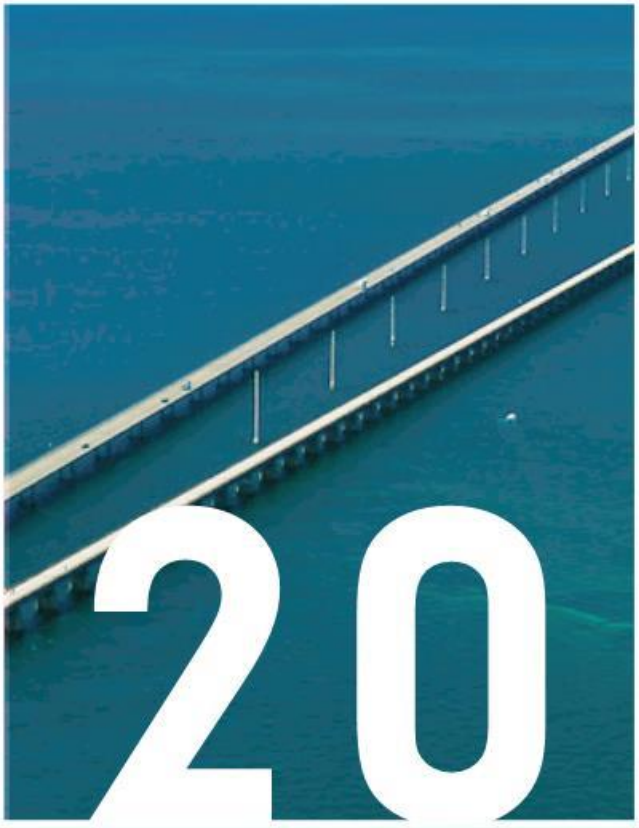
CONNECTING OVERSEAS TO ADVANCE SAFE TRAVEL

FDOT TSM&O
Transportation Systems Management & Operations

FLP
Office of Freight, Logistics and Passenger Operations



INFRA GRANT APPLICATION

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GRANT REQUEST:
$5.0M

GRANT TYPE:
SMALL PROJECT; PREDOMINANTLY RURAL

Keys COAST
1
Connecting Overseas to Advance Safe Travel

Basic Project Information	
Project Name	Keys Connecting Overseas to Advance Safe Travel (COAST)
Project Sponsor	FDOT District 6
Was an INFRA application for this project submitted previously?	No
Project Costs	
INFRA Request Amount	$5M
Estimated federal funding (excluding INFRA)	N/A
Estimated non-federal funding	$4.02M
Future Eligible Project Cost (Sum of previous three rows)	$9.02M
Previously incurred project costs (if applicable)	$0.29M
Total Project Cost (Sum of "previous incurred" and "future eligible")	$9.32M
Are matching funds restricted to a specific project component? If so, which one?	No
Project Eligibility	
Approximately, how much of the estimated future eligible project costs will be spent on components of the project currently located on the National Highway Freight Network (NHFN)?	12%
Approximately how much of the estimated future eligible project costs will be spent on components of the project currently located on the National Highway System (NHS)?	100%
Approximately how much of the estimated future eligible project costs will be spent on components constituting railway-highway grade crossing or grade separation projects?	N/A
Approximately how much of the estimated future eligible project costs will be spent on components constituting intermodal or freight rail projects, or freight projects within the boundaries of a public or private freight rail, water (including ports), or intermodal facility?	20%
Project Location	
State(s) in which the project is located	Florida
Small or large project	Small
Urbanized Area in which project is located, if applicable.	Key West
Population of Urbanized Area	60,000 including Significant Tourist Traffic
Is the project currently programmed in the?	
TIP	Yes
STIP	Yes
MPO Long Range Transportation Plan	N/A
State Long Range Transportation Plan	No
State Freight Plan	Yes

Note: INFRA = Infrastructure for Rebuilding America; STIP = Statewide Transportation Improvement Program; TIP = Transportation Improvement Program; MPO = Metropolitan Planning Organization

Table of Contents

List of Tables

List of Figures

Acronyms/Definitions

3GPP	Third Generation Partnership Project
AADT	Average Annual Daily Traffic
AOEM	Automobile Original Equipment Manufacturers
API	Application programming interface
ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation
ATC	Advanced Transportation Controller
ATSPM	Automated Traffic Signal Performance Measures
BCA	Benefit-Cost Analysis
BSM	Basic Safety Message
C-V2X	Cellular Vehicle to Everything
CAV	Connected and Automated Vehicle
CCTV	Closed-Circuit Television
CE	Categorical Exclusion
CEI	Construction Engineering Inspection
COAST	Connecting Overseas to Advance Safe Travel
CON	Construction
ConOps	Concept of Operations
CRF	Crash Reduction Factor
CRFC	Critical Rural Freight Corridor
CV	Connected Vehicle
D6 PLEMO	District 6 Planning and Environmental Management Office

DHSMV	Department of Highway Safety and Motor Vehicles
DOR	Florida Department of Revenue
DSRC	Dedicated Short Range Communications
EDC	Every Day Counts
EER	Environmental Evaluation Report
ERP	Environmental Resource Permitting
ERDA	Environmental Resources Desktop Analysis
EST	Environmental Screening Tool
ETDM	Efficient Transportation Decision Making
FAC	Florida Administrative Code
FCC	Federal Communications Commission
FCND	Freight Container Number Database
FDACS	Florida Department of Agriculture and Consumer Services
FDCA	Florida Department of Community Affairs
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FDR	Final Design Review
FHWA	Federal Highway Administration
FIU	Florida International University
FSP	Freight Signal Priority
FWC	Florida Fish and Wildlife Conservation Commission
FY	Fiscal Year
GDOT	Georgia Department of Transportation
GNSS	Global Navigational Satellite System
HMI	Human-Machine Interface
HRR	Hardware Requirements Review
ICD	Interface Control Document
ICS	Interface Control Specification
IIS	Internet Information Server
INFRA	Infrastructure for Rebuilding America
ITS	Intelligent Transportation System
MAP	CAV geometric map
MCSAW	Motor Carrier Size and Weight
MOU	Memorandum of Understanding
NEPA	National Environmental Policy Act
NHFN	National Highway Freight Network
NHS	National Highway System
NPS	National Park Service
NPV	Net Present Value
O&M	Operations and Maintenance
OBU	On-Board Unit
ORR	Operational Readiness Review
OSADP	Open Source Application Development Portal
PDR	Preliminary Design Review
PE	Preliminary Engineering
PHFS	Primary Highway Freight System
PID	Personal Information Device
PSEMP	Project Systems Engineering Management Plan
RFP	Request for Proposal
RITSA	Regional ITS Architecture
RSU	Roadside Units

RTMC	Regional Transportation Management Center
RTVM	Requirements Traceability Verification Matrix
SAE	Society of Automotive Engineers
SCMS	Security Credential Management System
SDR	System Design Review
SEP	Systems Engineering Processes
SFWMD	South Florida Water Management District
SHPO	Florida Department of State, Division of Historic Resources
SICN	Statewide ITS Communications Network
SIS	Strategic Intermodal System
SME	Safety, Mobility, and Economic Development
SMART	Specific, Measurable, Achievable, Relevant, and Time-bound
SP	Service Packages
SPaT	Signal Phase and Timing
SRM	Signal Request Message
SRR	System Requirements Review
SSM	Signal Status Message
SwRI	Southwest Research Institute
SWRR	Software Requirements Review
SQL	Structured Query Language
TDC	Tourism Development Council
TIM	Traveler Information Message
TMC	Traffic Management Center
TRR	Test Readiness Review
TSM&O	Transportation Systems Management & Operations
TSP	Transit Signal Priority
UF	University of Florida
USACE	U.S. Army Corps of Engineers
USDOT	United States Department of Transportation
USFWS	U.S. Fish and Wildlife Service
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	Vehicle-to-Everything
WAVE	Wireless Access in Vehicular Environments
WIM	Weigh-in-Motion

List of References

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2. http://floridatransportationplan.com/
3. https://www.kwtransit.com/
4. https://www8.miamidade.gov/global/transportation/metrobus.page
5. https://www.monroecounty-fl.gov/328/Tourist-Development-Council-TDC
6. https://www.census.gov/quickfacts/fact/map/monroecountyflorida,fl/PST045217
7. https://drive.google.com/open?id=1Tx5OyuCydNhkQsPwp7LoYvQ9cvsyTESh&usp=sharing
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11. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812506

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    a. http://www.monroecounty-fl.gov/DocumentCenter/View/15979/Population-Estimates-for-Monroe-County-and-Incorporated-Areas?bidId
13. https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/atspm.cfm
14. https://www.ite.org/pub/?id=9b4b112a-f5d3-0a35-d9ff-6986e0c63348
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18. http://www.leg.state.fl.us/statutes/index.cfm?App_mode=Display_Statute&URL=0300-0399/0380/Sections/0380.0552.html
19. https://www.flrules.org/gateway/ruleNo.asp?id=28-20.140

List of Supporting Documentation

Link to documents - https://sunguide.info/connected-vehicles/2019-infra-grant/

1. 2017 Florida Statewide National Highway Freight Network
2. 2017 U.S. 1 Arterial Travel Time and Delay Study
3. U.S. 1 SunGuide Incidents Hot Spot Analysis
4. U.S. 1 Monroe County Crash Table and Heat Map
5. U.S. 1 Straight Line Diagram
6. Keys COAST Concept Design Plans
7. Keys COAST Field Review Checklist
8. Keys COAST Cost Detailed Breakdown
9. FDOT Work Program Backup
10. Keys COAST Benefit Cost Analysis Technical Memorandum
11. Keys COAST Benefit Cost Analysis
12. Keys COAST Concept of Operations
13. Keys COAST Project Systems Engineering Management Plan
14. Keys COAST Detailed Schedule
15. FDOT Master University Agreement
16. Keys COAST Project Readiness Matrix
17. Key West Comprehensive Plan
18. Monroe County Comprehensive Plan
19. Hurricane Evacuation Clearance Time Memorandum of Understanding
20. NEPA Documentation
21. Letters of Support

1. Project Description

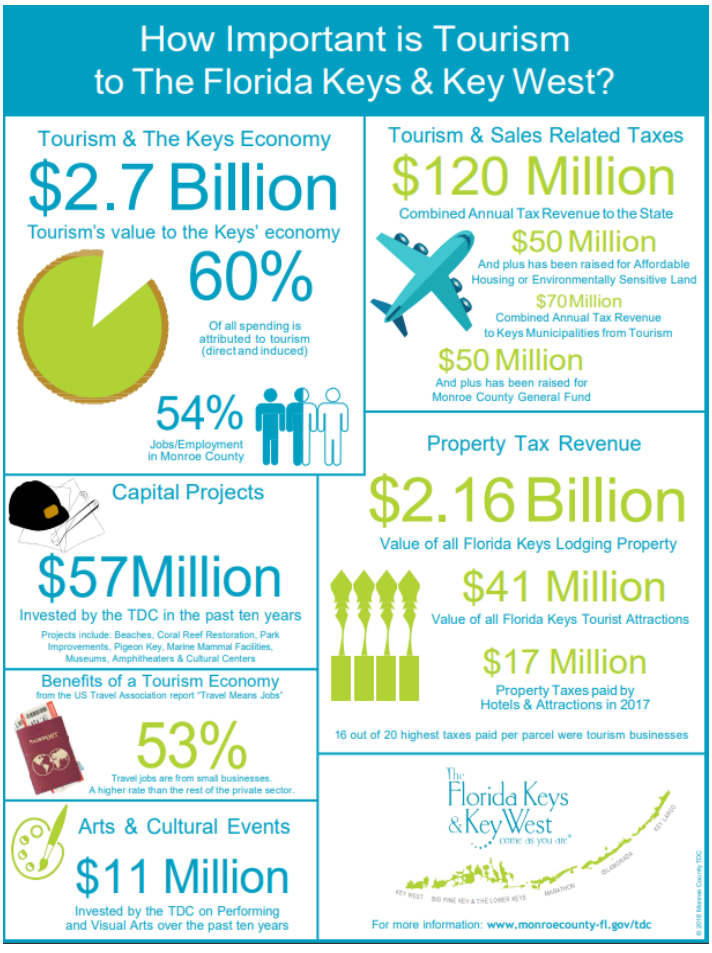
1.1. Background and Introduction

The Keys Connecting Overseas to Advance Safe Travel (COAST) is the first of its kind project in Florida Department of Transportation (FDOT) District 6 to deploy freight technologies and connected and automated vehicle (CAV) solutions along the 112.5-mile long U.S. 1 (Overseas Highway) in Monroe County, Florida (a.k.a., project segment). The project supports multimodal safety, mobility, and economic development (SME) goals of the FDOT CAV Business Plan[1] and three of the State of Florida's Transportation Plan[2] goals: safety and security for residents, mobility, and economic competitiveness.

The project segment is an important National Highway System (NHS) facility for Florida, with approximately 12 miles considered as a future National Highway Freight Network (NHFN). U.S. 1 is also part of the State of Florida's Strategic Intermodal System (SIS) supporting important freight and port facilities in the Florida Keys. This segment directly connects to two other NHFNs: Interstate 95 primary highway freight system (PHFS) and U.S. 27 critical rural freight corridor (CRFC). See supporting documentation for the 2017 Florida NHFN Map.

FDOT and Monroe County have identified the project segment as a priority corridor. FDOT has invested significantly in the active arterial management of this corridor from the District 6 Regional Transportation Management Center (RTMC). Additionally, a major ongoing investment in the project segment is the deployment of a wireless microwave communications network to provide a backup to cellular communications used by the existing Intelligent Transportation System (ITS) infrastructure, freight weigh-in-motion (WIM), and other traffic signal control features. FDOT is also expanding its Rapid Incident Scene Clearance (RISC) program to the project segment to allow for enhanced Traffic Incident Management (TIM), particularly for heavy vehicles. The route is also a critical emergency evacuation corridor for the Florida Keys.

Figure 1. Florida Keys Tourism Facts



Source: Monroe County Tourism Development Council

1.2. Regional and National Significance

U.S. 1 is an economic engine for all of the Florida Keys and is the only ingress/egress route for all modes of surface transportation to access the most southerly points of the continental United States. Monroe County, with the City of Key West as its county seat, is a popular tourist

destination. There is one seaport and two international airports in Monroe County that are served by U.S. 1. The Florida Keys have more than 40 freight generator locations (see map). Because there are no alternate routes around the chain of islands, U.S. 1 is the only viable route for the movement of goods to/from these ports and freight generators and the rest of the state. The project segment is also served by two major transit agencies – Key West Transit[3] and Miami-Dade Transit[4]. The project segment has two- and four-lane bidirectional road segments that carry up to 32,000 average annual daily traffic (AADT) comprising 12 percent truck traffic. The Keys COAST project holds regional significance and helps promote safer and faster travel through the U.S. 1 corridor using advanced technology. The solutions and applications proposed in this project are scalable to both state and national deployment.

According to the Monroe County Tourism Development Council (TDC)[5], the tourism industry employs 54 percent of the Florida Keys workforce (see Figure 1). The estimated value of Monroe County's tourism is $2.7 billion and 60 percent of spending in the county is attributed to tourism in 2017. This amount is set to increase with time and in turn generate more freight, transit, cargo, and vehicular traffic in the region. The Port of Key West is a major economic engine for the city and local businesses, bringing in almost a million total passengers per year resulting in a local business impact of approximately $85 million.

1.3. Mobility Challenges

The corridor currently faces several mobility challenges such as delays at traffic signals, drawbridge, and WIM. The current delay through these traffic control features, based on the latest travel time runs, is 14 minutes 11 seconds for a total trip of 2 hours and 30 minutes at an average speed of 46 miles per hour. See supporting documentation for the study. This delay does not include delays to the in-compliant freight traffic pulling in the WIM for a check each time, as well as delays to the emergency vehicles when reporting to incidents without priority and transporting patients to/from the hospitals spread apart due to the linear geography of the islands.

Special recurring annual events in the Florida Keys are world renowned and can bring tens of thousands of visitors to the Keys using U.S. 1 in the span of a weekend or a single day. In Fiscal Year (FY) 2017-2018, the project segment experienced more than 200 traffic incidents. See SunGuide® events in supporting documentation that led to partial or full lane closure **every other day** along a route which is the economic lifeline for a region without a viable alternate route for about 106 miles of the 112.5-mile project segment. The negative impact of the delays due to special events and traffic incidents is disproportionately higher for the freight and commercial vehicles.

To address these mobility issues, the project will deploy the following innovative CV applications, referred to as service packages (SP). Details of the overall project technical concept will be discussed later in the application. The SP are derived out of the United States Department of Transportation (USDOT) Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) and will be adopted in the District 6 Regional ITS Architecture (RITSA) after the ongoing State ITS Architecture updates.

- **CVO06 – Freight Signal Priority (FSP)**: This SP provides traffic signal priority for freight and commercial vehicles traveling in a signalized network. The goal is for freight vehicles to safely travel through signals with fewer stops, less delay and better travel time reliability.
- **CVO08 – Smart Roadside and Virtual WIM**: This SP includes the delivery of capabilities related to wireless roadside inspections and electronic screening/virtual weigh stations.

Wireless roadside inspection is defined by a safety screening capability that employs communications technologies to obtain information from a commercial vehicle that will allow safety screening of the vehicle and its driver.

- **PS03 – Emergency Vehicle Preemption**: This SP provides signal preemption for public safety-first responder vehicles. Both traditional signal preemption systems and new systems based on CAV technology are covered. The project will facilitate movement of public safety vehicles through an intersection by clearing queues, holding conflicting phases and transitioning back from preemption to normal signal operations.
- **TM04 – CV Traffic Signal System**: This SP uses both vehicle location and movement information from connected vehicles as well as infrastructure measurement of non-equipped vehicles to improve the operations of traffic signal control systems. The SP utilizes the vehicle information to adjust signal timing for one or a group of intersections to improve traffic flow, including allowing platoon flow through the intersection.
- **TM18 – Drawbridge Management**: This SP supports systems that manage drawbridges at rivers and canals and other multimodal crossings (other than railroad grade crossings, which are specifically covered by other SPs). The equipment managed by this SP includes control devices (e.g., gates, warning lights) at the drawbridge as well as the information systems that are used to keep travelers apprised of current and forecasted drawbridge status.
- **PT09 – Transit Signal Priority (TSP)**: This SP uses transit vehicle to infrastructure (V2I) communications to allow a transit vehicle to request priority at one or a series of signals. The SP provides feedback to the transit driver on whether the priority has been granted or not. This SP can contribute to improved transit performance by reducing the stoppage time at a signal.

1.4. Safety Challenges

The corridor currently faces several safety challenges ranging from freight, transit, pedestrian-bicyclist, and other motor vehicle crashes. A safety analysis was conducted for three years (2015 to 2017). Most crashes occurred around traffic signals and other traffic control elements along the corridor where the innovative technology deployment is proposed. There were 7,533 crashes in the last three years with 1,694 injury crashes and 51 fatal crashes as shown in Table 1. A total of **3% of crashes involved freight traffic**; **5% involved bicycles and pedestrians**, and **less than 1% involved transit**. A total of **seven (7) fatal crashes involved freight**, **one (1) fatal crash involved transit**, and **two (2) fatal crashes involved pedestrian/bicyclist** in the project limits.

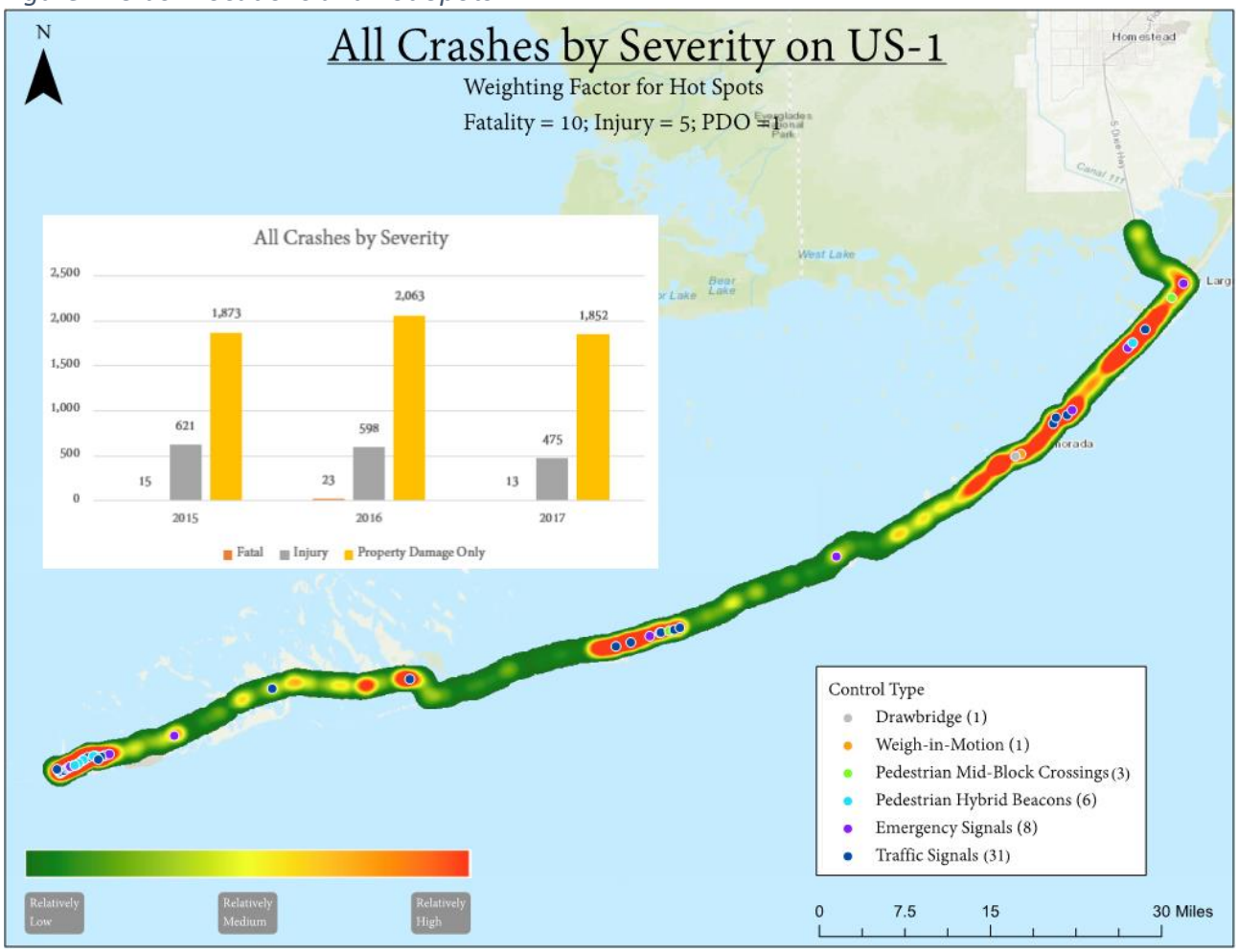
Figure 2 and the online map show the hotspot locations for crashes along U.S. 1. In addition, supporting documentation has the crash hot spots and locations identified by various road users.

Table 1. Crash Data Summary by Modes of Transportation

Modes	Severity	2015	2016	2017	Total
All Vehicles	Fatal	15	23	13	51
	Injury	621	598	475	1,694
	PDO	1,873	2,063	1,852	5,788
Total		**2,509**	**2,684**	**2,340**	**7,533**
Pedestrian/Bike	Fatal	0	0	2	2
	Injury	124	114	72	310
	PDO	13	14	20	47

Modes	Severity	2015	2016	2017	Total
	Total	**137**	**128**	**94**	**359**
	% of Total	**5%**	**5%**	**4%**	**5%**
Freight	Fatal	0	3	4	**7**
	Injury	10	18	16	44
	PDO	47	52	69	168
	Total	**57**	**73**	**89**	**219**
	% of Total	**2%**	**3%**	**4%**	**3%**
Transit	Fatal	0	1	0	**1**
	Injury	4	1	0	5
	PDO	9	5	3	17
	Total	**13**	**7**	**3**	**23**
	% of Total	**0.5%**	**0.3%**	**0.1%**	**0.3%**

Figure 2. Crash Locations and Hot Spots



As shown on the maps, the crashes are concentrated around the 50 traffic control elements (signals, drawbridge, WIM, emergency signals, and pedestrian signals). Therefore, the following CAV safety solutions identified as part of this project are all along these control locations based on the USDOT ARC-IT service packages:

- **VS12 – Pedestrian and Cyclist Safety**: This SP supports the sensing and warning systems used to interact with pedestrians, cyclists, and other non-motorized users that operate on the main vehicle roadways, or on pathways that intersect the main vehicle roadways. The goal is to disseminate safety messages to/from vehicular/non-vehicular traffic.
- **VS02 – Vehicle to Vehicle (V2V) Basic Safety**: This SP exchanges basic safety messages with surrounding CAVs to support and augment the safety warning and control automation features. These exchanges support the CV safety applications defined in Society of Automotive Engineers (SAE) J2945/1. As a part of this project, a warning about approaching vehicles and pedestrians to all modes of transportation with onboard units (OBUs) will be implemented.

2. Project Location

U.S. 1 (Overseas Highway), completed in 1938, connects a string of Keys and coral rock with 112.5 miles of concrete roadway. The project corridor begins at mile-marker 0.0 (24.555318, -81.804059) in Key West and ends at mile-marker 112.5 (25.242877, -80.434871) at Monroe County and Miami-Dade County line. Key West is the southernmost city in the continental United States. It is 1.5 miles wide and 4 miles long and is 153 miles southwest of Miami. U.S. 1 connects Key West and other cities along the Florida Keys to the major NHFN (I-95) and rural NHFN (U.S. 27) and acts as the **only link to interstate commerce** to travel to the southernmost tip of Florida using surface transportation. U.S. 1 connects to the **Naval Air Station**, **Key West International Airport**, **Marathon International Airport**, and the **Port of Key West**.

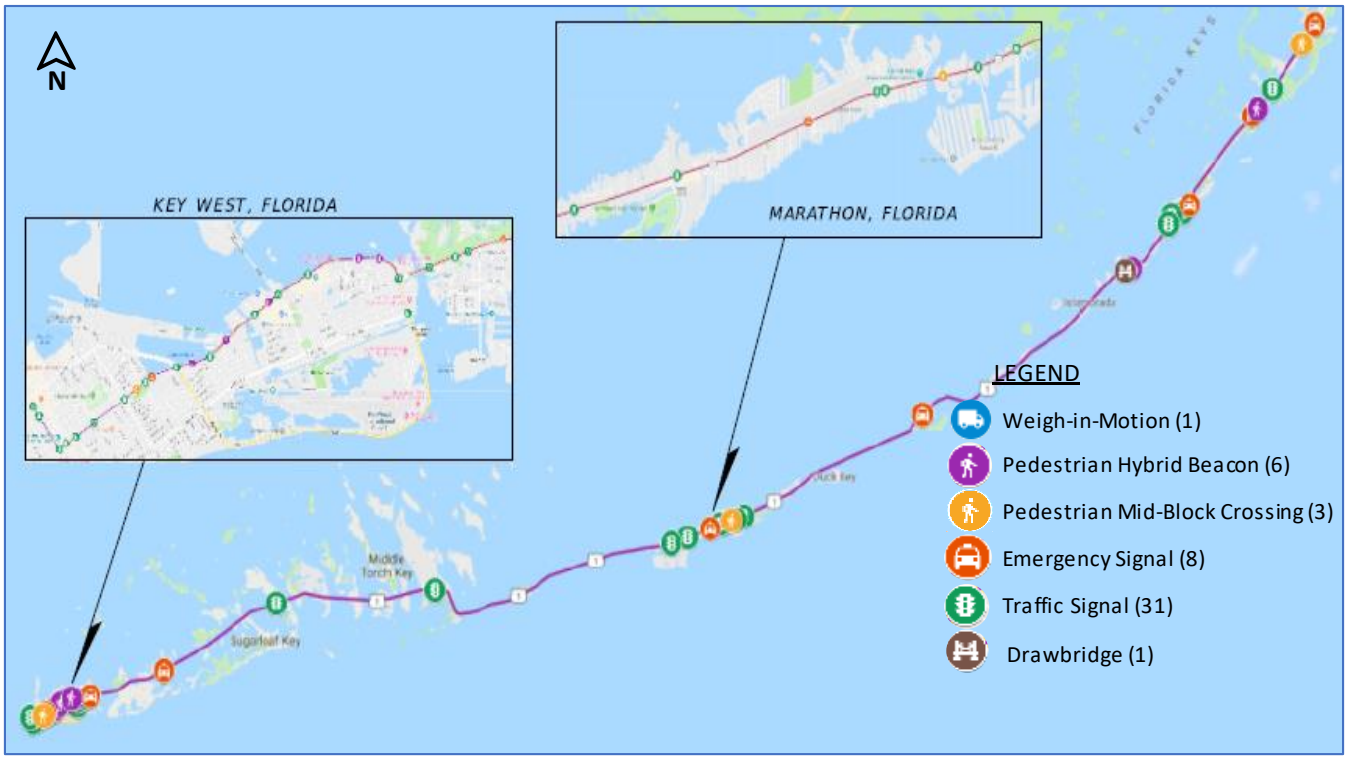
According to the 2017 United States Census Bureau[6], the City of Key West and other cities/town/villages along U.S. 1 are classified as urban and rural. The FDOT functional classification for U.S. 1 is rural principal arterial for about 35 miles of the project segment while the remaining portion is urban principal arterial (see FDOT straight line diagram supporting documentation).

The development in the county is predominantly low density and highly controlled consistent with its Area of Critical State Concern designation by the Administration Commission in 1975 and the Florida Legislature in 1979 (Section 380.0552 Florida Statutes) to protect the environmental and natural resources. That is why the character of the roadway corridor and the county region is considered **mostly rural**. The project area does not fall under any metropolitan planning organization region. The current population along U.S. 1 in the Florida Keys is approximately 77,000 according to the 2017 estimates from census.

The project consists of 50 traffic control elements including **one weigh-in-motion station**; **31 traffic signals**; **eight emergency signals**; **one drawbridge signal**; **six pedestrian hybrid beacons**; and **three mid-block crossings**. All these locations will be deployed with technology and CAV solutions that leverage the existing ITS infrastructure. Figure 3 shows the project elements and their locations. **Note**: five of the aforementioned pedestrian hybrid beacons in Key West are under construction and will be completed in 2019.

See details of the corridor in the Google Maps here[7]. Field reviews of all 50 elements shown in the Figure 3 are completed and the line of sight review of the Dedicated Short Range Communications (DSRC) and cabinet, controller, switches, communications, etc. details are recorded. See supporting documentation for the concept plans and technical detail spreadsheet.

Figure 3. Project Location Map



3. Project Parties

FDOT is the primary recipient of the grant. However, the project involves several local, state, and federal stakeholders that are directly involved in the project. The following table lists the project stakeholders, their agencies, influence level, and coordination status. FDOT also received letters of support from various stakeholders (in Table 2) as provided in the supporting documentation.

Table 2. Stakeholder Coordination Matrix

Agency Type	Stakeholder Names	Influence	Status	Method
State	FDOT District Offices	High	Complete	Meetings/Calls
State	FDOT Central Offices	Mid	Complete	Meetings/Calls
Freight	Florida Trucking Association	Mid	Complete	Meeting
Freight	FDOT Motor Carrier Size and Weight	High	Complete	Call
Freight	FDOT Freight Logistics and Planning	High	Complete	Meetings/Calls
Freight	FDOT Commercial Vehicle Operations	High	Complete	Call
Transit	City of Key West Transit	Mid	Complete	Meeting
Transit	Miami-Dade Transit	Mid	Complete	Call
Local	Monroe County	Mid	Complete	Call
Local	City of Key West	Mid	Complete	Meeting
Local	City of Marathon	Mid	Complete	Call
Local	Islamorada, Village of Islands	Mid	Complete	Call
Federal	United States Coast Guard (USCG)	Low	Complete	Meetings/Calls
Federal	Federal Highway Administration	Mid	Complete	Meetings/Calls

Agency Type	Stakeholder Names	Influence	Status	Method
Law Enforcement	Florida Highway Patrol (FHP)	Mid-Low	Complete	Meetings/Calls
Law Enforcement	Monroe County Sheriff's Office	Mid-Low	Complete	Meetings/Calls
Law Enforcement	Key West Police Department	Mid-Low	Complete	Meetings/Calls
Fire and Rescue	Key West Fire Department	Mid-Low	Complete	Meetings/Calls
Fire and Rescue	Key Largo Fire Department	Mid-Low	Complete	Meetings/Calls
Fire and Rescue	Monroe County Fire Rescue	Mid-Low	Complete	Meetings/Calls
Fire and Rescue	Islamorada Fire Rescue	Mid-Low	Complete	Meetings/Calls
Fire and Rescue	Marathon Fire Rescue	Mid-Low	Complete	Meetings/Calls
Private Freight	UPS, FedEx, Home Depot, Lowes, Walmart, Private Freight Operators, US Foods, Sysco, etc.	Mid-Low	Ongoing	Meetings/Calls
Federal Freight	USPS	Mid-Low	Ongoing	Meeting/Call

Note: Alternating highlighted bands are to help visualize distinct stakeholder groupings by agency type.

The project's secondary stakeholders who would also benefit from the WIM freight bypass system application are:

1. Department of Highway Safety and Motor Vehicles (DHSMV)
2. Florida Department of Revenue (DOR)
3. Florida Department of Agriculture and Consumer Services (FDACS)

These agencies are coordinated as part of the FDOT Motor Carrier Size and Weight (MCSAW) coordination on the Freight Container Number Database (FCND) application development. The smartphone application proposed as part of this project is a smaller piece to support the bigger MCSAW application for WIM bypass system.

4. Grant Funds, Sources, and Uses of Project Funds

The FDOT District 6 planned for the implementation of the Keys COAST project and invested funds to support this project. Based on preliminary engineering and concept development, FDOT has established a cost estimate of $9.02M for the design, CAV application development, equipment purchase (for RTMC, in-vehicle, in-field), construction, testing, and integration as well as other activities including a contingency amount. In addition, the cost estimate includes Construction Engineering Inspection (CEI) costs for FDOT oversight of the project. A breakdown of project costs is shown in Table 3.

As the owner and operator of the traffic signals and ITS devices in the Florida Keys, FDOT has already taken the necessary steps to prepare for the project including investments in the SunGuide® RTMC server equipment and upgrade of traffic signal controllers to support CAV. Systems Engineering Process activities commenced in Summer 2018 and have led to the development of a draft Concept of Operations (ConOps) and Project Systems Engineering Management Plan (PSEMP). See supporting documentation. These steps were fundamental in establishing the project's needs, benefits, stakeholder coordination, and scope requirements. The investments made to date for these activities are shown as incurred costs in Table 4. The details of the project cost breakdown with quantities are provided in the supporting documentation.

Table 3. Project Cost Breakdown

Description	Cost
SunGuide TMC Upgrades	
ATSPM-Signal Configuration, Vendor API for CV Data, Storage/Server Upgrade for ATSPM and CV Data, Security Credential Management System (SCMS)	$ 260,000.00
Field Upgrades	
Controller Upgrades, CCTV Cameras, Wireless Communications, ATSPM Loop Detection, UPS, APS, Police Panel	$ 2,851,900.00
Application Development	
Smartphone API, Pedestrian and Truck Weigh Station Modules	$ 300,000.00
Roadside Units (RSUs)	
Roadside Units (RSUs), Poles, Power and Point to Point	$ 710,000.00
On-board Units (OBUs)	
Deploy On-board Units on Test Vehicles	$ 1,250,000.00
Sub Total	**$ 5,371,900.00**
Other Project Cost	
Design, Systems Engineering, RFP, Project Management (Design Oversight)	$ 1,342,285.00
Volunteer Smartphone Use	$ 100,000.00
Testing and Integration	$ 80,000.00
Cloud Hosting	$ 65,000.00
Construction Engineering Inspection (CEI)	$ 805,750.00
Maintenance of Traffic (MOT), Mobilization	$ 429,752.00
Contingency	$ 429,752.00
Before and After Study	$ 400,000.00
Total Project Cost	**$ 9,024,439.00**

Note: ATSPM = Automated Traffic Signal Performance Measures; RFP = Request for Proposal

Note: FDOT has also made significant investment in the Statewide ITS Communications Network (SICN) for the Florida Keys. It is scheduled to complete by mid 2019. SICN will ultimately serve as a communications backbone once the statewide deployment is complete in later years. The Keys COAST project is proposed with the existing cellular communications and the cost to establish connections to the state microwave system is not included as part of this application request.

Table 4. Funding Breakdown for INFRA Grant

Phase	Federal	State	Local	Total
Preliminary Engineering (PE)	$ -	$ 250,000.00	$ -	$ 250,000.00
PE (SQL Server, Transparity)		$ 30,826.00	$ -	$ 30,826.00
PE	$ 203,275.00	$ 1,089,010.00	$ -	$ 1,292,285.00
Construction (CON) (2070 Controller 1C Module Upgrade)	$ -	$ 12,000.00	$ -	$ 12,000.00
CON	$ 4,008,244.00	$ 2,518,160.00	$ -	$ 6,526,404.00
CON SUPPORT (CEI Services)	$ 388,481.00	$ 417,269.00	$ -	$ 805,750.00
Before After Study	$ 400,000.00		$ -	$ 400,000.00
Total Project Cost	**$ 5,000,000.00**	**$ 4,317,265.00**	$ -	**$ 9,317,265.00**
Total Remaining Project Cost	**$ 5,000,000.00**	**$ 4,024,439.00**	$ -	**$ 9,024,439.00**

Notes: Yellow highlight indicates previously incurred cost = $292,826; INFRA = Infrastructure for Rebuilding America

As shown in Table 4, the future project cost is **$9.02M**, and of this amount, FDOT has programmed **$4.02M** commencing in Florida FY 18/19 through FY 22/23. Although, approximately 77.7% of these programmed funds are in FY 18/19 through FY 20/21, a sizable portion of the programmed funds is in FY 22/23. To advance the project and stay on track with the proposed schedule (project letting in May 2020), FDOT is implementing strategies to seek the additional required funds for project implementation. The following two options are being considered for additional funding.

- **Option 1: Seek INFRA Grant Funding ($5M):** If awarded, the **$5.0M** amount being requested will accelerate the Keys COAST project deployment. FDOT has identified and developed a strategy on how to use the funds when awarded, as shown in Table 5 (also see supporting documentation for additional details).
- **Option 2: Seek SIS/NHS and TSM&O Central Office Funding ($5M):** Currently there is no commitment from either of these two parties. However, even if funding is found and granted for use on the Keys COAST project, it is likely that funds will not be available until outer fiscal years (projected FY 2025/2026), and thus, the project will not be implemented on time. This option will be continually monitored for opportunities.

Table 5. Planned Funding Use Distribution

Phase	Code	FY	Federal	State	Local
CON (fed)	88716	FY 18/19 to FY 22/23	$ 4,008,244	$ 2,518,160	$ -
CON & Utilities (use for PE and Before/After)	88716	FY 18/19 to FY 22/23	$ 603,275	$ 1,089,010	$ -
CON SUPPORT	88718	FY 18/19 to FY 22/23	$ 388,481	$ 417,269	$ -
ENVIRON	88849	N/A	N/A	N/A	N/A
ROW	88777	N/A	N/A	N/A	N/A
Total			**$ 5,000,000**	**$ 4,024,439**	

Based on the above distribution, **FDOT will contribute 45 percent of the total project cost** and is **requesting a 55 percent match from the INFRA grant**. The percentage distribution by source and $5.0M dollar INFRA amount being requested is shown in Table 6.

Table 6. Remaining Project Cost

Total Remaining Project Cost	**$ 9,024,439.00**	**100%**
INFRA Grant Request	$ 5,000,000.00	55%
Estimated Federal Match	$ -	0%
Estimated Local Match	$ -	0%
Estimated FDOT Match	$ 4,024,439.00	45%
Total Federal Contribution	$ 5,000,000.00	55%

The solutions proposed in the project are value engineered to provide cost-effective solutions that are effective, reliable, and efficient. The project will leverage the existing infrastructure and build upon the existing systems and is a part of a larger regional vision for this intermodal corridor.

5. Merit Criteria

The detailed description of merit and selection criteria is provided in the following sub-section. Table 7 summarizes the selection criteria qualification checklist.

Table 7. Project Selection Criteria Checklist

#	Selection Criteria	Section #	Meets/Not Applicable
1	Support for National or Regional Economic Vitality	See Section 5.1	Meets
2	Leveraging of Federal Funding	See Section 5.2	Meets
3	Potential for Innovation	See Section 5.3	Meets
3.1	Technology	See Section 5.3.1	Meets
3.2	Project Delivery	See Section 5.3.2	Meets
3.3	Innovative Financing	See Section 5.3.3	Not Applicable
4	Performance and Accountability	See Section 5.4	Meets
5	Geographic Diversity	See Section 5.5	Meets
6	Previous Awards	See Section 5.6	Meets
7	Project Readiness	See Section 6	Meets

The Keys COAST project supports specific, measurable, achievable, relevant, and time-bound (SMART) goals:

- **Specific**: solutions proposed in this project focus on specific modes of transportation and promise to provide expected benefits to each mode. The project also identified specific locations to deploy project solutions based on background studies and research.
- **Measurable**: the baseline is defined, and stakeholder coordination is complete. The project performance measures developed will be included as part of the Before and After Study in partnership with University of Florida (UF) and Florida International University (FIU).
- **Achievable**: all solutions proposed are ready to be deployed and existing ITS infrastructure will be leveraged to achieve project goals of safety and mobility improvements of all modes.
- **Relevant**: the project goals align with Florida Transportation Plan and national goals, as well as the FDOT's 2019 CAV Business Plan, 2018 STAMP Action Plan, 2017 TSM&O Strategic Plan, and the 2018 District 6 TSM&O Program Action Plan.
- **Time-bound**: the project will be completed in 18 months and the Before and After Analysis windows are defined around the timeframe to complete the project evaluation.

5.1. Criterion #1: Support for National or Regional Economic Vitality

The Florida Keys is a major tourist destination and consists of a seaport, a Naval Air Station, and two international airports that generate a large number of freight and tourist traffic, in addition to the normal commuter traffic. The solutions proposed in the project are anticipated to yield the following outcomes to the region and can be scaled to the nation with similar deployments:

1. Reduced travel time for all traffic by 20% - 30%[8].
2. Reduced incident response time for first responders by 15% - 25%[8].
3. Reduced number of stops for first responders by 10% - 20%[8].
4. Reduced greenhouse gas emissions by 5% – 15%[8].
5. A crash reduction factor with 30% penetration of CV applications in 20 years is 5%[9]; 14% for 50% penetration; 36% with 100% penetration for vehicles with lane departure assist and automated braking features only (low-level automation).
6. A significant safety benefit is anticipated due to the WIM bypass system from the reduction of freight crashes around the Plantation Key WIM and due to freight signal priority at intersections as shown in the heat map here[10].

Note: Significant safety benefits can be achieved as the CV penetration increases and even more when the CAV penetration increases, which has the potential to eliminate 94% of the human error crashes[11]. However, this high-level penetration and benefits are not assumed in this BCA section. The existing FDOT agreements with the infrastructure data share companies will disseminate the signal phase and timing (SPaT) and MAP data via inbuilt Automobile Original Equipment Manufacturers (AOEM) vehicles. District 6 is already working with a few of these companies to share data for all signals along this corridor in preparation for this project.

The expected benefits and costs of the project are analyzed using the 'Benefit-Cost Analysis (BCA) Guidance for Discretionary Grant Programs' published by USDOT. The technical memorandum along with the spreadsheet for BCA analysis is provided in the supporting documentation. The costs associated with the Keys COAST project include the deployment cost, previously incurred cost, and the operations and maintenance (O&M) cost. The benefits are derived from three major outcomes – savings in travel time, increased safety due to decrease in crashes, and savings in emissions. The following assumptions were made for the BCA analysis:

- Service life of the CV infrastructure is 20 years.
- Analysis period for the BCA is 20 years (2020-2039).
- Base-line year for the no-build scenario is 2017.
- Discount rate used at 3% and 7% to obtain the net present value (NPV).
- Average CV penetration in 20 years is assumed to be 30%. CV penetration is expected to grow faster than 30% in the next 20 years due to private party onboard unit and smart phone applications development/penetration.
- Average trip length is 50% of the total corridor length at 56.3 miles.
- Average travel time saved (average trip length, 30% CV penetration) is 2 minutes 7 seconds.
- AADT growth - first ten years 1% annually; then 2030-2039 no increase is assumed.
- Average freight travel time savings due to the WIM bypass system is 5 minutes.
- Average emergency vehicle travel time savings due to signal preemption is 3 minutes.
- Freight crash reduction due to WIM bypass is 50%.
- Baseline risk is 1, which suggests that for future year no-build alternatives, the crashes would be the same as the average annual crash in the baseline year.
- Average gas mileage performance for a vehicle is 25 mpg and for freight is 15 mpg.

The **deployment cost is $9.02M**, **previously incurred project cost is $0.29M**, and the **O&M cost over a 20-year period is $17.37M**. The annual value of travel time savings for different transportation modes – vehicle, freight, transit, and emergency vehicles is $9.10M for the 2017 base year. These benefits for the future operational year of analysis are discounted at a 7% yearly rate to obtain vehicle total travel time savings of $100.91M for the project. The safety benefit is obtained by estimating the crash reduction factor (CRF) for the future year with assumed 30% CV market penetration. The discounted monetized value of the project's safety benefits is $144.38M for all vehicles (see Table 8). The emission benefits include CO2, SO2, VOCs, NOx, and PM2.5. The discounted monetized value of emission savings for the project is $14.74M for all vehicles.

Table 8. Benefit Cost Analysis for All Vehicles for 20 Years

Benefits	Undiscounted	NPV (3% Discount)	NPV (7% Discount)
Safety Benefits	$ 295,707,600	$ 211,549,800	$ 144,378,800
Driver Travel Time	$ 209,707,000	$ 149,111,000	$ 100,910,200
Environmental	$ 30,976,100	$ 21,913,300	$ 14,736,700

Total Benefit	**$ 536,390,700**	**$ 382,574,100**	**$ 260,025,700**
Project Cost	**$ 9,317,300**	**$ 9,317,300**	**$ 9,317,300**
O&M Cost	**$ 17,366,000**	**$ 11,981,000**	**$ 7,711,300**
B/C	**55.71**	**39.77**	**27.08**

For freight (see Table 9), the discounted travel time savings is $46.27M; discounted monetized safety benefits value is $15.95M; and the discounted monetized emission savings value is $5.51M.

Table 9. Benefit Cost Analysis for Freight for 20 Years

Benefits	Undiscounted	NPV (3% Discount)	NPV (7% Discount)
Safety Benefits	$ 32,670,900	$ 23,372,900	$ 15,951,500
Driver Travel Time	$ 96,153,300	$ 68,369,300	$ 46,268,600
Environmental	$ 11,633,700	$ 8,215,600	$ 5,513,400
Total Benefit	**$ 140,457,900**	**$ 99,957,800**	**$ 67,733,500**
Project Cost	**$ 9,317,300**	**$ 9,317,300**	**$ 9,317,300**
O&M Cost	**$ 17,366,000**	**$ 11,981,000**	**$ 7,711,300**
B/C	**13.21**	**9.44**	**6.44**

The **disbenefit** for this project **is zero** since the operation of the traffic would not be affected during the deployment. The residual cost is zero since the analysis period is 20 years of operation and the service life of the CV infrastructure is also assumed to be 20 years. The O&M costs and all the benefit costs for future operational years are discounted by 7% to obtain a base-year analysis value.

The **benefit-cost ratio based on the 7% discount rate is 27.08 for all vehicles and 6.44 for freight**. The benefits achieved through this project will support regional economic vitality as evidenced by the expected safety and mobility improvements for all modes including freight, transit, pedestrians, and bicycles and their interactions with vehicles. Moreover, being the primary highway connection to the mainland and the nation, mobility improvements will translate to improvements in freight supply chain; compliance with growth management policies that prioritize emergency evacuation; improve access to the military facilities; improve first-responder operation; and improve employment opportunities and access to affordable housing.

5.2. Criterion #2: Leveraging of Federal Funding

Federal funds will be used to fund capital improvements for the technology and connected signals deployment. As an effort to maximize the non-federal contribution, existing private partnerships with a few of the infrastructure data share companies will be leveraged. These companies will disseminate SPaT/MAP data to vehicle onboard units, translating to significant savings to FDOT and to this project and **increased CAV vehicular penetration**. All matching funds used in this project are state funds and there is no other tangible contribution by private industry. The INFRA federal fund will expedite the CAV technology deployment along U.S. 1 in Monroe County all the way to the City of Key West to cover all the state signals in the county.

5.3. Criterion #3: Potential for Innovation

Several technology solutions proposed in the project support CAV operation such as FSP, WIM bypass (credential verification), TSP, SPaT/MAP broadcasting, emergency signal preemption, and drawbridge operation (advance notification). See *Sections 1.3. Mobility Challenges* and *Section 1.4. Safety Challenges* for the list of innovative CV and technology applications to be deployed in the project. With these applications the project will:

- Accelerate innovative technology deployment in the state and subsequently share lessons learned and best practices for nationwide deployment. Some of the innovative solutions that are not commonly known in the freight operations being done in this project are:
  - Use of freight bypass system with RSU and smartphone application to allow for more in-compliant freight to bypass the Plantation Key WIM. The credentials are tallied with the upstream WIM, and if they match, the smartphone application will notify freight to bypass the Plantation Key WIM saving freight vehicles a significant amount of time and reducing conflicts for potential crashes at the ingress and egress points.
  - Use of an advance drawbridge close warning would prevent several crashes concentrated around drawbridges as well as provide advance notification to allow for better trip planning by freight and all vehicles.
  - FSP will allow for freight traffic to communicate with signals and allow for faster crossing at the signals as a priority.
- Utilize innovative procurement methods and invite vendors for questions and answers prior to RFP. After shortlist, invite vendors for field demonstration of application functionality based on requirements developed and presented in PSEMP and ConOps.

5.3.1. Innovation Area #1: Technology

The project entails various innovative technologies to be deployed and there are two innovations, WIM bypass and drawbridge advanced warning, that are firsts in the nation. The overall project innovative technologies and applicable solutions proposed are:

- Freight WIM bypass system via smartphone application credential verification from the upstream WIM station
- FSP using RSUs
  - SPaT and MAP data dissemination via RSUs
- Drawbridge open/close advance notification to plan for a trip
- V2I communications
  - RSUs – over 60 RSUs deployed on the 50 traffic control elements
  - Over 250 OBUs deployed on FDOT and partner stakeholder vehicles and some volunteer vehicles
- ATSPM deployed in RTMC for active and near real-time traffic signal monitoring
- V2V communications to notify vehicle presence within the DSRC range
- SPaT and MAP data dissemination at the signals to reduce congestion and improve travel time through the corridor.
- All RSUs will be cellular-capable and DSRC-capable
- Solutions proposed for multimodal safety and use of some smartphone applications will allow for automatically capturing and reporting safety-related issues (e.g., identifying and documenting near-miss incidents). Smartphone applications are specifically proposed for the WIM bypass system, serving as OBUs for all vehicles, and pedestrian-bicyclist safety.
- Solutions proposed in this project will allow for situational awareness for all road users in the DSRC range to allow for vehicle-to-everything (V2X) communications.
- SCMS and cybersecurity is part of this project and will be deployed for all DSRC enabled devices and firewall security enabled for any cloud hosted environment.
- The project enables efficient movement of goods and services to serve signals near the seaport, airports, and the Naval Station.

- All signals will be equipped with CCTVs and additional lane detectors as additional ITS technology to support ATSPM for active arterial management.

5.3.2. Innovation Area #2: Project Delivery

The contracting and procurement process used in this project is the best value procurement via a design-build contracting mechanism. The project will have construction engineering inspection oversight and project design oversight by the in-house system managers. As part of the best value procurement, the following approaches will be used:

1. FDOT will invite vendors at the pre-RFP stage for questions and answers.
2. FDOT will conduct the field verification test to demonstrate solutions functionality prior to making a final selection on the vendor.

FDOT has a pre-defined National Environmental Policy Act (NEPA) process and the project falls within the Categorical Exclusion (CE) Type I. Since the approval has an expiry date of one-year for construction to start, the paperwork for approval from NEPA is developed and provided in supporting documentation and will be submitted upon the announcement of grant results. The process of filing the paperwork and receiving approval is automated through the FDOT Efficient Transportation Decision Making (ETDM) process.

The FDOT electronic payment system and the invoice approval system will help expedite the payment for the contractors and its consultants. This will minimize any delays occurring due to the non-payment of the invoices.

5.3.3. Innovation Area #3: Innovative Financing

The project is funded with state funds for the state match portion. This project does not entail any innovative financing or revenue generation.

5.4. Criterion #4: Performance and Accountability

FDOT District 6 has identified its Master University Agreement as the contract vehicle to perform a comprehensive before and after evaluation of this project (see supporting documentation). The cost of this effort is included in the project cost estimates. FDOT's authorized representative and the project team leader, Yamilet Diaz, has first-hand experience in managing before-after evaluations for technology projects to ascertain their effectiveness in relation to a pre-established Systems Engineering Plan and the Performance Objectives.

FDOT District 6 owns, operates, and maintains the traffic signals and ITS infrastructure along U.S. 1 in Monroe County. The District has strong support from the local agencies (see Table 2) including the engineering departments, emergency responders, and law enforcement agencies. The District currently uses a multi-year funded performance-based ITS Maintenance Contract for maintenance of the traffic signal and ITS system and an Asset Maintenance Contractor for the roadway. The existing system is operated from the District 6 RTMC (24X7X365) through a performance-based multi-year funded TMC Operations Contract. All related Financial Project IDs have programmed funds on an annual basis in the adopted FDOT Work Program to cover the existing and projected needs. Each of these specific contract mechanisms has been utilized by the District for more than 10 years without any funding related performance issues. The contractors must utilize documented approved procedures, process maps, standard operating guidelines, training, and other documentation to ensure the workforce is trained and accountable for their

performance. The O&M for the Keys COAST project will also be performed by the District using the existing contract mechanisms for their remaining terms, and subsequent procurements of similar contracts.

The U.S. 1 traffic signals within the City of Key West are currently operated and maintained by the city on behalf of the District through a performance-based Traffic Signals Maintenance Compensation Agreement. However, beginning on July 1, 2020, for greater synergies with the remainder of the Monroe County Traffic Signals and ITS system, the O&M of these signals will also be assumed by the District. The O&M funding for the existing system is already programmed and as of July 1, 2020, will be performed using the ITS Maintenance contract mechanism.

The project's O&M needs will be incremental to the existing O&M responsibilities. The project O&M costs have been estimated to be $914,000 annually, including allowance for additional SunGuide TMC operations staffing, maintenance, and recurring communications costs. The current programmed five-year funding for the aforementioned contract mechanisms will be supplemented to account for the project O&M costs. FDOT has an annual process for developing the five-year work program which will be used to meet the O&M needs of the deployed systems.

FDOT has invested in the Systems Engineering Process for this project, and if INFRA funds are awarded, intends to let the project as early as May 2020, as shown in our project schedule. We agree to a project construction start date no later than September 30, 2022. If this milestone is not met, FDOT agrees to forfeit up to 10 percent of the award amount. Systems Engineering documents will be foundational to minimizing risk and the Requirements Traceability Verification Matrix (RTVM) will be a tool for compliance and accountability during the project implementation. Additionally, the district intends to use the proven FDOT Design-Build delivery process for this project with an adjusted score feature and a technical demonstration step. The District will utilize its TSM&O Technical Consultant and CEI Consultant for oversight of the Design-Build delivery and adherence to requirements, specifications, quality, and schedule.

5.5. Criterion #5: Geographic Diversity

The Florida Keys that are within Monroe County, are a chain of islands connected by 112.5 miles of U.S. 1, extending from Key Largo to Key West, representing the most southerly point of the continental United States. The project corridor spans across various rural and urban settings all through the corridor. The corridor connects various jurisdictional and geographic boundaries such as City of Marathon, Islamorada, Villages of Islands, and the City of Key West to Miami-Dade County and the rest of Florida. The nature of these areas along U.S. 1 is rural-like. According to the 2017 US Census Bureau[12] estimates and Monroe County website, the following populations are recorded along U.S. 1:

1. City of Key West: 24,597
2. City of Marathon: 8,775
3. Islamorada, Villages of Islands: 6,326
4. Other cities and Unincorporated Monroe County: 37,191

Total population along U.S. 1 is approximately 77,000. In addition, as discussed earlier, a significant amount of tourist population visits the Florida Keys throughout the year and often time doubles the population. The project caters to diverse population and mix of urban and rural areas and local agencies.

5.6. Criterion #6: Previous Awards

This project is requested for a federal grant for the first time. No previous grants were received or requested, or any applications submitted to request any funding for this project. The INFRA grant request is well suited for this project due to anticipated benefits to freight traffic, and all solutions proposed for WIM and FSP can be scaled and ported to other parts of the state and nation along with the lessons learned from this project.

6. Project Readiness

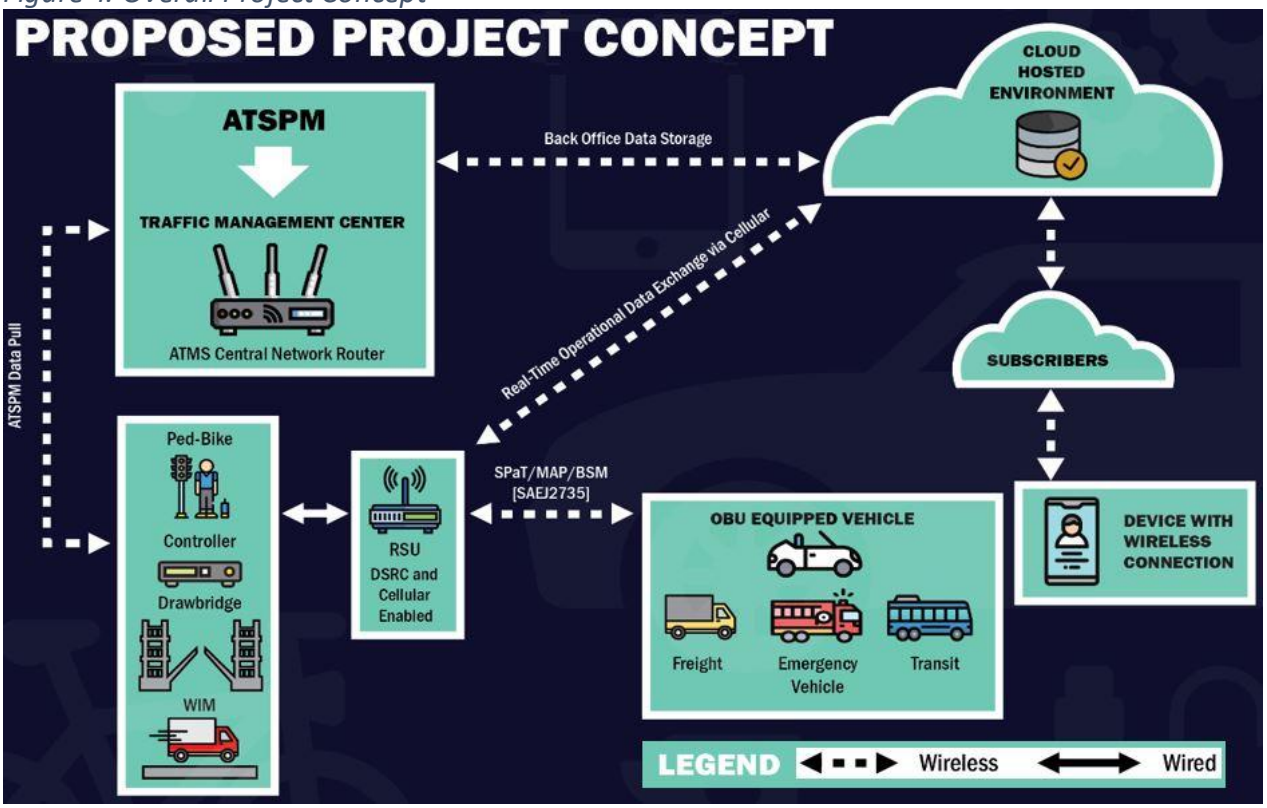
6.1. Technical Feasibility

The project ConOps and PSEMP have been developed, see supporting documentation. The ConOps describes the current state of operations, establishes user needs and the reasons for change, and defines desired operations for the project. The purpose of this document is to:

- Identify stakeholder and user needs and the proposed system expectations.
- Communicate the system developer's understanding of the user needs and how the system will meet those needs.

The PSEMP helps manage and control a project by using systems engineering processes (SEP) and identifies what items are to be developed, delivered, integrated, installed, verified, and supported. See the **proposed project concept** in Figure 4.

Figure 4. Overall Project Concept



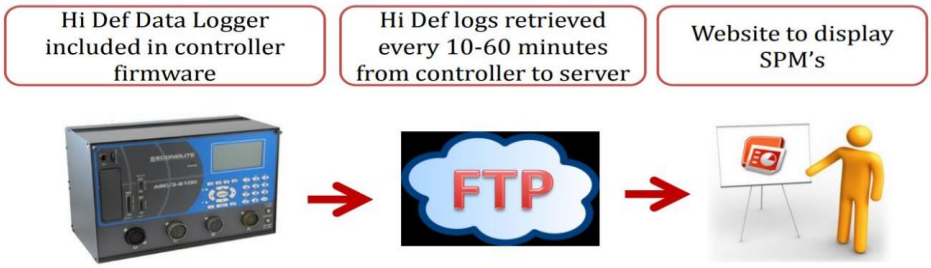
The Keys COAST project has two objectives. The **first objective** is to deploy the ATSPM software at the SunGuide RTMC for the 31 signals. ATSPM will improve signal operations with real-time operations monitoring and offers data for arrivals on green/red along with other performance

measures for signal retiming and coordination. ATSPM is FHWA's Every Day Counts (EDC) Initiative #4 Innovation (2017-2018)[13]. It is anticipated that the implementation of the ATSPM should decrease the need for a typical traffic signal retiming project that is conducted every three to five years. The costs and efforts associated with collecting performance data will be reduced.

ATSPM leverages controller's ability to capture high-frequency data in an Advanced Transportation Controller (ATC) already deployed on majority of traffic signals. The data will be sent to a server at a predetermined interval. The data is then available to be analyzed using one of several performance metrics.

The high-resolution data will be stored at District 6 RTMC. The open source ATSPM software will provide the capability to retrieve, configure, and process the data to develop performance measures. The performance measures support objectives and performance-based management of traffic signal maintenance and operations activities in a variety of tabular and graphical formats; provides capability to significantly enhance the performance of traffic signals to improve safety, efficiency, and reliability of field infrastructure; and, guide the targeted application and evaluation of advanced signal operational strategies. See Figure 5 for ATSPM process flow.

Figure 5. ATSPM Basic Process Flow



Source: UDOT Conference 11-2-16

The latest version of ATSPM will be used from the open source application development portal (OSADP) at https://github.com/udotdevelopment/ATSPM by Utah DOT. The implementation of the Keys COAST project will provide an opportunity to collaboratively improve and enhance ATSPM.

Figure 6. Detection and Performance Metric

Detection	Metric
None	Phase Termination Chart Split Monitor Preemption Details Pedestrian Delay
Lane-by-lane Presence Lane Group Presence	Purdue Split Failure
Lane-by-lane Stop Bar Count	Turning Movement Counts
Advanced Count	Purdue Coordination Diagram Approach Volume Approach Speed (requires detection with speed service)

Source: Utah DOT ATSPM Train-the-Trainer Workshop January 2017

The traffic volume data at each intersection will be gathered from inductive loop detectors or traffic cameras. Additional detector deployments are proposed as part of this project, based on type of traffic signal performance metric desired. CCTV cameras will be installed at these intersections to verify the performance of the detection system. Figure 6 shows the detection configuration with respect to the various metrics and Table 10 shows the detection requirements.

Table 10. Performance Measures and Detection Needed

MEASURE	DETECTION NEEDED
Purdue Coordination Diagram	Setback count (350 ft – 400 ft)
Approach Volume	Setback count (350 ft – 400 ft)
Approach Speed	Setback speed zone (350 ft – 400 ft)
Purdue Phase Termination	No detection needed or used
Split Monitor	No detection needed or used
Turning Movement Counts	Stop bar (lane-by-lane) count
Approach Delay	Setback count (350 ft – 400 ft)
Arrivals on Red	Setback count (350 ft – 400 ft)
Travel Time	Historical Data

The current operational status of the loop detection has been investigated at each intersection along U.S. 1. Additional conduit and pull boxes will be installed to accommodate the new loops at various intersections. The new infrastructure has been added to the cost estimate along with ATC. The requirements of an ATC used are from ATC 5201 v06.32[14] and FDOT Approved Products List[15] and latest Specification 671. The traffic controller upgrades on the U.S. 1 corridor have been added to the cost estimate and a majority of the traffic controllers are upgraded to meet these needs.

The traffic signals along U.S. 1 corridor are currently connected with SunGuide System via cellular communications. As part of this project, cellular modems are installed in each cabinet to send the intersection detection data back to the server. The servers at the District 6 RTMC will house the ATSPM software as well as data storage and processing. The ATSPM system will run on existing Microsoft Windows Servers and hosted by Microsoft Internet Information Server (IIS). The database server will be Microsoft Structured Query Language (SQL) server with Management Studio. The storage size of the database dependent on the number of detectors attached to a controller is defined.

The **second objective** of the Keys COAST project is to create a CAV ready U.S. 1 corridor. RSUs will be installed at each 50 traffic control locations, utilizing existing ITS infrastructure. CAVs act as vehicle probes moving along the corridor, which will also be used as ATSPM data.

It is anticipated that the RSUs will encompass at least 300-foot omnidirectional transmission radius. The footprint at each location is shown on concept plans in supporting documentation. The RSU and OBU selected will comply with the latest USDOT DSRC RSU specifications and the Third Generation Partnership Project (3GPP) Technical Specification Group Services and System Aspects Architecture enhancements for V2X services. Depending on the advancements of the RSU, the Keys COAST project will accommodate either the DSRC 802.11p, the Cellular Vehicle to Everything (C-V2X) Release 16, or both.

The RSU will communicate to the cloud-hosted environment using a cellular connection. In locations where the RSU is co-located with the ATC, the RSU will utilize the same cellular modem as the traffic controller. At the drawbridge and WIM, either a separate cellular modem will be installed or a cellular backhaul feature intrinsic to the RSU will be used.

Over 250 OBUs will be installed in FDOT/local agencies' vehicle fleet, emergency response, law enforcement, freight (major carriers only; rest use smartphone application), and transit vehicles. FDOT OBU equipped-vehicle drivers will be the only CAV users during the initial testing and integration phase of the project. The priority is that the system first test for basic DSRC message sending between the OBUs and RSU infrastructure (i.e., SPaT, MAP, TIM, BSM, SRM, and

SSM). Wireless Access in Vehicular Environments (WAVE) and SCMS messages are necessary for the CAV system to work at a basic security level. OBUs also use the Global Navigational Satellite System (GNSS). After that, the various service packages would be tested.

The pedestrians/bicyclists and freight vehicles will use a functional smartphone application to receive notices from RSU of an approaching vehicle, deliver vehicle approach alerts, and send Personal Information Device (PID) location information. PID applications might be leveraged from the USDOT CV Pilots or OSADP applications. The project will assign staff to test the smartphone application.

The preliminary cost estimate has been developed and details are provided in *Section 4. Grant Funds, Sources, and Uses of Project Funds*. The project risks and mitigation strategies have been identified in *Section 6.3.4. Assessment of Project Risks and Mitigation Strategies*. The following is a list of major components of the ATSPM and the CV systems that need to be installed in the RTMC and the field.

ATSPM System

RTMC

- Storage and Server Upgrade
- ATSPM software

Field

- Controller Upgrade
- Managed Field Ethernet Switch and CCTV Camera
- Cellular Modem
- Detection Loops, Conduit, Pull Boxes

CV System

RTMC

- SCMS
- Storage for CV Data
- Vendor Application Program Interface for CV Database

Field

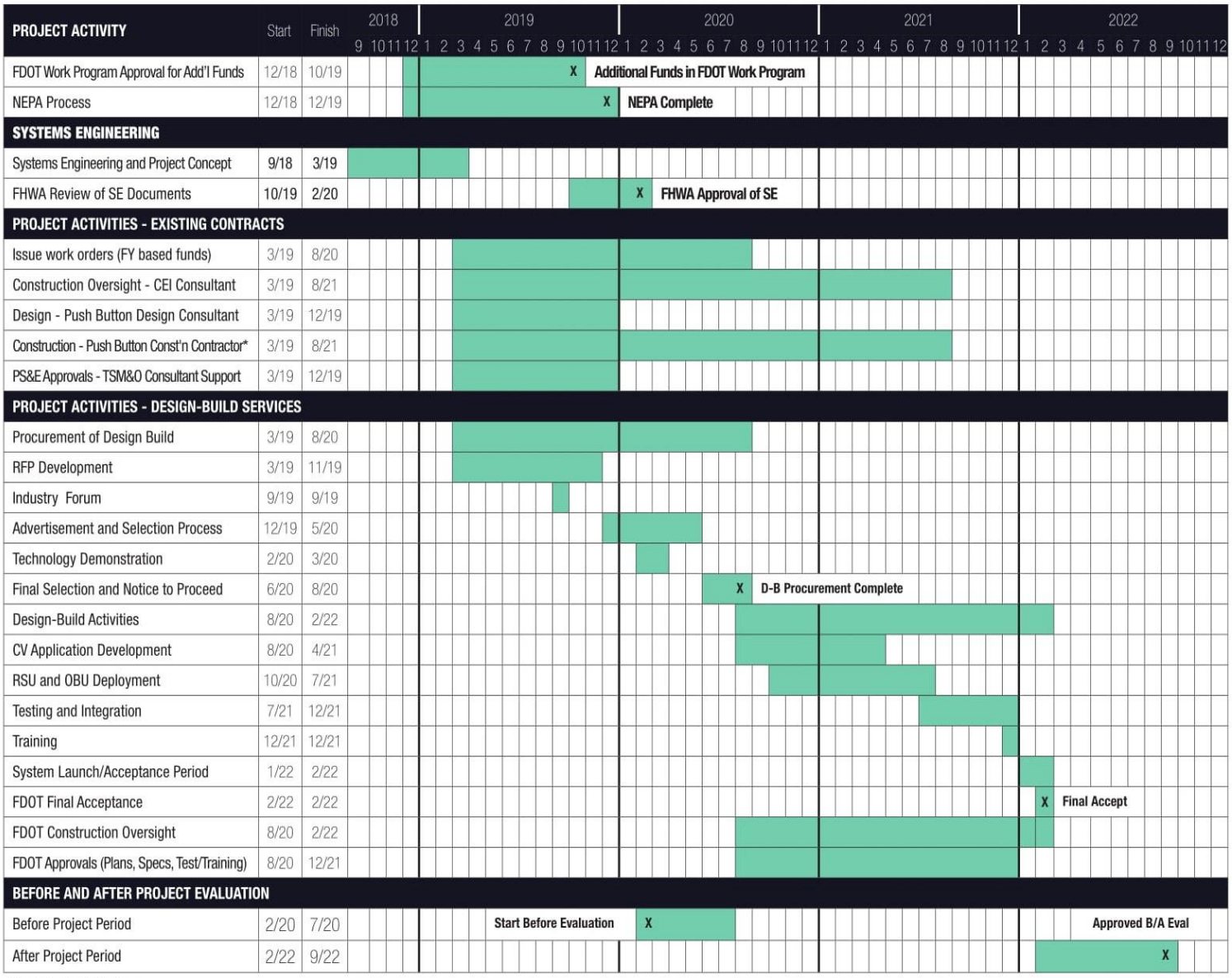
- RSU Unit, Conduit, Pull Boxes
- RSU Cellular Modem at Bridge and Weigh Station
- Smartphone Application Programming Interface (API) Development
- OBU Deployment in Vehicles
- Pedestrian Module Development
- Truck Weigh Station Module

See **project readiness matrix** for a summary of project readiness in supporting documentation.

6.2. Project Schedule

With approval of the INFRA grant funding, the Keys COAST project letting is anticipated as shown in the schedule in Table 11, including other major milestones. This project by its nature is technology based and poses little to no intrusion on the existing U.S. 1 traffic operation. The project will leverage existing infrastructure such as traffic signal mast arm structures for the installation of RSUs. Communications will rely on wireless cellular-based communications. As such, there are neither anticipated ROW acquisition nor environmental impacts, and therefore it qualifies for NEPA Type 1 CE. A detailed project schedule is provided in the supporting documentation.

Table 11. Proposed Project Schedule



X - Indicates Milestone
* Assumption - FDOT programmed FY 22/23 push button contract funding would be advanced if INFRA grant is awarded.
*Construction of project elements will be sequenced so that there is no conflict amongst contractors. FDOT has full control since push button contracts are being used.

6.3. Required Approvals

6.3.1. Environmental Permits and Reviews

Deployment of the Keys COAST project will be designed and constructed in accordance with all applicable state and federal environmental regulations. Environmental clearances and certifications will be coordinated and approved through the FDOT District 6 Planning and Environmental Management Office (D6 PLEMO) whose jurisdiction this project lies within.

As described in *Section 1 Project Description*, U.S. 1 is of significant regional and national importance but faces several safety and mobility challenges. This project will deploy innovative

CV applications that will not only address these mobility issues and support the critical regional economic vitality but will also inherently bring significant environmental improvements without the need of severe degradation to existing environmentally sensitive features. This project's use of technologies such as FSP, WIM bypass, and TSP will significantly reduce idle time of heavy vehicles, which will improve air quality and highway traffic noise since redundant deceleration/acceleration stages associated with traffic signals and congested intersections will be reduced. Since **all improvements related to the Keys COAST project are within the existing, maintained ROW that has been previously disturbed, it is anticipated there will be minimal involvement with any significant environmentally sensitive areas**.

Federal Compliance

The NEPA Class of Action for this project is anticipated to be a Type I CE under 23 CFR 771.117(c) (21)[16].

Federal regulatory agency coordination, review, and approval has been initiated with FDOT District 6 PLEMO. All necessary federal permits, approvals, and clearances will be obtained for any minor impacts to natural, cultural, or socioeconomically crucial features within the limits of construction of the Keys COAST improvement areas.

The Federal agency coordination includes, but is not limited to:

- Federal Highway Administration (FHWA)
- U.S. Army Corps of Engineers (USACE)
- U.S. Fish and Wildlife Service (USFWS)
- National Park Service (NPS)

State Compliance

State Environmental Resource Permitting (ERP) is conducted under Rule Chapter 62-330 of the Florida Administrative Code (FAC). When required, ERP permits authorizing work associated with the Keys COAST deployment will be prepared, coordinated, and approved through open communication with jurisdictional FDOT District 6 PLEMO and applicable state regulatory agencies.

The State agency coordination includes, but is not limited to:

- Florida Department of Environmental Protection (FDEP)
- Florida Fish and Wildlife Conservation Commission (FWC)
- Florida Department of Agriculture and Consumer Sciences (FDACS)
- Florida Department of Community Affairs (FDCA)
- Florida Department of State, Division of Historic Resources (SHPO)
- South Florida Water Management District (SFWMD)

Project Readiness

A preliminary environmental evaluation has been coordinated with FDOT District 6 PLEMO for the project. A memorandum outlining the preliminary District 6 PLEMO Environmental Resources Desktop Analysis (ERDA) and District Environmental Administrator concurrence of anticipated Type I CE to support the project readiness is found in the supporting documentation.

Required NEPA items that have been reviewed by District 6 PLEMO during this preliminary ERDA include:

- Local Traffic Patterns
- Planned Community Growth/Land Use Patterns
- Property Access
- Air Quality and Noise
- Water Quality
- Wetlands
- Navigation
- Floodplain Encroachment
- Wild and Scenic Rivers
- Endangered and Threatened Species, Wildlife, and Critical Habitats
- Right of Way Acquisition and Displacements
- Section 4(f) of the Department of Transportation Act
- Section 106 of the National Historic Preservation Act
- Contamination
- Controversy
- Permits

Resources utilized for this assessment included the FDOT Efficient Transportation Decision Making (ETDM) tool, Environmental Screening Tool (EST), State and Federal literature and database review, FDOT District 6 PLEMO coordination, and preliminary field reviews of the improvement locations. For details on the process required under Florida's assumption of NEPA policy, see the FDOT guide document here[17].

All work for the project will be done within existing FDOT right-of-way and will utilize existing traffic operations and ITS infrastructure. There is no new ground disturbance associated with this project's deployment and all environmentally sensitive areas within the project corridor will be preserved in their entirety. The ERDA to support project readiness has been completed and this project is fully ready to obtain the required Type I CE upon award of this grant. It is important to note that under Florida's assumption of NEPA policy, FDOT District 6 PLEMO is the authorizing agency to approve the Type I CE, and based on project coordination and ERDA performed to date, there is an extremely low risk of environmental review and permitting impacting the successful completion of this project.

6.3.2. State and Local Approval

As stated in earlier sections of this document, FDOT District 6 owns, operates, and maintains the traffic signals and ITS infrastructure along U.S. 1 in Monroe County. During the transition of the traffic signal system in Monroe County, Islamorada, and Marathon, the district established synergy with the local agencies (former maintaining agencies) for continued efficient and safe operation of the U.S. 1 corridor. Feedback during the recent stakeholder workshops for Keys COAST project from the local agencies has been that notable improvements at previous congested spots is a result of FDOT's direct involvement in real-time monitoring and management of the traffic signals as of July 1, 2018. FDOT has strong support from the local agencies including the engineering departments, emergency responders, law enforcement agencies, and transit agencies (see Table 2). Through this project, FDOT has extended its outreach to include other local agencies and stakeholders for additional gained support. *Section 3. Project Parties* of this application outlines various agencies contacted to date to inform them about the project and to obtain their support. Letters of support are provided in supporting documentation.

6.3.3. Federal Transportation Requirements Affecting State and Local Planning

FDOT is committed to the implementation of the Keys COAST project. Funding is programmed to support nearly half of the project's cost, which confirms local support. The district understands that a critical path item for this project will be to obtain participation commitment from freight companies. With strong local support and assistance from local freight coordinators, FDOT is committed to obtaining participation from Florida Trucking Association (FTA).

Additionally, the Keys COAST project on U.S. 1 in the Florida Keys is consistent with the Monroe County Comprehensive Plan and the City of Key West Comprehensive Plan. The project specifically supports objectives, policies, and goals of the Future Land Use, Traffic Circulation/Transportation, and Intergovernmental Coordination Elements of both plans, which are provided in supporting documentation. Selected statements have been excerpted below from the Monroe County Comprehensive Plan.

Objective 101.2 - As mandated by the State of Florida, pursuant to Section 380.0552, F.S.[18] and Rule 28-20.140, F.A.C.[19], and to maintain the public health, safety, and welfare, Monroe County shall maintain a maximum hurricane evacuation clearance time of 24 hours and will coordinate with the State Land Planning Agency relative to the 2012 Memorandum of Understanding (MOU) that has been adopted between the County and all the municipalities and the State agencies. This MOU is also included as supporting documentation.

- **Policy 101.2.3** - The County will consider capital improvements based upon the need for improved hurricane evacuation clearance times. The County will coordinate with the FDOT, the state agency which maintains U.S. 1, to ensure transportation projects that improve clearance times are prioritized.
- **Goal 301** - To provide a safe, convenient, efficient, and environmentally-compatible motorized and nonmotorized transportation system for the movement of people and goods.

Objective 301.3 - Monroe County shall encourage a multi-modal transportation system that is safe, convenient, and efficient, with complementary facilities to support non-motorized users.

Objective 301.4 - Monroe County shall plan for an intermodal transportation system that incorporates vehicles and alternative modes such as mass transit, and bicycle/pedestrian facilities. The county shall coordinate with other agencies and entities responsible for mass transit, bicycle/pedestrian, and vehicle transportation improvements occurring County-wide.

6.3.4. Assessment of Project Risks and Mitigation Strategies

The Keys COAST project is a highly innovative project that will employ cutting edge technology and new subsystems. The implementation of new technology adds risk and since the project has several subsystems new to FDOT District 6, project technical reviews will be an important task to reduce the risk. Under the project PSEMP and Section 4.6.1. Monitoring and Control, technical reviews can occur at various phases in the project. The project will use an Interface Control Specification (ICS) to specify all interfaces among subsystems (e.g., the signal controller to RSU, RSU to OBU). The contractor designing and integrating the system will write the ICS per RFP. When the interfaces have proven to work as specified in the ICS and the system is accepted, the ICS will become the Interface Control Document (ICD).

The project will review the system field functionality, at a minimum, to include Test Readiness Review (TRR) and Operational Readiness Review (ORR). Other preliminary reviews such as the following may also be considered necessary:

- System Requirements Review (SRR)
- System Design Review (SDR)
- Hardware Requirements Review (HRR)
- Software Requirements Review (SWRR)
- Preliminary Design Review (PDR)
- Final Design Review (FDR)

The TRR is a formal review conducted before starting a formal acceptance test of the system. It describes the objective and contents of the review, when it should be held, and who should attend. The products to be reviewed at the TRR include:

- Final Acceptance Test Plan
- Acceptance Test Procedures
- Preliminary Installation and Checkout Plan
- Acceptance Criteria and the process to correct deficiencies
- Updated ICD and ICS
- Test Support Equipment Needs
- Risk Items

The ORR will be held before the full-scale deployment and operation of the project. The ORR focuses on all the elements that need to be completed prior to operating the system. The items that are addressed during the ORR include:

- Disposition of the acceptance test discrepancies
- Training status and operations and maintenance procedures

As this will be a Design-Build project, the Contractor will perform these tests and will include each of the operations subsystems in the deployment:

- SCMS and RSU interface with the signal controller, signal controller to RTMC communications and CV alert transmissions to RTMC
- RSU DSRC message set (BSM, TIM, etc.). By mode: fleet vehicle, emergency, truck, and transit vehicle message verification.
- Aftermarket OBU (V2V and V2I) DSRC message set (BSM, TIM, etc.). Although V2V is not part of the FDOT vehicle fleet's new uses, the OBUs should be V2V capable and tested.
- All aftermarket OBU equipment installed in 250 FDOT fleet/partner vehicles
- OBU Human-Machine Interface (HMI) installations and utility testing
- Pedestrian application functionality and pedestrian to RSU message set
- Pedestrian warning to OBU communications
- Drawbridge and Weigh Station RSU operations and communication to OBU
- ATSPM software and communications to signal controllers
- SunGuide interfaces to CV and ATSPM modules. The Design-Build firm will install the ATSPM software and integrate it with the SunGuide system. All other system integrations with SunGuide will be done by the Design-Build firm.

Project risks are listed in Table 12 with a risk rating (low-medium-high). While all the risks are considered solvable, the risk rating indicates the likelihood and costliness of running into a delay in addressing the issue.

Table 12. Project Risks and Rating (Low-Medium-High)

Project Risk	Rating	Mitigation
Federal Communications Commission (FCC) licensing at each location	Low	Early application on FCC website. FDOT SICN is responsible and on track for filing the application.
Vehicle detectors sufficient for ATSPM accuracy	Low	Additional infrastructure including new pull boxes and bored conduit in anticipation of defective or absence of loops
SunGuide software integration of ATSPM	Low	Selecting qualified D/B contractor
SunGuide software integration of CV alert modules	Medium	Applying lessons learned from previous CV projects in Tampa and Tallahassee
Cellular communications may present latency or reliability problems	Medium	Measuring cellular signal strength and DSRC interference at intersections
OBU delivery per specifications and fully compatible with RSU module	Medium	Allowing sufficient time in the schedule for a vendor to develop/procure the OBU
OBU DSRC message set compatible for service packages	Medium	Selecting OBU vendor carefully and with well-written specifications
OBU HMI is sufficient and successful for human user	Medium	Selecting OBU vendor carefully and with well-written specifications
DSRC 802.11p versus C-V2X Release 16	Medium	Track the advancement of both technologies. Flexibility is needed to choose one technology over the other.
Interoperability	Medium	Applying lessons learned from other deployment projects in the state and USDOT CV projects to allow for interoperability with devices proposed in these projects.
Schedule for design and construction as OBU design, development, installation, training and testing may be the critical path	High	Allowing sufficient time for the development and implementation of the OBU technology. Include time for the PID application testing, TRR and ORR.
TRR and ORR of OBU, RSU and Personal Information Device (PID) DSRC messaging, SCMS, controller cellular transmissions, etc.	High	The products of the TRR will need to be submitted and approved prior to any testing. The development of the products will need to be included in the project schedule. The items relating to the ORR will also be shown in the schedule.
PID application development	High	The high-level user needs are to be traced to detailed requirements in the Requirements Traceability Verification Matrix (RTVM). Detailed requirements will trace forward to performance tests.
SCMS deployment (requires specialist treatment)	High	Allowing sufficient time for first-instance failed operations tests of CV equipment and SCMS

7. Large/Small Project Requirements

Based on the requirement provided in the INFRA Notice for Funding Opportunity, the project falls within the small project category:

1. Project is located in Monroe County, Florida.
2. Total project cost is $9.32M including previously incurred cost.
   - Total future project cost is $9.02M.
3. Cost-share requested at $5.0M from INFRA; State share is $4.02M.

See *Section 4. Grant Funds, Sources, and Uses of Project Funds* for more information on project cost.