

Project Systems Engineering Management Plan

SR 826/Palmetto Expressway Express Lanes from US 1 to SR 836



FLORIDA DEPARTMENT OF TRANSPORTATION

District Six

**1000 NW 111th Avenue
Miami, Florida 33172**

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Table of Contents

1.1	Document Overview	1
1.2	Need for a Project Systems Engineering Management Plan	1
1.2.1	Project Identification.....	1
1.2.2	Purpose and Scope	2
1.2.3	Technical Project Summary Schedule.....	2
1.2.4	Relationship to Other Plans	2
	1.2.4.1 Relationship to Florida’s Ten-Year ITS Cost Feasible Plan .2	.2
	1.2.4.2 Relationship to Florida’s Statewide ITS Architecture	3
	1.2.4.3 Relationship to Other “On-project” Plans	3
1.3	Applicable Documents.....	3
1.4	Systems Engineering Processes	4
1.4.1	Developing the Project Intelligent Transportation System Architecture	4
1.4.2	Creating High-Level Functional Requirements.....	5
1.4.3	Creating Detailed Requirements.....	5
1.4.4	Performing Trade-off Studies, Gap Analyses, or Technology Assessments.....	5
1.4.5	Performing Technical Reviews.....	5
1.4.6	Identifying, Assessing and Mitigating Risk	6
1.4.7	Creating the Requirements Traceability Verification Matrix	6
1.4.8	Creating Performance Measure Metrics	7
	1.4.8.1 Measures of Effectiveness	7
	1.4.8.2 Measures of Performance	8
1.4.9	Conducting System Testing, Integration, Verification, Validation, and Acceptance Planning.....	8
	1.4.9.1 System Integration.....	8
	1.4.9.2 System Testing	8
	1.4.9.3 System Acceptance	9
1.5	Project Management and Control	9
1.5.1	Organization Structure.....	10

1.5.2	Managing the Schedule.....	10
1.5.3	Procurement Management	10
1.5.4	Risk Management	11
1.5.5	Subcontractor Management	11
1.5.6	Engineering Specialty Integration	11
	1.5.6.1 Data Management Engineering	11
	1.5.6.2 Configuration Management	11
	1.5.6.3 Test Engineering	12
1.5.7	Monthly Project Status Reviews.....	12
1.5.8	Change Management	12
1.5.9	Quality Management.....	12
1.5.10	Systems Acceptance	12
1.5.11	Operations and Maintenance, Upgrade, and Retirement....	12
1.5.12	Lessons Learned	13

List of Figures

Figure 1.1 – Intelligent Transportation System Project Stages 10

List of Acronyms and Abbreviations

CEI	Construction, Engineering, and Inspection
CFP	Cost Feasible Plan
CCTV	Closed Circuit Television
ConOps	Concept of Operations
CPM	Critical Path Method
DMS	Dynamic Message Sign
FDOT	Florida Department of Transportation
ITS	Intelligent Transportation System
MOE	Measure of Effectiveness
MOP	Measure of Performance
MTR	Minimum Technical Requirement
MVDS	Microwave Vehicle Detection System
MTBF	Mean Time Between Failure
O&M	Operations and Maintenance
PD&E	Project Development and Environment
PERT	Project Evaluation and Review Technique
PITSA	Project Intelligent Transportation System (ITS) Architecture
PSEMP	Project Systems Engineering Management Plan
QA	Quality Assurance
QC	Quality Control
QM	Quality Management
RITSA	Regional Intelligent Transportation System (ITS) Architecture
RTVM	Requirements Traceability Verification Matrix
SELS	Statewide Express Lane Software
SEMP	(Florida’s Statewide) Systems Engineering Management Plan
SEP	Systems Engineering Process
SITSA	Statewide Intelligent Transportation System (ITS) Architecture
TSP	Technical Special Provision

DEVELOPING A PROJECT SYSTEMS ENGINEERING MANAGEMENT PLAN

1.1 Document Overview

This document is the **preliminary draft** of the Project Systems Engineering Management Plan (PSEMP) for the *SR 826/Palmetto Expressway Express Lanes From US 1 to SR 836* project. A PSEMP is a plan that helps manage and control a project utilizing systems engineering processes (SEP). The PSEMP identifies what items are to be developed, delivered, integrated, installed, verified, and supported.

This is a living document that is expected to be updated accordingly during the design and construction phases.

The document is organized as follows:

- Section 1.2 – Need for a PSEMP
- Section 1.3 – Applicable Documents
- Section 1.4 – Systems Engineering Processes
- Section 1.5 – Project Management and Control

1.2 Need for a Project Systems Engineering Management Plan

The Florida Department of Transportation (FDOT) requires high-risk intelligent transportation systems (ITS) projects using federal funds to use a SEP.¹ The PSEMP documents how systems engineering will be used for ITS project management.

Florida's Statewide Systems Engineering Management Plan (SEMP) is used as a reference guide in the creation of this PSEMP.

1.2.1 Project Identification

Project Name: *SR 826/Palmetto Expressway Express Lanes From US 1 to SR 836*.

Financial Project Identification: *432639-1-22-02*

Federal Aid Project Number: *Insert the federal aid project number when/if available.*

¹ FDOT Procedure titled Systems Engineering and ITS Architecture (Topic No 750-040-003). Available online at <http://www.dot.state.fl.us/proceduraldocuments/procedures.shtm>.

1.2.2 Purpose and Scope

This document serves as the PSEMP for the SR 826/Palmetto Expressway Express Lanes from US 1 to SR 836 project within FDOT District Six. It provides planning guidance for the technical management, procurement, installation, and acceptance of the project, which includes:

- Implementation of dynamically priced express lanes
- Access and ramp connections to and from the express lanes (ingress and egress access points)
- Interchange improvements – Modification of existing entrance and exit ramps serving the interchanges within the project limits
- Intersection improvements – Widening and turn lane modifications along the cross streets to facilitate the ramp modifications and improve the access and operation of the corridors upstream and downstream from the interchanges
- Implementation of ramp connectors to the US 1 Busway

Further details of the project can be obtained by reviewing other documents, such as the Project Development and Environment (PD&E) Study, Corridor Concept of Operations (ConOps), Quality Assurance (QA) Plan, Operations and Maintenance (O&M) Plan, etc.

1.2.3 Technical Project Summary Schedule

This project will be delivered via design-build. The preliminary schedule shows procurement commencing in April 2021 with contract award planned for April 2022.

This section will be updated as more schedule details are developed.

1.2.4 Relationship to Other Plans

1.2.4.1 Relationship to Florida's Ten-Year ITS Cost Feasible Plan

The Ten-Year ITS Cost Feasible Plan (CFP) is a ten-year program and resource plan that identifies ITS projects in the overall context of Florida's ITS Corridor Implementation Plans.² It represents a commitment of state- and District-managed ITS funds to provide a coordinated statewide program to develop ITS infrastructure on Florida's major intrastate highways. The SR 826/Palmetto Expressway Express Lanes from US 1 to SR 836 project is not currently reflected in the Ten-Year ITS CFP.

The FDOT’s current Ten-Year ITS CFP is available online at:

<https://www.fdot.gov/traffic/its/projects-deploy/ten-year-cfp.shtm>

1.2.4.2 Relationship to Florida’s *Statewide ITS Architecture*

The *PSEMP for SR 826/Palmetto Expressway Express Lanes from US 1 to SR 836* project is not yet included in the District Six Regional ITS Architecture (RITSA), which was developed as part of the Statewide ITS Architecture (SITSA). More information on the current SITSA is available online at <https://www.fdot.gov/traffic/its/projects-arch/sitsa.shtm>.

1.2.4.3 Relationship to Other “On-project” Plans

The following documentation is referenced as part of the *SR 826/Palmetto Expressway Express Lanes from US 1 to SR 836* Project Systems Engineering Management Plan:

- Florida’s Statewide Systems Engineering Plan, Appendix R – Concept of Operations Template, June 16, 2018.
- SR 826/Palmetto Expressway Express Lanes from US 1 to SR 836 Concept of Operations, drafted July 2019
- SR826/Palmetto Expressway Concept of Operations from I-75 to the Golden Glades Interchange, drafted July 2016
- SR 826/Palmetto Expressway Express Lanes from US 1 to SR 836 Project Development and Environment Study, FM No. 432639-1-22-02.
- 95 Express Lanes Phase 2 Concept of Operations for I-95 from Golden Glades Interchange to Broward Boulevard, April 18, 2015
- SR 826/I-75 Express Lanes Concept of Operations for I-75 from I-595 to Palmetto Expressway/SR 826 and Palmetto Expressway/SR 826 from US 41/SW 8th Street to NW 154th Street, April 2013, updated February 2016

1.3 **Applicable Documents**

The following documents, of the exact issue shown, form a part of this document to the extent specified herein. In the event of a conflict between the contents of the documents referenced herein and the contents of this document, this document shall be considered the superseding document.

National ITS Architecture (Version 8.2)	United States Department of Transportation 400 Seventh Street, Southwest Washington, D.C. 20590 http://www.standards.its.dot.gov/LearnAboutStandards/NationalITSArchitecture
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SITSA	Information on Florida Statewide ITS Architectures (SITSA) is available on line at https://www.fdot.gov/traffic/its/projects-arch/sitsa.shtm
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1.4 Systems Engineering Processes

Key processes that will be used are:

- Developing the Project ITS Architecture (PITSA)
- Development and/or Validation of High-level Functional Requirements
- Development and/or Validation of Detailed Functional Requirements
- Technical Reviews
- Risk Identification, Assessment, and Mitigation
- Creation of the Requirements Traceability Verification Matrix (RTVM)
- Standalone Testing and Acceptance

1.4.1 Developing the Project Intelligent Transportation System Architecture

The Project is not currently identified in the RITSA and should be added as the design and construction work advances. The service packages that have been selected from the RITSA to develop the PITSA include but aren't limited to:

- ATMS01 – Network Surveillance
- ATMS04 – Traffic Metering
- ATMS05 – FDOT District 6 Express Lane Management
- ATMS06 – Traffic Information Dissemination
- ATMS07 – Regional Traffic Control
- ATMS08 – Incident Management
- ATMS09 – Traffic Forecast and Demand Management
- ATMS10 – Electronic Toll Collection

New ITS components are also proposed as a part of the Project. The new devices include additional dynamic message signs (DMS), microwave vehicle detection systems (MVDS), closed circuit television (CCTV) cameras, hub equipment shelter with backup power, and other supporting infrastructure (e.g. conduit, pull boxes, splice vaults). In addition, fiber optic backbone cables, lateral fiber optic cables, distribution switches, and the integration of all components into SunGuide and the FDOT Statewide Toll Pricing software. As the majority of these devices are similar to existing ITS devices, they are also covered within the existing market packages.

Also proposed as new ITS equipment is the Toll Amount DMS and Lane Status DMS to incorporate the addition of the express lanes along SR826.

1.4.2 Creating High-Level Functional Requirements

It is recommended that high-level functional requirements for the Project be developed by FDOT District Six and used to develop the project requirements. Candidate high-level functional requirements include:

- Optimize the use of express lanes capacity by increasing overall passenger throughput
- Offer a new commute option by providing meaningful congestion relief to those willing to pay for it
- Maintain free-flow conditions (>45 mph) in the express lanes to ensure trip reliability
- Reduce congestion on general use lanes compared with projected level
- Provide effective and efficient operations by upgrading equipment and implementing new ITS technologies
- Use net toll revenues to finance facility modifications, operations, and maintenance
- Maintain safety in the express lanes and the overall project corridor
- Acquire public and partner/stakeholder acceptance and satisfaction
- Accommodate the busway ramp connector to/from the express lanes

1.4.3 Creating Detailed Requirements

The high-level functional requirements for this project will be refined into detailed functional requirements and will be provided as a part of future procurement documents. The functional requirements will include a combination of functional, performance, and physical requirements. As the project progresses through design, the functional requirements will be refined into a RTVM as discussed in Section 1.4.7.

Minimum technical requirements will be included in the design-build procurement package to be developed in the future.

1.4.4 Performing Trade-off Studies, Gap Analyses, or Technology Assessments

The ConOps compares the program needs with the capabilities of the existing system components, functions, and features. The ConOps also summarizes the proposed system improvements and analyzes where gaps exist between the existing system components and the program needs. No additional studies are requested for this project. Should a need for trade-off studies, gap analyses or technology assessments be identified it is anticipated that these activities will occur during the design-build design / construction criteria development process.

1.4.5 Performing Technical Reviews

Under the design scope, it is anticipated that the Design Consultant or the Design-Build Contractor will develop and submit the following ITS plans and documents for review and approval:

- PSEMP
- RTVM
- 60% Design Plans
- 90% Design Plans
- Final Design Submittal

During implementation, it is anticipated that the Contractor will submit the following for review and approval:

- Test Plan and Procedures
- Subsystem Acceptance Plan and Procedures
- System Acceptance Plan and Procedures
- Final Acceptance Plan and Procedures
- Subsystem Component Documentation
- System Component Documentation
- Training Plan and Materials
- As-Built Documentation

1.4.6 Identifying, Assessing and Mitigating Risk

During design various project risks will be identified and documented. Risks will be assessed as low, medium, or high. The measures that can be taken to mitigate the risks will be compiled and tracked. Completion of these tasks will yield a risk matrix that is considered a living document. Risks are evaluated throughout a project's life cycle, as risks may change during the execution of the project. The following areas are specifically considered for risk identification:

- Known problems in the existing system,
- Operational danger,
- Current technology,
- Critical path tasks in the project schedule
- Approach to project implementation phasing

1.4.7 Creating the Requirements Traceability Verification Matrix

The project requirements will be defined during the design process. A RTVM will be developed based on the Functional Requirements. The RTVM will be developed, submitted, and updated based on project requirements. Once completed, the RTVM will become an Appendix to this PSEMP.

Once stakeholder needs and requirements have been defined, the RTVM will be created. Among other items, the matrix references all stakeholder needs typically identified in a ConOps document (and any other potential requirements sources). System requirements are then referenced in the matrix. Such requirements specify what the system will do; they are derived from and are directly

traceable to stakeholder needs. The system requirements may include minimum technical requirements, specifications, or technical special provisions.

System requirements must be verifiable and a method to verify compliance to each requirement is also referenced in the RTVM in addition to compliance results. The purpose of this early assignment of a verification method, long before the system requirements will actually be verified, is to make sure there is thought given to how the requirement will be verified from the very start.

Subsystem requirements and high-level design components may also be referenced in the RTVM, depending on project needs.

The matrix will provide backward and forward traceability, at a minimum, between stakeholder needs, system requirements, and verification test cases. The matrix can be maintained directly in a database or spreadsheet for small projects or generated and maintained with a requirements management tool for more complex projects. The Test Manager (typically provided by the CEI on design-bid-build projects) will use the RTVM to ensure that each requirement is properly tested. The organization that defines the detailed requirements also creates the RTVM.

1.4.8 Creating Performance Measure Metrics

Performance measures should be established for use in determining whether or not the anticipated level of performance is being achieved once the Project is completed and operational. The FDOT ITS Central Office compiles an annual report summarizing the progress of the Statewide ITS System. This annual report is supplemented with performance measures on ITS managed roadways provided by the individual Districts. These performance measures are generated from the SunGuide® Software Performance Measures Reporting System and include both measures of effectiveness (MOEs) and measures of performance (MOPs).

1.4.8.1 Measures of Effectiveness

The MOEs will be used to determine how well the system design meets the requirements and quantify the project benefits. The following MOEs will be summarized by FDOT District Six on a monthly and annual basis:

- Total Trips
- Revenues
- Transit Usage
- Tolls
 - Monthly Revenue
 - Total Revenue
 - Minimum and Maximum Range
 - Average Weekday
 - Average Peak Period
 - Average Weekend
 - Average Off Peak

- 85th Percentile Weekday
- Volume (express lanes and general use lanes)
 - Average Weekday
 - Average Weekend
 - Average Peak Periods
- Speed (express lanes and general use lanes)
 - Average Overall
 - Average Peak Periods
 - Percent of Time Above 45 mph
- Facility Availability
 - Percentage of Time Closed due to Planned Events
 - Percentage of Time Closed due to Non-recurring Events

1.4.8.2 Measures of Performance

The MOPs are the performance measures that are required to achieve positive MOEs. They are typically related to system or component availability, operating performance, and data quality. The following measures of performance are expected to be detailed in the Functional Requirements:

- Minimum Repair Times
 - Telecommunications
 - CCTV cameras
 - MVDS
 - DMS
 - Power Systems
- MVDS Accuracy Levels
- Mean Time Between Failure (MTBF) requirements

1.4.9 *Conducting System Testing, Integration, Verification, Validation, and Acceptance Planning*

1.4.9.1 System Integration

The respective Construction contractors will be responsible for the Project system integration. As a part of this integration, the Construction contractors will be responsible for integrating all ITS components installed in their contract into the SunGuide® software and the FDOT Statewide Express Lanes software (SELS), testing, and making operational a fully functioning ITS/toll system.

1.4.9.2 System Testing

The Construction contractors will be responsible for all standalone and subsystem tests for replaced/upgraded devices and new equipment.

For the applicable tests the Construction contractors will develop and submit for approval a test plan and test procedures for testing applicable project hardware, software, and/or infrastructure installed. The test plan and procedures will be developed and executed to confirm that all functionality of the existing ITS system, along with all requirements covered by the approved component designs, are met by the equipment and/or system elements once they are in place and/or operational per the requirements of the contract documents. The test plan, procedures, and subsequent testing activities are to be developed and executed for all required tests. Each required testing stage will commence only after successful completion of the previous phase. Execution of the test phases will be the responsibility of the Construction contractors and, minimally, includes the following testing stages:

- Standalone/Unit
- Subsystem(for replaced/upgraded devices only)
- System
- Final Acceptance

The test plans and procedures will be reviewed and approved by FDOT District Six. The approved plans and procedures must be adhered to and final test results will be submitted by the construction contractors at the completion of each test to FDOT District Six for approval. FDOT District Six and/or its designated representative will be permitted to witness any and all tests.

1.4.9.3 System Acceptance

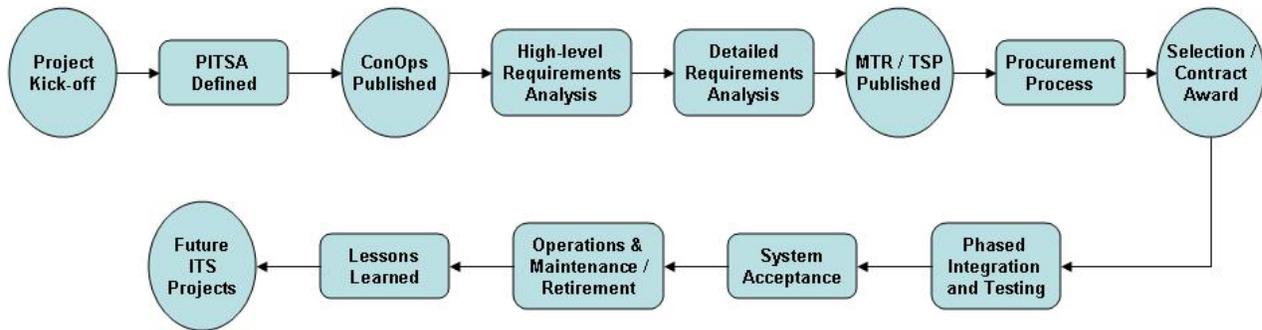
The Final Acceptance will be granted by FDOT District Six upon the Construction Contractor's successful completion of the Standalone Tests, Subsystem Testing, System Testing, 90-day system burn-in and the approval of all required submittals per the contract requirements by FDOT District Six.

1.5 Project Management and Control

The successful completion of SEPs described in Section 1.4 herein form the backbone for project success. The Overall Project Manager's responsibility is to ensure that tasks are completed on schedule and at cost. Hence, the Overall Project Manager's responsibility is to put proper controls in place that help achieve this goal.

Figure 1.1 shows stages for an ITS project. The Overall Project Manager's responsibility starts with project kick off and ends with O&M. There will be various people and organizations that help throughout this process. The Systems Engineer will typically select the RITSA service packages to define the PITSA. The Consultant will typically perform duties including, but not limited to, the high-level requirements analysis for publication of the MTRs/TSPs. The District office will be responsible for the procurement process, and selection and award of the contract. A Contractor will perform construction/installation, which will be supervised by the Construction Project Manager on behalf of the Overall Project Manager. System acceptance will be supervised by the District office or an independent verification and validation team. The approach to system maintenance will be decided by the District at a later time.

Figure 1.1 – Intelligent Transportation System Project Stages



The following areas will be covered in this section:

- Organization structure
- Managing the schedule with a project evaluation and review technique (PERT) chart, and the critical path method (CPM)
- Procurement management
- Risk management
- Subcontractor management
- Engineering specialty integration
- Monthly project status reviews
- Change management
- Quality management (QM)
- Systems acceptance
- O&M / upgrade / retirement
- Lessons learned

1.5.1 Organization Structure

The FDOT District Six Project Manager provides the oversight for the Project. FDOT is providing funding for the design and construction of the Project which provides the final design and implementation of the ITS project in Miami-Dade County.

1.5.2 Managing the Schedule

The high-level schedule milestones are discussed in Section 1.2.3. The detailed schedules with critical paths will be made available as the project progresses. The design and construction contractors will use the schedule in order to monitor/evaluate progress. The project schedule will show the project tasks, task durations, and task dependencies.

1.5.3 Procurement Management

The construction contractors or design-build contractor as applicable will procure the contractual items to comply with the contract documents and the technical requirements contained within.

1.5.4 Risk Management

The preliminary risk identification, assessment, and mitigation approach is described in Section 1.4.6 herein. The Overall Project Manager reviews the matrix created by the Systems Engineer, and adds some project-level or external risks that the Systems Engineer may think are important. This generates a new risk matrix. The new risk matrix will be evaluated by the Overall Project Manager and the Systems Engineer on a regular basis, especially during or after major reviews.

1.5.5 Subcontractor Management

The selected design and construction contractors will be responsible for managing any subcontractors that may be needed for the project. The design and construction contractors will provide a subcontractor management plan to FDOT District Six for review and approval.

1.5.6 Engineering Specialty Integration

Engineering specialties are highly specialized engineering disciplines included in the project to support the FDOT ITS Project Manager. These specialists increase the expertise available to the project team and support the specialty requirements of the project. The design and construction contractors will include the following specialties during the appropriate project phase as required. For this project, all ITS related engineering and implementation will be provided by the ITS Design Team and/or the ITS Contractor. The design and construction contractor representatives will be supported by other FDOT resources as required.

1.5.6.1 Data Management Engineering

The data management engineering specialty will address the overall data management for the project. The primary functions of the data management specialty will consist of:

- Administration of contract deliverables and records per FDOT standards
- Data quality and copy control
- Maintenance and control of supplier-developed and purchaser-furnished information

The data management engineering will be provided by the construction contractor(s) and the ITS contractor(s) under the oversight of FDOT District Six and / or its agents.

1.5.6.2 Configuration Management

The configuration management engineering specialty will address the configuration management of the installed/upgraded devices. This specialist will also be responsible for the documentation and application source codes, as applicable. The configuration management engineering specialty will be provided by the construction contractor(s) and the ITS contractor(s). Configuration management data related to SunGuide will be provided by the Contractor to FDOT District Six for integration into SunGuide as appropriate.

1.5.6.3 Test Engineering

The test engineering specialist will verify the compliance of the functional requirements and identify any special tests or test equipment. The test engineering specialist will be provided by the ITS Contractor(s).

1.5.7 Monthly Project Status Reviews

During the planning and design stages, FDOT District Six will conduct meetings with the design consultants on an as-needed basis coinciding with key project milestones. During construction, FDOT District Six will schedule monthly project status reviews with the construction contractors throughout the contract duration. At the review meetings items such as project schedule, cost, action items, etc., will be discussed in detail and documented.

1.5.8 Change Management

This project will follow the standard FDOT change order process for all changes on design and construction projects. The FDOT District Six Project Manager will generally decide the acceptance of design changes and construction changes. Changes to the existing Statewide Express Lanes Software are not anticipated as a part of this project. Furthermore, with no statewide impacts associated with this project, there are no anticipated resolutions required from the FDOT Change Management Board (CMB).

1.5.9 Quality Management

The design and construction contractors will provide Quality Assurance Plans to FDOT District Six for review and approval.

1.5.10 Systems Acceptance

System acceptance is addressed in Section 1.4.9.3.

1.5.11 Operations and Maintenance, Upgrade, and Retirement

At the start of construction, the construction contractor will be responsible for the maintenance of ITS devices within the project limits or as otherwise defined in the Contract. As a part of this maintenance support, the construction contractor will prepare an ITS Repair Plan for submittal and approval by FDOT District Six. Once completed, the ITS Repair Plan will become an Appendix to this PSEMP. This plan will be supplemented with a written assessment of all existing ITS devices and acceptance of the current condition of all ITS devices and infrastructure on the project.

FDOT District Six will be responsible for all aspects of operations and maintenance, upgrade and retirement for the Project at the conclusion of the warranty period.

1.5.12 Lessons Learned

As the project progresses, key comments and subsequent action items from design review and/or construction phase progress meetings will be tracked and documented. The system engineering process will assist project stakeholders in evaluating project performance and tracking of pertinent issues to ensure that all project requirements are met.

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0.5		Initial draft	K. Palmer, RS&H
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1.1		Edits based on Corradino comments	K. Palmer, RS&H
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