNAL PERFORMANCE

The New Hampshire Department Of Transportation and City of Dover, New Hampshire

Final Report

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AID Demo
Accelerated Innovation Deployment

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Table of Contents

Executive Summary

This Project showcases a number of innovative technologies to produce Automated Traffic Signal Performance Measures, also commonly known as ATSPMs, utilized to better manage traffic signals in the City of Dover, New Hampshire. The City of Dover has been making incremental improvements to their traffic signal infrastructure over the past ten years. This Project complemented their past efforts by adding enhancements to and standardizing seventeen core intersections within the Central Avenue corridor, fourteen of which are currently included in their centrally managed traffic signal system. These seventeen intersections include four coordinated systems located along major access points in, out, and through the City of Dover including three direct connections to the Spaulding Turnpike, a regional controlled access highway that bisects the City of Dover. By making strategic upgrades to the core infrastructure and implementing technology to gather a number of Automated Traffic Signal Performance Measures the City of Dover aims to achieve noticeable improvements in highway efficiency, safety, air quality, and mobility for area residents following this project through being pro-active in managing traffic, rather than relying primarily on customer complaints as the only source of problem identification.

Additionally, there were a number of secondary objectives included within the project: coordination was started between the New Hampshire Department of Transportation's Traffic Management Center in Concord with the City of Dover's signal system, the "Dover Download" newsletter was utilized to allow for the public to provide feedback and have access to useful information about traffic conditions, and an opportunity for allowing technology transfer and best practices knowledge sharing between the City of Dover and the New Hampshire Department of Transportation as well as other municipalities throughout the New England region.

Introduction

ACCELERATED INNOVATION DEPLOYMENT (AID) DEMONSTRATION GRANTS

The Federal Highway Administration (FHWA) AID Demonstration Grants Program, which is administered through the FHWA Center for Accelerating Innovation (CAI), provides incentive funding and other resources for eligible entities to offset the risk of trying an innovation and to accelerate the implementation and adoption of that innovation in highway transportation. Entities eligible to apply include State departments of transportation (DOTs), Federal land management agencies, and tribal governments as well as metropolitan planning organizations and local governments which apply through the State DOT as subrecipients.

The AID Demonstration program is one aspect of the multi-faceted Technology and Innovation Deployment Program (TIDP). AID Demonstration funds are available for any project eligible for assistance under title 23, United States Code. Projects eligible for funding shall include proven innovative practices or technologies such as those included in the Every Day Counts (EDC) initiative. Innovations may include infrastructure and non-infrastructure strategies or activities, which the award recipient intends to implement and adopt as a significant improvement from their conventional practice.

REPORT SCOPE AND ORGANIZATION

This report serves as a documentation of the work completed as part of this project. The report is organized into five sections: Project Overview, Project Details, Project Outcomes and Lessons Learned, and Recommendations and Implementation.

Project Overview

The City of Dover's (City) long-range intent is to connect all thirty-four traffic signals to an existing Central Management System (CMS) for improved maintenance and operations. Four separate coordinated signal systems, covering fourteen signalized intersections, were connected to and communicating to the CMS and this project expanded this system to three additional signals. This project also introduced an improved workflow for signal optimization and operations that will provide increased mobility, reduced delays during peak commuting periods, balanced green times during off-peak hours, and allow for faster maintenance response to malfunctioning equipment. New Hampshire Department of Transportation (NHDOT) and the City aim to demonstrate that by implementing new automated signal system capabilities, communities across the state and region can improve traffic operations and improve driver satisfaction.

The City of Dover is a prime candidate for demonstrating an Automated Traffic Signal Performance Measures (ATSPM) system. The City is a leader in traffic signal technologies in the northern New England area as a result of its on-going investments in its traffic signal infrastructure and its engagement of an on-call consulting traffic operations engineer to manage the CMS.

The four coordinated signal systems selected for this project had a mixture of stop bar detection technology and traffic signal controller brands. The City, looking to replace their in-pavement loops due to their constant breakage caused by pavement deterioration particularly during the freeze-thaw cycles of the winter months, has committed to a policy of replacing loops with above-ground video detection as part of signal maintenance or roadway improvement projects completed through a given signalized intersection. They have standardized on the Cubic Gridsmart video-based detection system and have had great success deploying the systems throughout the City with plans of having this system at all intersections. In general, the City has found that managing the efficient operation of traffic signals using continuous volume data collected by the video system is far better than one-time snap shots obtained from manual turning movement counts or road tube recording devices.

In 2019 the City established a microwave communication network for emergency services and other City communications that spanned the extents of the City. The new microwave system replaced a wireless system that was used for the traffic network, However, upon initial installation it was not possible to integrate the signal systems with the new microwave network. This project installed new microwave radios at key signalized intersections allowing for the signal systems to be connected to the microwave network and take advantage of the improved stability and data transfer speeds. Additionally, all existing twisted pair copper-based intersection interconnect was replaced with fiber optic based interconnect to further improve stability and data transfer speeds.

The City has a traffic management server configured with McCain's Transpartity CMS system. In order to accommodate the proposed ATSPM system, the server needed to be upgraded with more storage space and updated to a newer version of Microsoft Windows server.

The ATSPM system that was established as part of this project is made up of three major systems. The primary system is the Transparity SPM software that was procured under this project and expanded the Transparity CMS system to be able to handle the high-resolution data produced by the traffic signal controllers. The second system is the utilization of the vehicle tracking data collected by the Gridsmart video-based detection system through the use of the Application Programing Interface (API) built into the video processor at each intersection and custom data visualizations created with Microsoft Power Bi. The final system included establishing a travel time monitoring system throughout the City using Streetsmart units installed at key intersections that were procured under this project; in previous projects, the City has had success using portable travel time monitoring devices temporary deployed to corridors to determine before and after effects of signal timing changes.

Figures 1, 2, 3, and 4 on the following pages each detail the intersections where equipment was deployed and improvements were made under this project for each of the four coordinated signal corridors as described in the previous paragraphs.

After the ATSPM system was installed and operational, the City began the process of evaluating the system, determining standardized operating procedures for using the system in a variety of situations, and exploring optimizing the ATSPM system. Parallel to the evaluation of the ATSPM system, public outreach was conducted utilizing an existing newsletter managed by the City called "Dover Download".

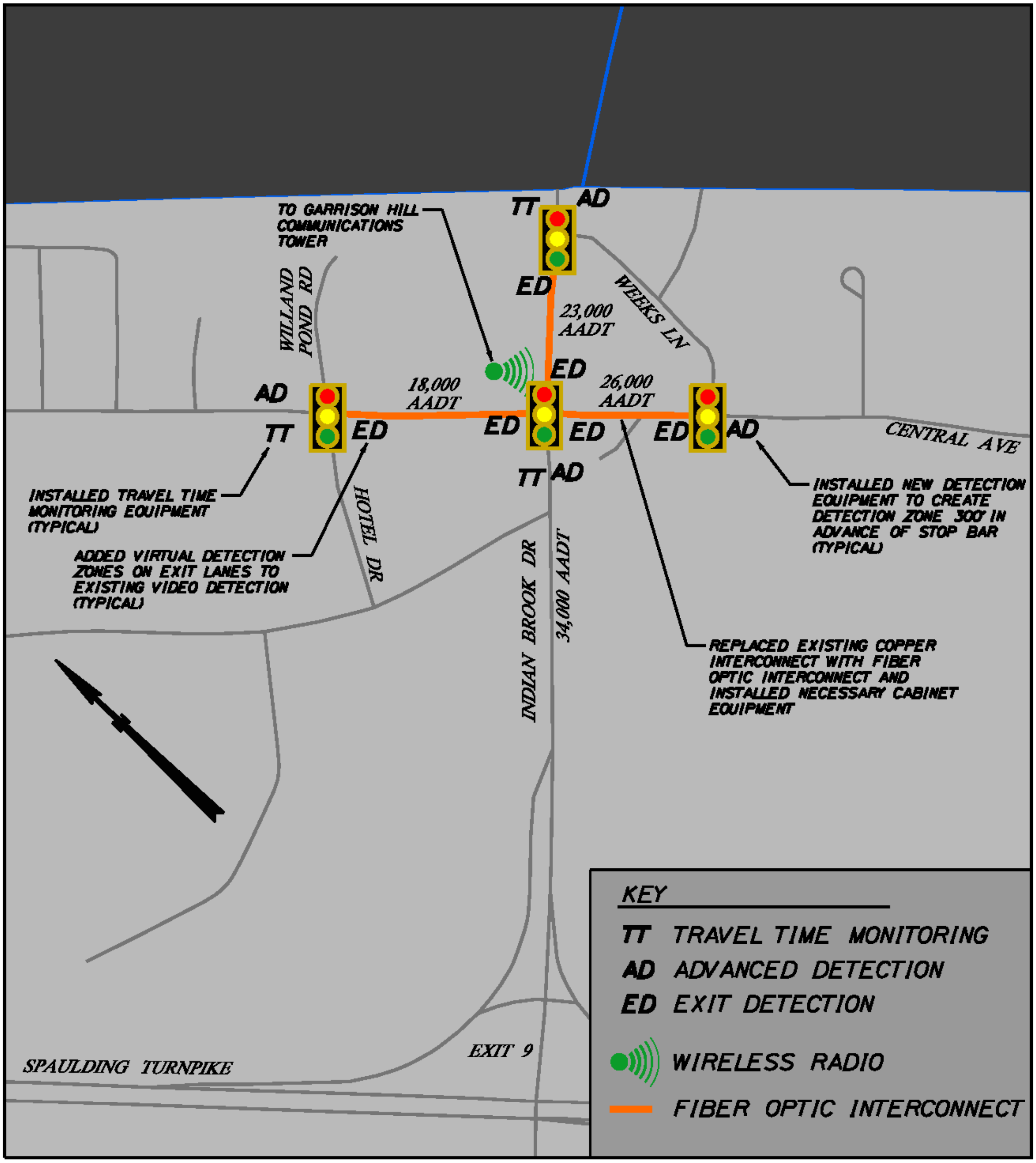

Figure 1. Weeks Crossing Corridor Improvements

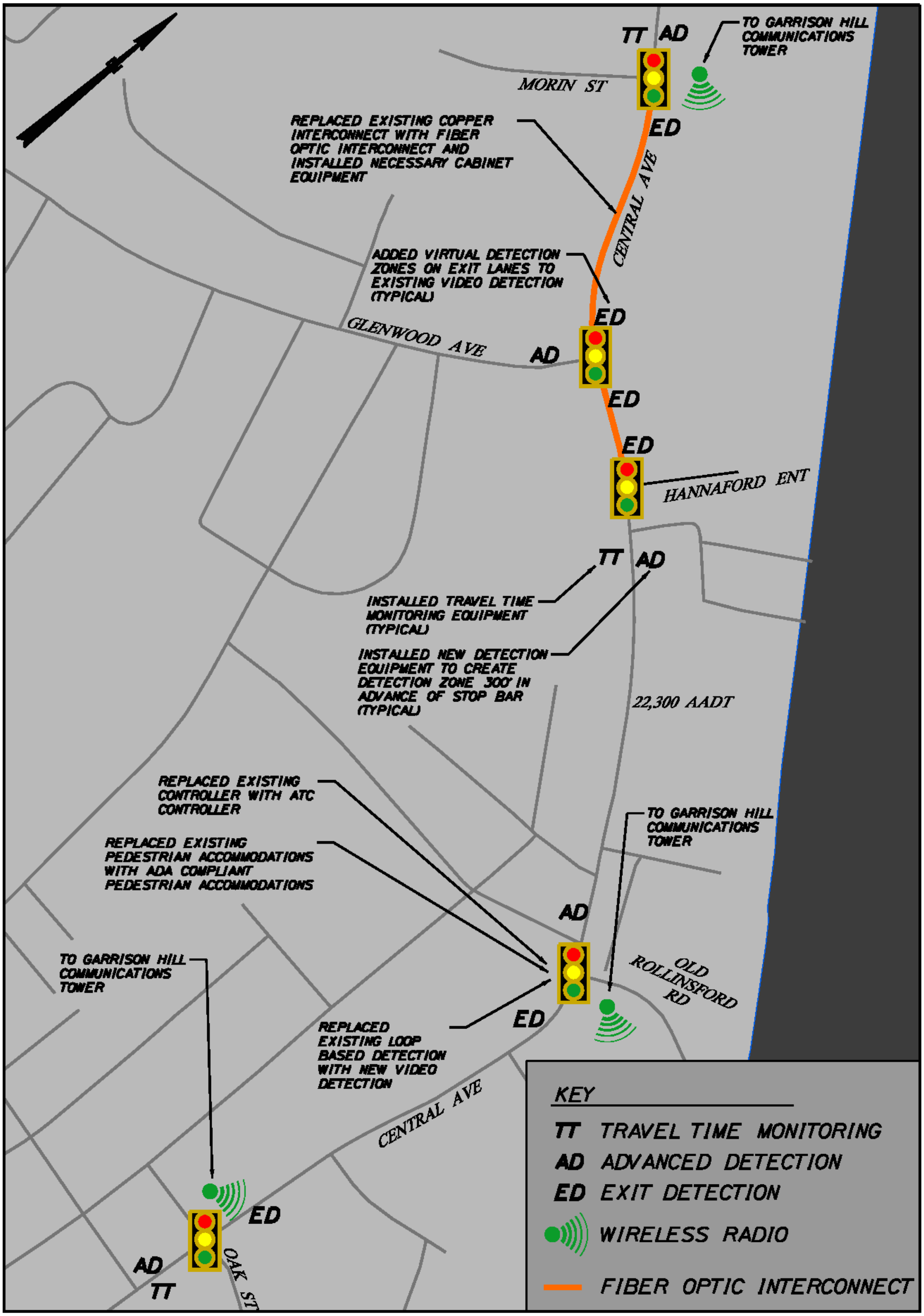

Figure 2. North Central Avenue Corridor Improvements

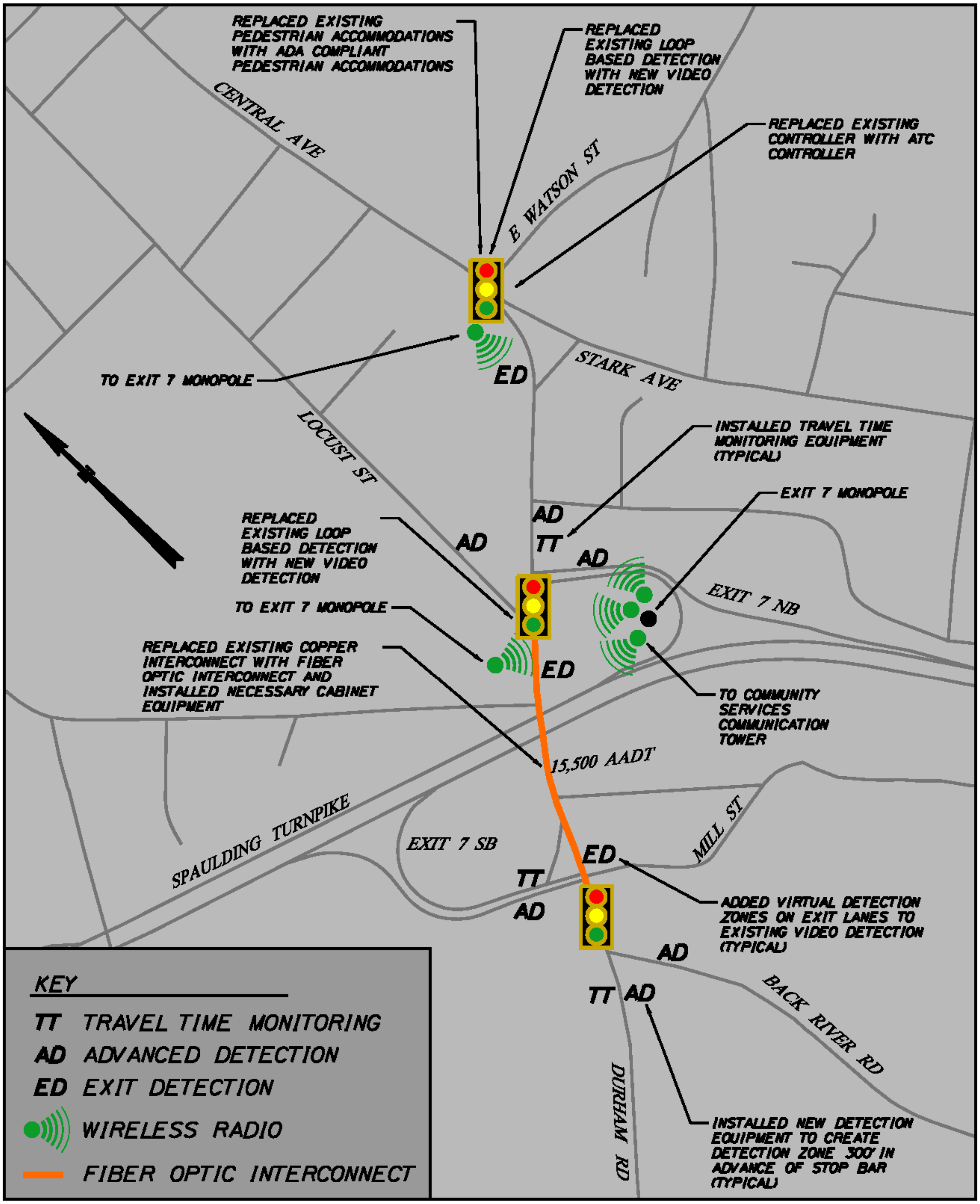

Figure 3. Durham Road Corridor Improvements

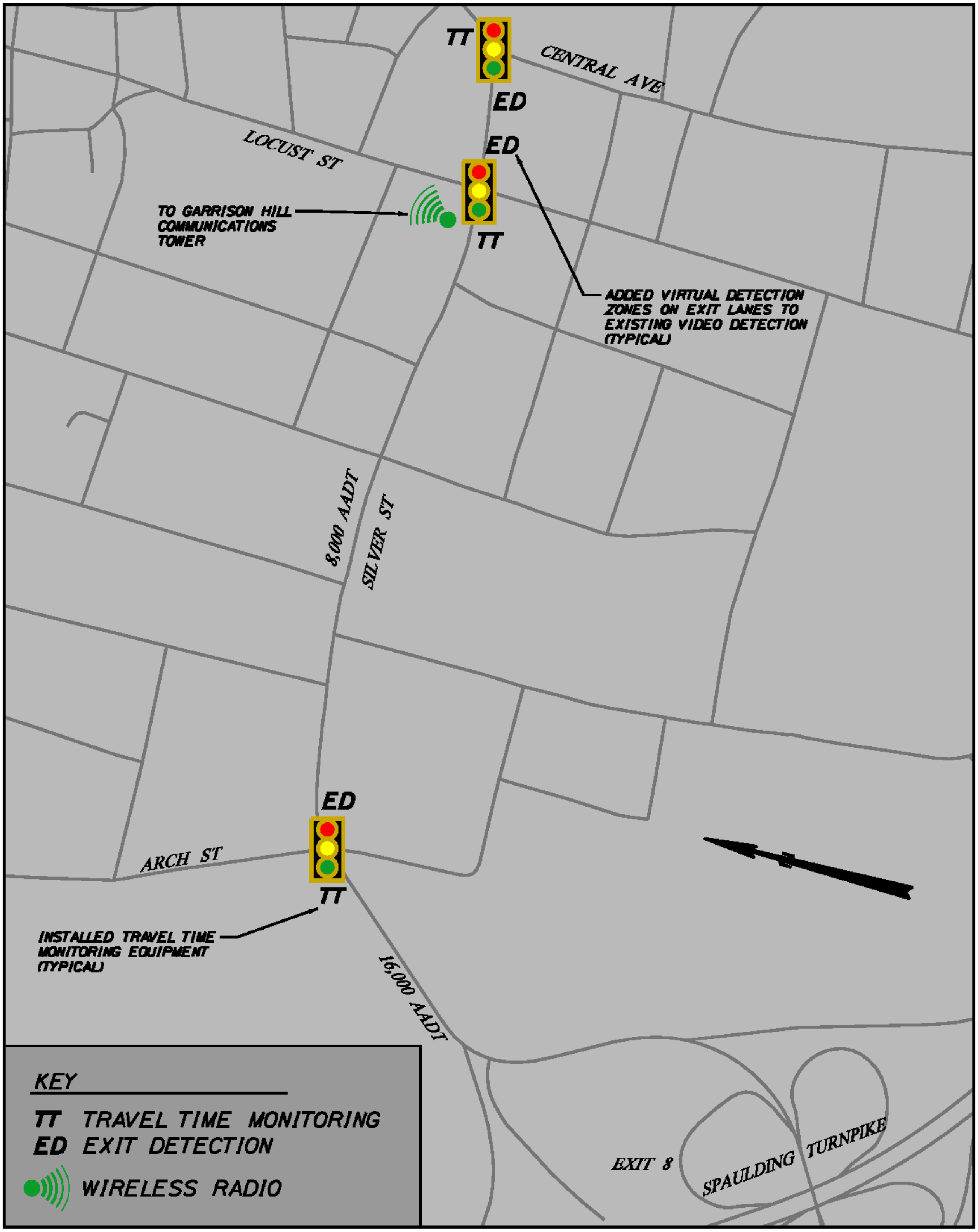

Figure 4. Silver Street Corridor Improvements

Project Details

BACKGROUND

The City of Dover, NH is the state's oldest permanent settlement and its fastest growing city. It is located in the seacoast area and has a current population of approximately 30,000. The City and NHDOT have a combined total of thirty-four traffic signals located throughout the city limits. The City Council began its quest for improved traffic operations on its primary arterials in 2009. Over the past thirteen years the City's Community Services Department has overseen the construction of a wireless communication system with the latest update establishing a microwave based high level communications backbone linking four communication towers throughout the City. The microwave communication network is utilized to connect four coordinated corridors with a CMS residing on a dedicated server at the Community Services facility. The City's CMS is comprised of McCain's Transparity Central Management Software utilizing McCain ATC traffic signal controllers at each of the signalized intersections.

Each of the four coordinated systems has its own distinct characteristics and operational goals and are described in the following sections:

The Weeks Crossing System is adjacent to Exit 9 on the Spaulding Turnpike and serves both commuting traffic to and from the City of Rochester, the City of Somersworth, and the City of Dover in the peak weekday periods, as well as the retail shoppers to the area from the greater region. This system runs time-of-day based dual cross-coordination during weekday and weekend peak periods. The primary goal for the corridor is to accommodate heavy volumes at the Central Avenue and Indian Brook Drive intersection throughout the day (both north-south on Central Avenue and east-west on Indian Brook Drive) with minimal delay.

The North Central Avenue System is a traditional linear arterial corridor on Central Avenue that is subject to volume peaks from commuter traffic. This system currently runs mainline coordination with fixed time of day plans during weekday and weekend peak periods. This corridor was expanded as part of this project to include two additional intersections on Central Avenue to the south, Central Avenue at Old Rollinsford Road and Central Avenue at Oak Street. The primary goal for the corridor is maintaining progression on the mainline (Central Avenue) while accommodating side street queues with manageable delays.

The Silver Street System is an arterial feeder route into the City's Central Business District from Exit 8 on the Spaulding Turnpike. Traffic entering Silver Street from the west disperses as they progress to the east toward the downtown. Each of the system intersections previously ran as isolated free operation. Coordination plans were implemented as part of this project. The primary goal for the corridor is minimizing overall travel delays through the network.

The Durham Road System is an arterial servicing the northbound and southbound Exit 7 signalized off-ramps for the Spaulding Turnpike, as well as traffic to and from the City's High and Middle schools located just south of the corridor on Durham Road. Traffic is heaviest during school start and end times as well as normal commuter times, which overlap in the AM peak hour. Currently, this system is running fixed time-of-day plans designed around these peak periods. This system was expanded as part of this project to include one additional intersection to the north on Central Avenue, Central Avenue at Stark Avenue. The primary goal for the corridor is managing the significant queuing that results during the school peak hours while maximizing throughput on the mainline during peak periods and managing side street delays. This system consists of a total of five signalized intersections. Of the five, there are two pairs of intersections which are each controlled by a singular controller, adding to the complexity of this system.

As can be seen from the above descriptions, each of the four core systems are different in their respective operational characteristics even though they all are located in key locations surrounding the City's downtown. As such, this project provides the opportunity to test the ATSPM system under different operational conditions to determine any performance measure norms that can be applied in Dover and other communities in the northern New England area.

PROJECT DESCRIPTION

Systems Engineering for ATSPM System

The project was approved and started in May 2019. The first major task was completing the Systems Engineering process for the ATSPM System.

In June 2019, Eddie Curtis, Team Leader of Innovative Operations Strategies Office of Transportation Management FHWA, visited New Hampshire and provided training on the Systems Engineering process which at the time was being updated to the modern guidance. The two-day training covered the basic process, the (at the time draft) Model Systems Engineering Documents, and the Concept of Operations Table of Sample Statements to produce a basic concept of operations. The training was attended by City staff, the City's traffic consultant, NHDOT staff, and New Hampshire FHWA staff.

The training was successful and all that attended felt that much was learned about how to determine the requirements for a proposed system. The training also allowed interested parties to have a similar understanding of all the potential requirements and make decisions and provide input. Overall, the training notably reduced the effort required to go through the procurement process, described in the next section.

In the months after the training, the basic concept of operations was expanded and a formal draft concept of operations and system requirements document was created by early October 2019, which were reviewed both by Eddie Curtis and the NHDOT resulting in the final draft documents produced in November 2019. A copy of the final concept of operations and the system requirements are included within the Appendix.

Procurement of ATSPM System

In February 2020 a notice to proceed to procurement was issued. The City prepared and issued a Request for Information (RFI) package to be distributed and responded to by ATSPM system vendors. A copy of the RFI is included within the Appendix. The City received responses from McCain Inc., Econolite Systems, and Q-Free Intelight Inc. A summary of the RFI responses prepared by the City's traffic consultant is included within the Appendix.

The responses from the RFI were then used to finalize the System Requirements and a Request for Proposals (RFP) was prepared. A copy of the RFP is included within the Appendix. In May of 2020 the RFP was distributed to the vendors that responded to the RFI. Only McCain Inc. and Econolite Systems responded to the RFP. A team from the City's traffic consultant reviewed the submitted proposals based on the proposed "best value" evaluation as outlined in the RFP. Both proposals scored very well and the resulting scores from McCain Inc. and Econolite Systems were 86.75 and 86.40 respectively. As the two scores were significantly close, the City prepared a list of clarifying questions for each vendor and it was determined that McCain Inc.'s proposed Transparity SPM system best met the requirements of the City as the system can operate at full functionality in a closed network system without access to the internet, whereas Econolite Systems' proposed Centracs SPM system requires a connection to Econolite Systems' cloud network to function. A Memorandum from the City's traffic consultant describing the selection process and recommending that the City select McCain Inc.'s Transparity SPM system is included within the Appendix. McCain Inc.'s Transparity SPM System was selected by the City.

Unfortunately, there were delays in implementing the system caused by multiple disruptions to the communications network preventing the traffic server from communicating with the signal network, particularly between October 2020 to July 2021. The fiber-optic based connection between the City's Community Services building and the communications tower was damaged by rodents two separate times over the course of the project. Construction of an access road caused accidental destruction of a large section of the fiber-optic based connection line that required a significant amount of the line to be replaced. These disruptions in communications between the signal network and the traffic server, prevented the full deployment of the Transparity SPM system, prevented data collection, and greatly hampered the progress of the project.

Outside of the disruptions, the City continued to work with McCain Inc. to get the Transparity SPM system installed on the traffic server and make any necessary changes to the traffic signal controllers. The first major task was that the City's traffic server needed to be upgraded to a newer version of Windows Server in order to support the Transparity SPM software and newer SQL server. The Transparity SPM software was installed and initially configured based on historic information. There was a short period of time in starting in early March 2021 where communications were restored and the Transparity SPM software was fully configured and connected to the traffic signal controller for the first time. A memorandum is included in the Appendix from the City's traffic consultant that summarizes the initial review of the ATSPM system for the Durham Road system. The communications network was disrupted again shortly after until July 2021.

In December of 2021 the City's traffic consultant met with McCain Inc. staff and evaluated the Transparity SPM System against the original System Requirements that were produced through the systems engineering process. Overall, the system met or exceeded the system requirements as agreed upon in the RFP selection process. As such, the Transparity SPM System was accepted and the system started maintenance and support.

Procurement of Signal Equipment

Parallel to the ATSPM System procurement, the City coordinated with its signal contractor to procure and install the necessary signal equipment to bring all seventeen intersections to the same equipment standard and to be prepared to collect SPM data once the ATSPM System was deployed.

From February to December 2020 the majority of signal equipment, as listed below, was purchased and deployed to Dover’s intersections and *Table 1: Procured Signal Equipment* on the following page details the signal equipment at each intersection.

- April 2020 - Installed two new McCain Omni Ex2 traffic signal controllers.
- April 2020 - Replaced existing non-ADA compliant pedestrian activation buttons with pedestrian APS push buttons at two intersections.
- June 2020 - Replaced five legacy Gridsmart Detection Systems with the newest model.
- September 2020 - Installed three new Gridsmart Detection Systems.
- September 2020 - Replaced existing twisted pair copper based interconnect within the Weeks Crossing System, Glenwood System, and Durham Road System with fiber optic based interconnect.
- August 2020 - Removed existing wireless communications and installed new microwave based communications at seven key intersections.
- August 2020 - Installed advanced detection at ten key intersections.
- October 2020 - Installed Streetsmart travel time monitoring systems at twelve key intersections.
- August 2021 - Reconfigured the signal indication phasing assignment at the Durham Road at Back River Road and Durham Road at Mill Street intersections.
- December 2021 - Signal indication modifications and reconfigured signal indication phasing assignment at the Central Avenue at Locust Street and Central Avenue at the Exit 7 northbound Spaulding Turnpike off-ramp.

Table 1: Procured Signal Equipment

Intersection	Controller	Detection	Communications	Interconnect	Advance Detection	Travel Time Monitor	APS Pedestrian Button
Central Ave at Hotel Dr	McCain	Gridsmart	-	Fiber Optic	Gridsmart	Streetsmart	-
Indian Brook Dr at Weeks Ln	McCain	Gridsmart	-	Fiber Optic	Gridsmart	Streetsmart	-
Central Ave at Indian Brook Dr	McCain	Gridsmart	Microwave	Fiber Optic	Gridsmart	Streetsmart	-
Central Ave at Weeks Ln	McCain	Gridsmart	-	Fiber Optic	Gridsmart	-	-
Central Ave at Morin St	McCain	Gridsmart	-	Fiber Optic	Gridsmart	Streetsmart	-
Central Ave at Glenwood Ave	McCain	Gridsmart	Microwave	Fiber Optic	Gridsmart	-	-
Central Ave at Hannaford Ent	McCain	Gridsmart	-	Fiber Optic	Gridsmart	Streetsmart	-
Central Ave at Old Rollinsford Rd	McCain	Gridsmart	Microwave	-	-	-	RDP
Central Ave at Oak St	McCain	Gridsmart	Microwave	-	Gridsmart	Streetsmart	-
Central Ave at Stark Ave	McCain	Gridsmart	Microwave	-	-	-	RDP
Central Ave at Locust St	McCain	Gridsmart	Microwave	Fiber Optic	Gridsmart	Streetsmart	-
Durham Rd at Mill St	McCain	Gridsmart	-	Fiber Optic	Gridsmart	(2) Streetsmart	-
Silver St at Arch St	McCain	Gridsmart	-	Fiber Optic	Gridsmart	Streetsmart	-
Silver St at Locust St	McCain	Gridsmart	Microwave	Fiber Optic	Gridsmart	Streetsmart	-
Silver St at Central Ave	McCain	Gridsmart	-	Fiber Optic	Gridsmart	Streetsmart	-

**Note: Lowlighted equipment represents equipment already installed at the intersection before this project.*

Prior to procuring the travel time monitoring systems, the City's traffic consultant completed an in-field evaluation comparing Wi-Fi vs Bluetooth technologies to determine which technology would be the best fit for the Dover area. Demo Streetsmart units, which use Wi-Fi based technology, were compared with portable Bluetooth based units installed along the North Central Avenue System. Ultimately the Wi-Fi based technology outperformed the Bluetooth units by about 10-20% in terms of match count and match frequency and also was the less expensive option. Within the Appendix is a memorandum from the City's traffic consultant overviewing the test and the results.

Database Development and Enhancing ATSPM Automation

The deployed SPM System consists of three major data sources: the high resolution data collected from the McCain controllers is collected by and stored within a SQL database residing on Dover's Traffic Server, the video detection collects a significant amount of useful metrics that are archived within the video detection processor itself at each intersection, and the Streetsmart travel time monitoring system tracts partial device information and sends it to the Streetsmart Cloud to be matched and post processed into travel time statistics. These data sources and the analysis of the data is described in greater detail in the Data Collection and Analysis section of this report.

Public Outreach

Public Outreach was conducted utilizing an existing newsletter hosted by the City called "Dover Download". This project was featured in the newsletter published on February 5th 2021 and included a link to an online survey that readers could respond to. The survey consisted of five groups of statement or questions that were intended to establish a baseline for issues observed by the traveling public and to identify priorities for each corridor. The first four statement based groups included the following statements for each signal corridor and the question for each answer was rated on a five point scale ranging from "Strongly Agree" to "Strongly Disagree":

- I regularly drive through this system.
- My travel is part of a commute to work.
- My travel is a non-commuting decision.
- I don't frequently have to stop in the system.
- I find myself waiting on the side street while there isn't traffic on the major street.
- Traffic tends to move slower than average through the corridor.
- While behind other vehicles, I have to wait for multiple green lights before getting through.
- I tend to avoid this system during peak traffic times.

The fifth group of questions asked respondents to rank the systems in order of their frustration with the system and then also included general demographic information regarding age group, binned in ten to fifteen year increments, and residence, including the City of Dover and nearby municipalities.

The survey was available online until March 1st 2021 and in total there were 386 responses to the initial online survey. 153 participants also provided additional comments on particular issues or specific intersections. Sixty-four percent of comments regarding the signal systems were specifically for the Durham Road System. In addition, 156 respondents agreed to receive future updates on the project and to be included follow up surveys.

This project was featured in the newsletter three additional times, highlighting major changes that were made to the signal corridors:

- July 30th 2021: Overviewed the changes made to the Durham Road system and asked for public feedback. There were eighteen responses to the survey.
- January 21st 2022: Overviewed the changes made to the Silver Street system and asked for public feedback. There were 107 responses to the survey.
- April 1st 2022: Overviewed the changes made to the Weeks Crossing system and the North Central Ave system and asked for public feedback. There were twenty-three responses to the survey.

Unfortunately, the three follow up surveys didn't receive the same number of respondents as the initial survey.

ATSPM System Testing and Signal Corridor Optimization

From June of 2021 to October of 2022 the City evaluated the ATSPM system and utilized the signal performance data to optimize the traffic signals in each system.

Durham Road System

Based on the results of the public outreach survey, the Durham Road system was the first corridor evaluated. As previously mentioned, the corridor has significant levels of congestion during the AM, school release, and PM peak hours resulting in oversaturated conditions on most of the major movements, in particular the northbound Durham Road approach and the westbound Back River Road approach.

The City's traffic consultant reviewed the signal performance measures generated by the ATSPM system using a methodology developed by the consultant, named the design headway methodology, to estimate the required amount of time that each approach should be serviced to account for the required demand. The methodology utilizes a combination of traffic volumes, split history, vehicle speed at the stop bar, advance detection activations, and detector occupancy to estimate the flow rate of vehicles when the approach is at capacity and then this information can be used to determine the amount of time the signal indications should be green to service the approach. It was found that using the design headway methodology greatly reduced the amount of time required to optimize signal timings in a simulated environment.

While reviewing the SPMs it was found that the existing phase sequence for the Durham Road at Back River Road and Durham Road at Mill Street intersections had unforeseen issues that weren't easily identifiable before the ATSPM system was implemented. Due to the close proximity of the intersections, both signals are connected and are controlled by a single traffic signal cabinet and traffic signal controller leading to a relatively complex phasing assignment with a large number of signal indications phased as overlaps. It was found that there were certain scenarios where some movements were being skipped in the phase sequence and other scenarios where the same approach could receive two green indications within the same cycle. Additionally, there were known inefficiencies at the intersection caused by the exclusive pedestrian phases; as the two intersections were controlled by a single traffic signal controller, when a pedestrian phase was serviced at one of the intersections vehicular traffic would receive a red indication for all movements at both intersections. As such the City's traffic consultant developed a new phase assignment and phase sequence that simplified the operation of the signal, improved flow between the two intersections, and split the exclusive pedestrian phases. A memorandum describing the proposed changes is included within the Appendix. The proposed phase assignment and phase sequence were deployed to the intersection end of August 2021. The improvement was immediately noticeable, especially in the peak hours; the ATSPM system recorded a ten percent increase in traffic during the peak hours on the northbound Durham Road approach at the Durham Road and Locust Street intersection, suggesting that there was a notable increase in the flow rate through the Durham Road at Back River Road and Durham Road at Mill Street intersections.

Silver Street System

Following the Durham Road system improvements, the SPMs were reviewed for the Silver Street system. In particular, the travel time monitoring system showed that there appeared to be a trend of about twenty-five to thirty percent of drivers heading southbound on the Spaulding Turnpike destined for the central business district of the City decide to utilize Exit 7 (Durham Road) rather than Exit 8 (Silver Street); this is notable as Exit 8 and Silver Street is the more direct route. Historically, the Silver Street corridor has been uncoordinated to best serve the large amount of traffic entering and exiting the corridor along the various side streets and the distance between the Silver Street at Arch Street and Silver Street at Locust Street intersections is about half a mile making it difficult to coordinate using traditional methods. It was also observed that Google Maps was evenly recommending both Exit 7 and Exit 8 to southbound travelers on the Spaulding turnpike in the peak hours.

Using the SPM data collected from the ATSPM system, the City's traffic consultant designed coordination plans for the corridor utilizing the design headway methodology. The goal of the proposed coordination plans was to provide bi-directional progression along Silver Street while still minimizing queues and delays on the side street movements, particularly at the Silver Street at Locust Street intersection.

The coordination plans were deployed to the Silver Street system in January of 2022. During the deployment the SPMs were used to calibrate the offset between the Silver Street at Arch Street and Silver Street at Locust Street intersections to allow for good progression despite the large separation between the intersections. In the weeks following the deployment, Google Maps began recommending Silver Street as the primary route to drivers and reporting that the estimated travel time would be about one minute shorter than using the Exit 7 interchange. Over the following months there was roughly a ten percent decrease in left turning traffic at the Exit 7 southbound ramp in the peak hours where as other movements at the Durham Road at Back River Road and Durham Road at Mill Street intersections remained roughly consistent, suggesting that the coordination on Silver Street resulted in some drivers changing their travel patterns and began using Exit 8 rather than Exit 7.

Weeks Crossing System and North Central Avenue System

In the past the Weeks Crossing System and North Central Avenue Systems have always been analyzed separately as evaluating both systems, nine signals in total, using traditional methods was cost prohibitive due to the scope of data collection and difficulty of in-field calibration. The City's traffic consultant designed coordination plans utilizing the design headway methodology and data collected by the ATSPM system. To meet the goals of both systems, the coordination plans were designed to allow for two stages of progression centered around the Central Avenue at Indian Brook Drive intersection; additionally, each group of intersections were evaluated to see if there were any opportunities to improve flow. The first state of progression is focused around progression from Central Avenue at Indian Brook Drive to Central Avenue at Oak Street. The second stage of progression is designed around accommodating traffic going to and from the City of Somersworth and the City of Rochester from Exit 9 of the Spaulding Turnpike through the Central Avenue at Indian Brook Drive intersection.

The coordination plans were deployed to the corridor April 2022 and there were immediate benefits observed at the Indian Brook Drive at Weeks Lane and Central Avenue at Oak Street intersections due to the improvements to flow at these intersections. Following the deployment, the coordinated offsets and splits were optimized utilizing the SPM data relative to the advance detection deployed in the two systems. Of note, the Purdue coordination diagram, split utilization, and detector occupancy reports were all particularly useful and notably reduced the amount of time and effort required to calibrate the proposed timings to field conditions.

Development of Standard Operating Procedures

Standard Operating Procedures (SOPs) were developed to help users efficiently utilize the ATSPM system and make the system more accessible. The SOPs outline the information required to access the system, how the data is organized such as folder structures, and procedures for accessing and using the ATSPM system related to the proposed use cases in the concept of operations developed during the systems engineering process. The SOP document is included within the Appendix. The procedures are broken into three sections:

- Software Access: each procedure provides step by step guidance for accessing the software that make up the ATSPM system.

- Routine Operations: each procedure outline tasks that are intended to be completed regularly such as daily, weekly, or monthly.
- Common Use Cases: each procedure details recommended steps to respond to and troubleshoot common issues within the traffic signal system.

Coordination with New Hampshire Department of Transportation Traffic Management Center

In August of 2021, City Staff, the City's traffic consultant, and NHDOT Staff met to start discussions related to potential opportunities to integrate the City's traffic network with the NHDOT's traffic management center. In this meeting it was identified that there were a few possible options for coordination. There was interest in getting "read-only" access for NHDOT staff to view Transparity and the Gridsmart cameras, an updated memorandum of understanding should be reviewed regarding the six traffic signals owned by NHDOT within the City of Dover, and incident management plans could be explored. Over the following months the group met monthly to continue the discussion.

It was determined that the recently completed project at the Route 4 and Exit 6 intersections, located on the southern side of the City of Dover, was not a good candidate for integrating into the City's system as the installed signal equipment was not compatible with the City's Transparity or Gridsmart systems. However, the Indian Brook Drive at Exit 9 intersections both have older signal equipment that should be replaced in the near future and would also be ideal intersections to integrate into the City's traffic network. This could be accomplished relatively simple by a wireless connection to the intersections of the Weeks Crossing system.

Initially it was identified that new incident management plans might be worthwhile. In particular having preprogrammed coordination plans implemented in the traffic signal controllers so that if a section of the Spaulding Turnpike had to be closed then the plans could be triggered as needed. It was noted that in order to best design the coordination plans it would be ideal to have an understanding of how traffic on the Spaulding Turnpike would distribute across the roadway network. It was suggested that the Seacoast Travel Demand Model, managed by the Strafford County and Rockingham County Regional Planning Commissions (RPC), could be used to determine the traffic distribution. However, the Strafford County RPC identified that it would not be feasible to use the Seacoast Travel Demand Model. It was also estimated that major closure events only happen one to two times a year.

In the final meeting held in December 2021 it was confirmed that the development of incident management plans was not cost effective due to the complexity of determining the various possibilities and the infrequency of closure events. It was also determined that future access to the City's Transparity and Gridsmart video detection could be established in a future project, such as a future signal improvement project for the Indian Brook Drive at Exit 9 intersections.

DATA COLLECTION AND ANALYSIS

Performance measures consistent with the project goals were jointly established for this project by NHDOT, The City of Dover, and FHWA to qualify, not to quantify, the effectiveness of the innovation to inform the AID Demonstration program in working toward best practices, programmatic performance measures, and future decision-making guidelines. Data was collected to determine the impact of implementing an automated traffic signal performance measure system on safety, schedule, cost, quality, and user impacts before, during, and after construction and demonstrate the ability to:

- Achieve a safer environment for the traveling public and workers
- Reduce overall delivery time and associated costs related to optimizing traffic signals
- Reduce impacts to the traveling public and project abutters
- Satisfy the needs and desires of the traveling public

This section discusses how the City of Dover established baseline criteria, monitored and recorded data during the implementation of the innovation, and analyzed and assessed the results for each of the performance measures related to these focus areas.

Data Types

The following sections detail the four different data sources that make up the ATSPM system established as part of this project.

Transparity Central Monitoring System

The Transparity Central Monitoring System's primary function is the monitoring and management of the connected traffic signal controllers. The data types used by the system include the event/alarm logs collected from the controllers and the signal timing archive. The Transparity System stores all of the collected data within the SQL server located on the Dover Traffic Server and a copy of the signal timing report for each intersection is kept on the Windows Desktop of the Sebago Technics user account on the Traffic Server.

The event/alarm logs consist of an event-by-event summary of notable changes occurring at the traffic signals, these are primarily Online and Offline Events and various Coordination based alarms. The logs can be saved to a CSV file so that they can be analyzed to produce performance measures or summarized as needed. An example of the log data is shown in *Table 2: Transparity Event Log* on the following page:

Table 2: Transparity Event Log

Source	Category	User name	Date	Qualifier	Name	Message
Event	Alarm	System	10/31/2022 12:32:07 AM	Traffic Controller	3.1 Silver @ Central	Alarm: Offline
Event	Alarm	System	10/31/2022 07:05:52 AM	Traffic Controller	4.1 Route 108 @ Back River	Alarm: Coordination Fault
Event	Alarm	System	10/31/2022 07:09:00 AM	Traffic Controller	4.1 Route 108 @ Back River	Alarm: Coordination Fault Removed
Event	Alarm	System	10/31/2022 7:22:05 AM	Traffic Controller	3.1 Silver @ Central	Alarm: Offline Removed

The signal timing archive is intended to save a copy of the traffic signal controller programming in case there is a critical failure of or damage to the controller. The archive also provides a secure method to view and modify signal timings without risk of corruption or partial changes. The archive copy of the controller programming can also be exported to a database file which can be uploaded to another controller for bench testing. Transparity has a built-in reporter that can convert the archive programming into a user-friendly report. A copy of a timing report is attached at the end of this memorandum.

Transparity SPM

The traffic signal controllers produce high-resolution data that tracks the majority of functions within the traffic signal controller at a tenth of a second resolution. The Transparity SPM system collects the high-resolution data from the traffic signal controllers and stores it within the Transparity SQL server located on the Traffic Server. An example selection of the data stored on the Transparity SQL server representing a typical phase service request is shown in *Table 3: Signal State Data* on the following page:

Table 3: Signal State Data

Timestamp	Event Code	Event Name	Event Parameter
10/31/2022 07:58:49.9 AM	82	Detector On	1
10/31/2022 07:58:49.9 AM	43	Phase Call Registered	1
10/31/2022 07:59:57.0 AM	0	Phase On	1
10/31/2022 07:59:57.0 AM	1	Phase Begin Green	1
10/31/2022 08:00:01.3 AM	81	Detector Off	1
10/31/2022 08:00:02.0 AM	3	Phase Min Complete	1
10/31/2022 08:00:03.3 AM	82	Detector On	1
10/31/2022 08:00:03.8 AM	81	Detector Off	1
10/31/2022 08:00:05.0 AM	6	Phase Force Off	1
10/31/2022 08:00:05.0 AM	7	Phase Green Termination	1
10/31/2022 08:00:05.0 AM	8	Phase Begin Yellow Clearance	1
10/31/2022 08:00:10.0 AM	9	Phase End Yellow Clearance	1
10/31/2022 08:00:10.0 AM	10	Phase Begin Red Clearance	1
10/31/2022 08:00:12.0 AM	11	Phase End Red Clearance	1
10/31/2022 08:00:12.0 AM	12	Phase Inactive	1

Gridsmart Detection System

The Gridsmart Detection System has three different stored data types. This data can be accessed through the Gridsmart application programming interface (API) and a remote connection to each processor within each signal cabinet. The signal performance measures can also be accessed through the Gridsmart Client software.

The first data set consists of the vehicle tracking data stored by the video processor's AI detection algorithm. The vehicle tracking data is organized by detection zone and consists of a vehicle-by-vehicle summary of various measures. An example of the vehicle tracking data is shown in *Table 4: Vehicle Tracking Data* below.

Table 4: Vehicle Tracking Data

Software Version	Revision	Timestamp	UTC Offset	Turn	Vehicle Length	Speed	Signal State	Seconds in Zone	Vehicles in Zone	Seconds of Signal	Seconds since Green	Free Flow Speed	Calibration Speed
8	2	105	-300	L	11	8	G	25.4	0	3.58	0	15	17
8	2	10726.5	-300	U	11	14	PG	1.8	0	312.52	1773.79	15	17
8	2	41212.5	-300	L	31	1	Y	2.2	1	0.45	2155.74	13	17

The Gridsmart Detection System tracks the current signal state through a synchronous data link control (SDLC) connection to the traffic signal controller. The signal state data is stored by event with the current signal indication state represented by a sixteen-character string, one character for each signal phase. An example of the signal state data is shown in *Table 5: Signal State Data* below:

Table 5: Signal State Data

Timestamp	Event Code	Signal State
73024.8	215	GRRRRGURGRRGUUUU
73037	215	YRRRRGURYRRGUUUU
73040	215	RRRRRGURRRRGUUUU

Parallel to the vehicle tracking data and signal state data, the Gridsmart Detection System is also building a minute-by-minute summary of signal performance measures. The signal performance measures incorporate the data from the vehicle tracking data and signal state data and include the following data elements: occupancy time, percent arrival on green, greens received, green time, red time, green occupancy time, red occupancy time, right turning volume, through volume, left turning volume, u-turning volume, speed exiting the detection zone, and percent arrival on red. Each data element has sixteen columns, one for each phase tracked by the Gridsmart Detection System. An example of the signal performance measures table is shown in *Table 6: Signal Performance Measures* below; For clarity, only one phase of data is shown for each signal performance measure.

Table 6: Signal Performance Measures

Software Version	Timestamp	Occupancy Time	% Arrival on Green	Green Received	Green Time	Red Time	Green Occupancy Time	Red Occupancy Time	Rights	Thrus	Lefts	UTurns	% Arrival on Red
2	1100	37	91	1	2	32	21	0	0	11	0	0	21
2	1101	57	11	1	25	52	8	0	1	3	0	0	15
2	1102	36	29	0	8	37	6	0	1	4	0	0	20

Streetsmart Travel Time Monitoring System

The Streetsmart travel time monitoring system utilizes Wi-Fi based devices in traveling vehicles to estimate travel times between signalized intersections equipped with the system. At each equipped intersection is a Streetsmart processor with both a Wi-Fi based and cellular based antenna. At a high level, the Streetsmart processor emulates a wireless network, when Wi-Fi based devices try to identify the wireless network created by the Streetsmart processor, the Streetsmart processor captures a piece of the device's wireless connection information: the processor then converts the Wi-Fi based device's wireless connection information to a unique device ID. The device ID generated by the Streetsmart processor is then sent to the Streetsmart Cloud through the cellular based antenna. Within the Streetsmart Cloud, device IDs from the various locations are paired based on various routes configured by the user. The user is able to run reports for the configured routes and can export the data. For each configured route there are five different travel time combinations calculated using various timestamps collected when a device first enters the range of the system, when it has its highest signal strength, and when it exits the range of the system. An example of the Route Travel Time report is shown in *Table 7: Travel Time* on the following page:

Table 7: Travel Time

Timestamp (EPOC)	Strengths	Firsts	Lasts	Minimum	Maximums
1609459216791	30.033	28.633	30.131	20.031	39.733
1609461150895	25.631	25.631	25.631	20.031	39.831
1609463154395	38.731	30.329	39.629	20.031	50.335

Data Analysis and Reporting

It was quickly determined during the RFP process that the built-in reporting of the ATSPM system's various components was limited in how much data could be viewed at one time and the data was spread out over multiple software. For instance, most of the SPM reports included within Transparity SPM are limited to a single day or even a couple of hours. While the built-in reporting of the Gridsmart Client allows for averages over data ranges but doesn't provide statistics or analytics. As such, in order to efficiently view trends and variations the data would need to be exported from the ATSPM system so that it could be brought into custom reports and consolidated into one location.

The City's traffic consultant developed scripts designed to retrieve data from the various data sources. The scripts are written in scripting languages including SQL programing language, Virtual Basic Script, and Python. Once the baseline data retrieval was established, the City's traffic consultant was able to determine methodologies for automating the process.

The City's traffic consultant then developed custom reports and dashboards utilizing Microsoft Power Bi, a data analytics and visualization software. The Power Bi reports are able to import the data collected by the scripts and can produce a suite of statistics, analytics, and charts; the reports are also fully interactive allowing for users to filter and manipulate data in real time. Due to size constraints, each intersection is limited to a year's worth of data for each report. There were three report types created for this project and each report type is described in greater detail below.

The first report type is dedicated to the information collected from the Gridsmart detection system. The intended focus of the report is on traffic volumes, however there are options to view the entire range of SPMs gathered from the API. The following lists each chart or table title and a short description:

- *Monthly Average Daily Sum of Data Value Chart:* each point on the line graph for each phase represents the total daily sum of the data value for each day plotted against the month.
- *Weekly Average Daily Sum of Data Value Chart:* each point on the line graph for each phase represents the total daily sum of the data value for each day plotted against the week number.
- *Daily Sum of Data Value:* each point on the line graph for each phase represents the total daily sum of the data value for each day plotted against the date.
- *Maximum Daily Following Hour Sum of Data Value Chart:* each point on the line graph represents the maximum recorded following hour volume for each day plotted against the date.
- *Average fifteen-minute sum of data value by Phase Chart:* each point on the line graph represents the sum of the data value for each fifteen minute interval averaged over the selected data range for each phase plotted against the fifteen minute interval.
- *Average fifteen-minute sum of data value by Data Type Chart:* each point on the line graph represents the sum of the data value for each fifteen minute interval averaged over the selected data range for each data type plotted against the fifteen minute interval.
- *Average Following Hour Sum of Data Value Chart:* each point on line graph represents the following hour volume for each fifteen minute interval averaged over the selected data range for each phase plotted against the fifteen minute interval.
- *Estimated Capacity from Design Headway Methodology Chart:* each point on the line graph represents the ratio between the green time per vehicle for each interval compared to the green time per vehicle at capacity determined using the design headway methodology for each phase plotted against the fifteen minute interval.
- *Data Value Statistics Table:* the table includes statistics for each phase calculated for each fifteen minute interval and then averaged over the selected data range for each fifteen minute interval including: average, standard deviation, 95^{th} percentile confidence interval, and maximum recorded value.
- *Following Hour Sum List:* each row of the list shows the sum of the data values for the indicated interval and the following three intervals.
- *Highest Following Hour Sum to Daily Sum Ratio Table:* the table includes, for each phase, the ratio between the highest Following Hour Sum and Daily Sum for each day averaged for each month.
- *Highest Following Hour Sum to Average Daily Sum for the Selected Dataset Table:* the table includes, for each phase, the ratio between the daily sum

averaged over each month compared to the average daily sum calculated over the selected data range for each month.

- *Data Value Capacity Analytics Table:* the table includes, for each phase, analytics derived from the data collected by the detection processor calculated for each fifteen minute interval and then averaged over the selected data range for each fifteen minute interval including: green time per cycle, green time per vehicle, vehicles per cycle, design headway calculated using the design headway methodology.

The second report was built for the data collected by the Transparity SPM system. The report focuses on typical SPMs and allows the user to view a large range of charts and data all at one time. The following lists each chart or table title and a short description.

- *Sum of Detector Duration Chart:* each point on the line graph for each detector represents the average total sum of time where the detector was activated plotted against the fifteen minute interval.
- *Average Detector Duration Chart:* each point on the line graph for each detector represents the average amount of time that each detector was active per actuation plotted against the fifteen minute interval.
- *Detector Statistics Table:* the table includes statistics related to the detection activations for each detector, including: count, sum, average, standard deviation, and 95th percentile confidence interval.
- *Average Actuated Split Duration Chart:* each point on the line graph for each phase represents the fifteen minute average duration of green and yellow time for each time the phase was serviced plotted against the fifteen minute interval.
- *Average Actuated Split Utilization Chart:* each point on the line graph for each phase represents the ratio between the Average Actuated Split Duration and the programmed split time within the controller plotted against the fifteen minute interval.
- *Split Statistics Table:* the table includes statistics related to the split actuations for each phase, including: count, sum, average, standard deviation, and 95th percentile confidence interval.
- *Split Service Frequency Chart:* each point on the line graph for each phase represents the number of times each phase was serviced over the entire date range plotted against the fifteen minute interval.
- *Split force Off Frequency Chart:* each point on the line graph for each phase represents the percent frequency that the Actuated Split Duration exceeded the programmed split time in the controller plotted against the fifteen minute interval.
- *Force Off Frequency Statistics Table:* the table includes statistics related to how often each phase forced off, including: count, force off count, percent frequency.

- *Sum of Detector Duration by Cycle Time Chart:* each bar on the clustered bar graph for each detector represents the sum of all detector activations grouped by when the initial cycle time of detector activation was recorded plotted against the amount of time since the start of the current cycle.
- *Phase Start of Green Cycle Time Frequency Chart:* each point on the scatter graph represents the recorded beginning of green for each phase for each cycle plotted against the amount of time since the start of the current cycle.
- *Average Start and End of Green Cycle Time Table:* the table includes the average start and end of green for each phase based on the amount of time since the start of the current cycle.
- *Estimated Sum of Detector Duration Within Green Interval with Adjusted Offset Chart:* each point on the line graph for each phase represents the sum of detector duration based on the start and end of green time plotted against a range of adjusted offsets to the start and end times.

The final report type was designed for the Streetsmart travel time monitoring system. This report utilizes the data gathered from the Streetsmart API and creates visualizations that make it easier to view the data and to identify trends in traffic patterns. The following lists the title of each table or chart and a short description.

- *Daily Average Travel Time by Type Chart:* each point on the line graph represents the average travel time for each pair type plotted against the date.
- *Average Travel Time by Type Chart:* each point on the line graph represents the average travel time for each pair type plotted against the fifteen minute interval.
- *Average Travel Time by Date Chart:* each point on the line graph represents the average travel time for each date plotted against the fifteen minute interval.
- *Selected Average vs Previous Three Week Average Chart:* each point represents the average travel time of the selected data range and the average travel time of from the previous three weeks of the selected data range plotted against the fifteen minute interval.
- *Histogram of Travel Times Chart:* each bar on the bar graph represents the count of travel times for each date sorted in five second bins within the selected date range plotted against the five second bins.
- *Statistical Variance Testing Results Chart:* each point represents the calculated T-value and maximum observed T-value of fifteen minute intervals of the statistical testing to identify a significant difference between the average travel time of the selected data range and the average travel time of the previous three weeks plotted against each date.
- *Average of T-Test Results Chart:* each point represents the average of results from statistical testing of fifteen minute intervals to identify a significant difference between the average travel time of the selected data range and the average travel time of the previous three weeks plotted against fifteen minute interval.

- *Travel Time Statistics Chart:* the table includes statistics, for each pair type, for each date and fifteen minute interval including: average travel time, previous three week average, T-test result for the statistical testing to identify a significant difference between the average travel time of the selected data range and the average travel time of the previous three weeks.

SAFETY

Safety is always a primary concern for both the workers delivering the project and the users of our infrastructure during construction. All work as part of this project was completed with minimal impact to the traveling public. There were not any injuries or incidents to workers, inspectors, or the public related any of the construction completed under this project.

SCHEDULE

The following summarizes the timeline for the major events of this project:

- May 2019 - Start of project
- June 2019 – System Engineering Training
- February 2020 - Notification to Proceed for Procurement of SPM System
- September 2020 – Transparity SPM Selected following RFP Process
- December 2021 - Field Equipment Installation Complete
- December 2021 – Requirements Validation of Transparity SPM Finished and Accepted
- October 2022 - Testing and Evaluation of SPM System Complete
- December 2022 – End of project

The methods traditionally employed by the City to deliver a comparable project would require a significant time investment of over five years. However, by making use of this innovation for this project we could realize a savings of at least two to three years.

There is also a financial component of time. With few exceptions, the purchasing power of today's money is greater than the purchasing power of the same amount in the future because of inflation; materials, fuel, labor, equipment, and supplies will generally cost more in the future than they do today.

Further this innovation notably reduces the amount of engineering time to optimize traffic signal timings and allows for larger projects than typical signal optimization projects would allow. This will have an ongoing benefit to future projects.

COSTS

The actual costs for the project compared to the estimated costs are shown in *Table 8: Project Cost Comparison Between Budgeted and Actual Costs* below:

Table 8: Project Cost Comparison Between Budgeted and Actual Costs

Task	Budget Amount	Actual Cost
0 – Authorized Pre-Contract Activities	$30,761.24	$30,761.24
1- Engineering Study and NEPA Documents	$9,500	$8,713.60
2 – Final Engineering Report and Procurement Documents	$2,300.00	$2,280.75
3 – Prepare Scope, Fee, and IGE for Remainder of Project Tasks	$700.00	$606.88
4a – Equipment Procurement, Inspection/Testing, Engineering, and Reporting (Sebago)	$254,813.76	$216,336.12
4b – Equipment Supply and Installation (Electric Light Company)	$510,800	$550,724.08
Reimbursable Expenses	$3,000.00	$2,452.33
Total	$811,875.00	$811,875.00

The extra costs associated with Task 4b – Equipment Supply and Installation were mostly a result of a larger than expected procurement cost for the ATSPM system and the follow up signal improvements at the Central Avenue at Locust Street and Central Avenue at Exit 7 Northbound Spaulding Turnpike Ramp intersections. The City's traffic consultant was able to efficiently complete the proposed scope of Task 4a to make up for the increased equipment costs and keep the project on budget.

Project Outcomes and Lessons Learned

Through this project, the City gained valuable insights about the procurement and use of an ATSPM system. The following summarizes the key observations, more detail can be found in the Project Description and Data Collection and Analysis sections.

- Learning about and utilizing the updated systems engineering process was very insightful and greatly reduced the amount of effort to produce a RFP and go through the procurement process. The supporting Concept of Operations and Requirements documents clearly outline to vendors the expectations of the proposed system leading to better proposals. The Requirements document in particular was useful later in the project when verifying that the installed system met the functionality agreed upon during the RFP and selection process.
- While testing the ATSPM system it was found that diagnosing intermittent or uncommon issues was far easier utilizing the high resolution data and the Transparity SPM software. During the project there was an intersection that was going into flashing operation at seemingly random and the basic reporting provided by the traffic signal controller or malfunction monitoring unit wasn't detailed enough to determine the cause. The event reporting produced by the Transparity SPM software was used to determine the exact sequence of events that lead to the flashing operation and ultimately identified an uncommon issue with the controller configuration.
- The ATSPM system has the ability to recognize traffic patterns beyond just simple traffic volume flows and provides enough information to be able to affect traffic patterns. Coordination was never considered in the past for the Silver Street system due to the traffic volumes suggesting that there wasn't a benefit to creating progression all the way through the corridor. However, using the ATSPM system it was identified that there were drivers utilizing the Durham Road System although the Silver Street system was a more direct route. After implementing coordination on the Silver Street system, the ATSPM system showed a reduction in delays along the corridor and in drivers utilizing the Durham Road system.
- The ATSPM system gives engineers the ability to optimize corridors larger than would typically be feasible utilizing typical signal optimization methods. The automated traffic volume data produced by the ATSPM system removes the need for in field data collection reducing costs and scheduling requirements; the data produced by the ATSPM system is also more robust than is typically possible with a one day or even multiple day traffic volume count. The SPM data can be used to calibrate and greatly reduce the effort required to optimize signal timings in a simulated environment, reducing engineering time and related costs. Finally, the ATSPM system greatly simplifies deploying traffic signal timings compared to in field implementation; engineers utilizing the ATSPM system are able to view and make adjustments to the entire corridor without needing to be physically present at the intersections. Additionally, the reporting produced by the system can ensure that the deployed timings are calibrated and operating as intended.

Recommendations and Implementation

RECOMMENDATIONS

The City determined based on the results of the data analysis and satisfaction from the facility users that it is proposed to adopt the ATSPM system into the standard operating procedures for managing the City's traffic signals.

However, the following areas were identified that could be improved upon in future projects:

- The ATSPM system is very sensitive to disruptions in communications between the field equipment and the traffic server. Any significant lapse in communications can result in significant amounts of lost data. Consideration should be made to implement redundant communications paths to the signal corridors. This could be accomplished by utilizing either redundant wireless connections or dormant cellular based connections that can be activated as needed to restore communications in the case that fiber-optic based interconnect is damaged or wireless radios become unresponsive.
- The ATSPM system should be expanded to include the remaining signalized intersections on Central Avenue, particularly the Central Avenue at Broadway and Central Avenue at Washington Street intersections, to allow for full interconnect, coordination, and management of the Central Avenue corridor.
- Consideration should be given to expanding the ATSPM system to signalized intersections associated with Exit 6, Exit 8, and Exit 9 of the Spaulding Turnpike as future projects and funding allow.
- Collaboration of the data from the ATSPM system should be considered with the City of Somersworth for the High Street traffic signal corridor to better accommodate traffic to and from the signals of the Week's Crossing system.
- Advance detection and travel time monitoring could be expanded to more of the signalized intersections to increase the functionality and full utilization of the ATSPM system.

STATUS OF IMPLEMENTATION AND ADOPTION

The ATSPM system is fully implemented and operational on the City's traffic network. There are plans for the system to be utilized and monitored as part of an ongoing signal operations contract where a consultant can assist City staff in managing and reviewing the SPM data collected by the system. As previously mentioned, it is the City's long-term plan to establish communications to every signalized intersection and expand the ATSPM system to intersections once they are connected to the City's traffic network. When feasible, any future signal maintenance or signal improvement projects will include connecting the signal to the City's traffic network.

Appendix

TECHNOLOGY TRANSFER

The project was presented in August 2022 to NHDOT staff, New Hampshire FHWA staff, and City staff. The presentation overviewed the scope of the project, the ATSPM system, procured equipment, and tasks completed.

This project was presented at the September 2022 nationwide ATSPM meeting hosted by the FHWA. The ATSPM meetings are well attended with representatives from multiple state department of transportation departments, municipal staff, engineers, and consultants. A recording of the presentation is made available by the FHWA and, at the time of this report, can be found in the “Automated Traffic Signal Performance Measures – Monthly Call Recordings” discussion within the “udotdevelopment/ATSPM” project on https://github.com.

Training was held for City staff in October 2022. The training reviewed basic traffic signal concepts and presented the capabilities of the ATSPM system while giving City staff the opportunity to ask questions related to the ATSPM system.

The project was presented in November 2022 at the Coastal Traffic Technology Seminar. This seminar was held in Portsmouth New Hampshire and was hosted by Coastal Traffic, a local distributer of traffic signal equipment. The seminar was attended by staff from multiple state department of transportation departments, municipal staff, engineers, and consultants, all from the greater New England area.

REFERENCED DOCUMENTS

- Concept of Operations
- System Requirements
- Request for Information: ATSPM System
- Request for Information Response Summary
- Request for Proposals: ATSPM System
- Request for Proposals, Recommendation Memorandum
- Durham Corridor Technical Memorandum – Baseline SPM Conditions
- Central Avenue Travel Time Monitoring System Evaluation
- Durham Road at Mill Street Proposed Signal Phasing Memorandum
- ATSPM System Standard Operating Procedures

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The AID Demonstration program provides funding as an incentive for eligible entities to accelerate the implementation and adoption of innovation in highway transportation. The AID Demonstration program is one initiative under the multi-faceted Technology and Innovation Deployment Program (TIDP).
For more information please visit:
https://www.fhwa.dot.gov/innovation/grants/