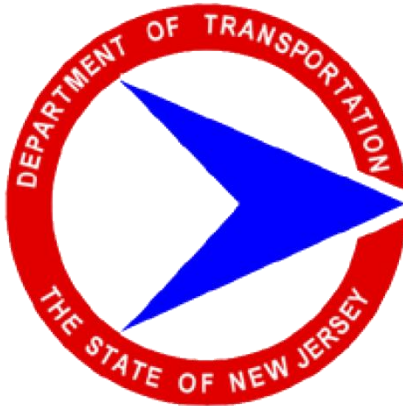


The New Jersey Department of Transportation

TSM Procedures Manual

Version 2.0



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A.1. Purpose

The Transportation Systems Management (TSM) Design Procedures Manual is intended to provide guidance to consultants and New Jersey Department of Transportation (NJDOT) in-house staff on matters pertaining to the design, installation, operation, and maintenance of the Department's network of Intelligent Transportation System (ITS) assets. The material in this document is a collection of knowledge representing overall guidance, procedures and industry best practices from NJDOT and, where applicable, other transportation agencies throughout the country. The procedures in this manual are in-line with the New Jersey ITS Strategic Plan and ITS Architecture.

The purpose of this manual is to serve as a "how-to" guide for all matters pertaining to ITS. This manual documents many processes and procedures which are already in place but not yet formalized. The manual serves two primary purposes: First, it serves as an introduction to consultants and NJDOT staff who are unfamiliar with the way NJDOT works with ITS. Second, it may be used as a reference guide for those who regularly work with ITS.

The Traffic Signal Optimization process follows a unique set of guidelines. Therefore, to minimize any confusion, a separate section has been entirely dedicated to Signal Optimization and the Signal Optimization Guidelines.

This manual is not intended to define the policies and procedures within divisions of NJDOT outside of TSM, and the reader is advised that any references to other divisions may not necessarily reflect the most up-to-date policies. Where TSM is required to interface with another division, a hyperlink to that division's published guidelines is provided.

A.2. Document Structure

A.2.1. Organization of material

The general structure of this manual is formatted to follow the timeline of an NJDOT ITS Project: Concept Development, Design, Construction, and Operations and Maintenance. Each project phase is organized into Section B through Section E. Within each project phase, the manual provides guidance, information on processes and state of the practice information on several different focus areas handled through TSM, including, but not limited to, ITS, Network, Work Zones, Operations and 511NJ.

Under Section A – Introduction, Consultants and NJDOT in-house staff are provided with an overview of TSM's responsibilities and organizational structure. In addition, direction on the ITS Project Process is provided and the different ITS Project types under which Mobility and Systems Engineering (MSE) is involved.

As described in the previous section, Traffic Signal Optimization, due to its unique set of guidelines, is included in Section F – Traffic Signal Optimization.

Finally, Section G - Administrative Procedures, addresses the logistical and clerical processes that are in place in order to support the successful implementation and operation of the Department's ITS program. This section is intended exclusively for NJDOT personnel.

A.2.2. Embedded links

Throughout this document, frequent references and hyperlinks are provided to other portions of this manual, as well as to documents, publications, and forms which exist outside of the manual. A catalog of all references throughout the manual is provided in Appendix H.3.

A.2.2.1. Links Within Manual

All references to other points within the manual, such as Section numbers, Figure or Table numbers, Appendices, or Page numbers are dynamically linked to the corresponding section. Readers who are viewing the manual electronically may click on the paragraph or page number and will be brought directly to the corresponding location in the manual.

A.2.2.2. Links Outside Of Manual

References to resources outside of this manual are visually separated from the text for easy identification and are organized to clearly communicate the information available in the link provided.

Hyperlinked references can be easily spotted by a distinct box containing four key elements.








<p>[1] TSM REFERENCE:</p>		<p>[3] ITS Devices Inventory [4] http://www.nj.gov/transportation/eng/elec/ITS/ITSDB.shtm</p>
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[1] Four different types of references are used:

- **EXTERNAL REFERENCE:** A website or publication not provided or hosted by NJDOT
- **NJDOT REFERENCE:** A website, form, etc. published by NJDOT but not unique to TSM
- **TSM REFERENCE:** A website, form, etc. used exclusively by TSM
- **MANUAL REFERENCE:** A section, file, image, or flowchart that is a part of this manual

[2] The icon indicates the format of the linked reference

Table A-1: Reference Formats

	<p>PDF</p>	<p>Adobe Portable Document Format</p>
	<p>RTF</p>	<p>Rich Text Format</p>
	<p>DOC/DOCX</p>	<p>Microsoft Word document</p>
	<p>XLS/XLSX</p>	<p>Microsoft Excel document</p>
	<p>HTML</p>	<p>HTML Web page</p>
	<p>DGN</p>	<p>MicroStation DGN file</p>
	<p>Folder</p>	<p>Folder/directory on NJDOT server</p>

[3] The top line of text contains a description of the reference

[4] The bottom line of text contains an active hyperlink to the reference

A.2.2.3. Non-Functioning Links

Readers are requested to contact MSE if any invalid or non-functional links are discovered in this document. For non-functioning references to locations on the NJDOT website (labeled “NJDOT REFERENCE”), it is suggested that readers check the Department’s Engineering page as referenced in Section A.6.8.

A.3. References

This manual is based heavily on information from the following sources:

- New Jersey ITS Strategic Plan (<http://www.nj.gov/transportation/eng/elec/ITS/pdf/10yearplan.pdf>)
- New Jersey ITS Architecture (http://njtpa.org/getmedia/edea680f-ce8c-47c6-b6fe-d78b815ccbc4/NJ-TSM-O-Strategic-Plan_Task-5_Final-NJ-Architecture_20141203)
- Institute of Transportation Engineers (ITE) (<http://www.ite.org/>)
- Manual on Uniform Traffic Control Devices (MUTCD) (<http://mutcd.fhwa.dot.gov/>)
- Federal Highway Administration (FHWA) (<http://www.fhwa.dot.gov/>)
- FHWA Guidance Document on Systems Engineering (<http://ops.fhwa.dot.gov/publications/seitsguide/index.htm>)
- FHWA Rule on ITS Architecture and Standards Conformity (pdf) (http://ops.fhwa.dot.gov/its_arch_imp/docs/20010108.pdf)
- Information on National ITS Standards (<http://www.standards.its.dot.gov/>)
- National ITS Architecture (<http://www.iteris.com/itsarch/>)
- Typical protocols and codes
- Discussions with NJDOT Transportation Systems Management staff
- Industry best-practices

A.4. Background and Overview

The New Jersey Department of Transportation (NJDOT, “Department”) was established in 1966 as the first State transportation agency in the United States. It is responsible for maintaining and operating the State’s highway and public road system, planning and developing transportation policy and assisting with rail, freight and intermodal transportation issues. New Jersey Transit, the State’s public transportation agency, is a subsidiary of NJDOT.

NJDOT owns, operates, develops and maintains the State’s public road system, including over 2000 miles of roadway. Most major Interstate, US, and State highways within New Jersey are under NJDOT jurisdiction, with the largest exceptions being county and local roads, toll routes, interstate bridges and tunnels, and the Palisades Interstate Parkway.


A.4.1. NJDOT Organizational Structure

The organizational structure of the Department is available on the Department website.

NJDOT REFERENCE:		New Jersey Department of Transportation – Organization Chart http://www.nj.gov/transportation/about/pdf/orgchart.pdf
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Many of the larger NJDOT projects, including major bridge and highway projects, are managed by Capital Program Management (CPM). These projects primarily involve heavy infrastructure construction or repair. CPM is comprised of six divisions: Right of Way and Access Management; Project Management; Capital

Program Support; Highway and Traffic Design; Bridge Engineering and Infrastructure Management; and Construction Services and Materials. While Intelligent Transportation Systems work may be included in CPM projects, the overall administration of these projects is handled according to the Capital Project Delivery procedures. Therefore, while the design guidelines and considerations described in this manual will still apply, the overall structure of the project will vary from those that are uniquely handled by TSM.

NJDOT REFERENCE:		Capital Project Delivery – Overview http://www.nj.gov/transportation/capital/pd/
-----------------------------	---	--

The Department’s Operations division is responsible for more than 1,300 personnel and more than 20,000 pieces of equipment to maintain NJDOT’s transportation infrastructure, including roadway and bridge maintenance, pavement and guide rail repair, signage (non-dynamic), roadway lighting, and emergency response. Operations is different from the similarly named Traffic Operations in that the former is concerned with the infrastructure itself, while the latter deals with the flow of, and routing of, traffic along the infrastructure. The two units work closely to coordinate traffic through areas of road work or incidents. NJDOT Operations is divided into three regions: North, Central, and South.

A.4.2. TSM Organizational Structure

Transportation Systems Management is responsible for ensuring safe and reliable movement of people and goods on New Jersey’s highway system through the oversight and management of a 24/7 statewide operation which is broken down into two sections: the Division of Traffic Operations and the Division of Mobility and Systems Engineering (MSE). From the perspective of Intelligent Transportation Systems, the Division of Traffic Operations is primarily responsible for day-to-day operation of ITS devices but also plays a role in identifying currently-unmet ITS needs. MSE is responsible for maintenance of existing ITS assets through the Statewide ITS Maintenance division of its Mobility Management unit, as well as the planning and implementation of future ITS work.

In cooperation with the New Jersey State Police, TSM oversees the Statewide Incident Management Program, NJDOT’s efforts to incorporate the Federal Highway Administration’s (FHWA) National Traffic Incident Management (TIM) Responder Training Program into New Jersey’s existing highway responder training initiative and traffic coordination for significant construction projects and special events.

The organizational structure of TSM is depicted in Figure A-1 below. As the organizational structure is subject to frequent changes, readers are encouraged not to rely on this figure beyond the stated effective date.

The names of certain divisions within MSE have evolved over time, and many contexts a legacy name may continue to be used. For instance, the terms “Mobility Management” and “ITS Maintenance” are often used interchangeably. Similarly, the terms “Advanced Arterial Management” and “Controlled Traffic Signal Systems” carry similar meanings.

TRANSPORTATION SYSTEMS MANAGEMENT

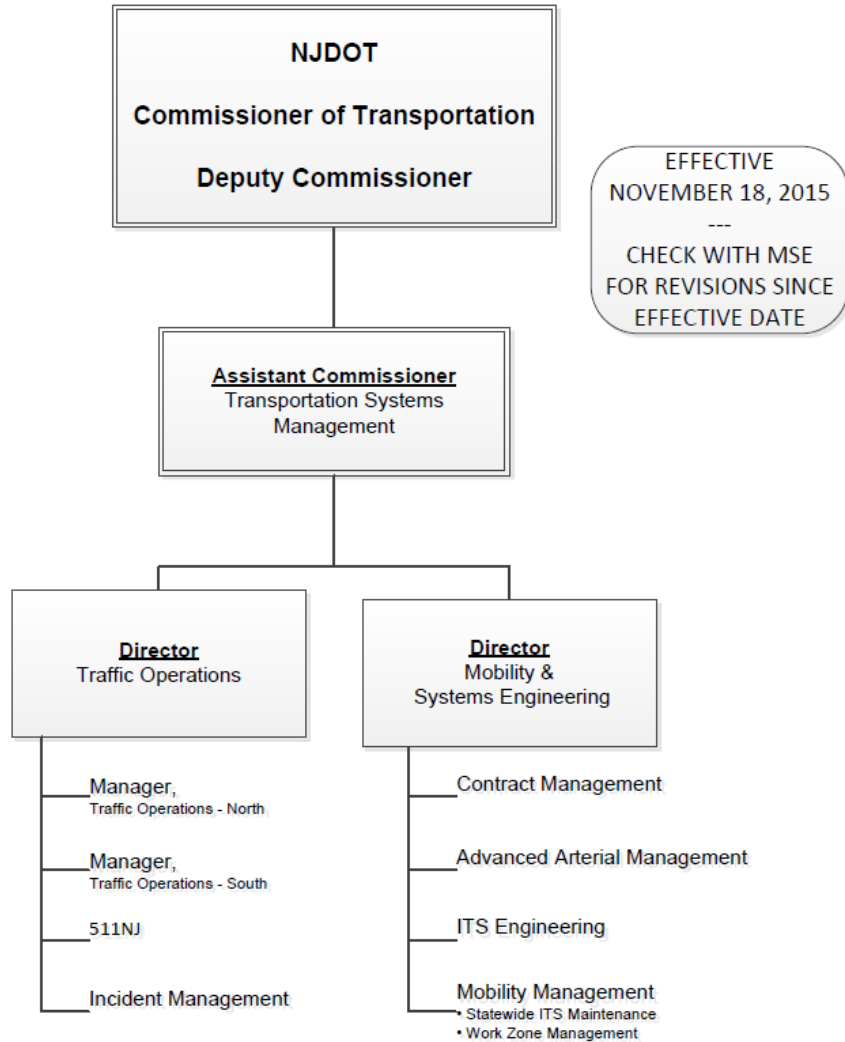


Figure A-1: TSM Organization Structure

A.4.3. Facilities

ITS devices are assigned to one of two Traffic Operations regions, North or South, usually dependent on the county on which the device is located. On weekdays between 4:00 am and 8:30 pm, the device will be operated from its assigned facility unless circumstances require additional collaboration between the North and South regions. On weekends and overnights, the North region Traffic Operators will assume traffic management responsibilities statewide.

In addition, The Arterial Management Center (AMC) is used by Advanced Arterial Management for corridor management and provides visibility to traffic cameras and vehicle detection systems.

A summary of these locations is presented below in Table A-2. A map of the Traffic Operations regions is in Figure A-2.

Table A-2: Operations Center Locations

Facility	Function	Counties covered
STMC	Traffic Operations – North (4:00 am-8:30 pm, Monday-Friday) Traffic Operations – Statewide (all other times)	Bergen, Essex, Hudson, Hunterdon, Middlesex, Morris, Passaic, Somerset, Sussex, Union, Warren
TOC-S	Traffic Operations – South (4:00 am-8:30 pm, Monday-Friday)	Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Mercer, Monmouth, Ocean, Salem
AMC	Advanced Arterial Management – Controlled Traffic Signal Systems (CTSS), Traffic signal optimization, timing, studies	Statewide

The Statewide Traffic Management Center (STMC) is a 24-hour facility in Woodbridge that is shared with the New Jersey Turnpike Authority and the New Jersey State Police. The Traffic Operations Center-South (TOC-S) is generally operational only from 4:00 am to 8:30 pm on Monday through Friday, except for emergencies or very special circumstances. TOC-S has the same capabilities within NJDOT as STMC and can function as a backup Traffic Operations Center. TOC-S is co-located with a major communications node on the NJDOT Fiber Optic network.

The Arterial Management Center (AMC) is located on the third floor of the Main Office Building at 1035 Parkway Avenue, Trenton. It is used primarily for engineering studies and management of CTSS corridors rather than Traffic Operations; however it has access to the same traffic cameras as the STMC and TOC-S. Software that is maintained at the AMC includes ATMS.now, IQCentral, SCATS, InSync, Streetwise, and OnTime. The AMC is staffed in two shifts each weekday: 7:30 am to 9:30 am, and 3:30 pm to 5:30 pm. Between 9:30 am and 3:30 pm, the AMC is staffed on an “as-needed” basis.

Historically, the functions performed at STMC were performed at the Traffic Operations Center – North (TOC-N) facility in Elmwood Park. Although the operations have been relocated to STMC, many department documents still make reference to TOC-N. The reader is advised that any reference to TOC-N should be interpreted to mean STMC. Similarly, the term “Traffic Operations Center” or TOC may be used, in this manual or elsewhere, to refer generically to either STMC or TOC-S.

Note that maintenance performed by the North and South divisions of the Statewide ITS Maintenance unit follows similar, but not identical, regional boundaries.

For staffing at STMC and TOC-S, refer to the following Operations Bulletins:

- OB 5.007B – TOC South Staffing Plan
- OB 5.008B – TOC North Staffing Plan

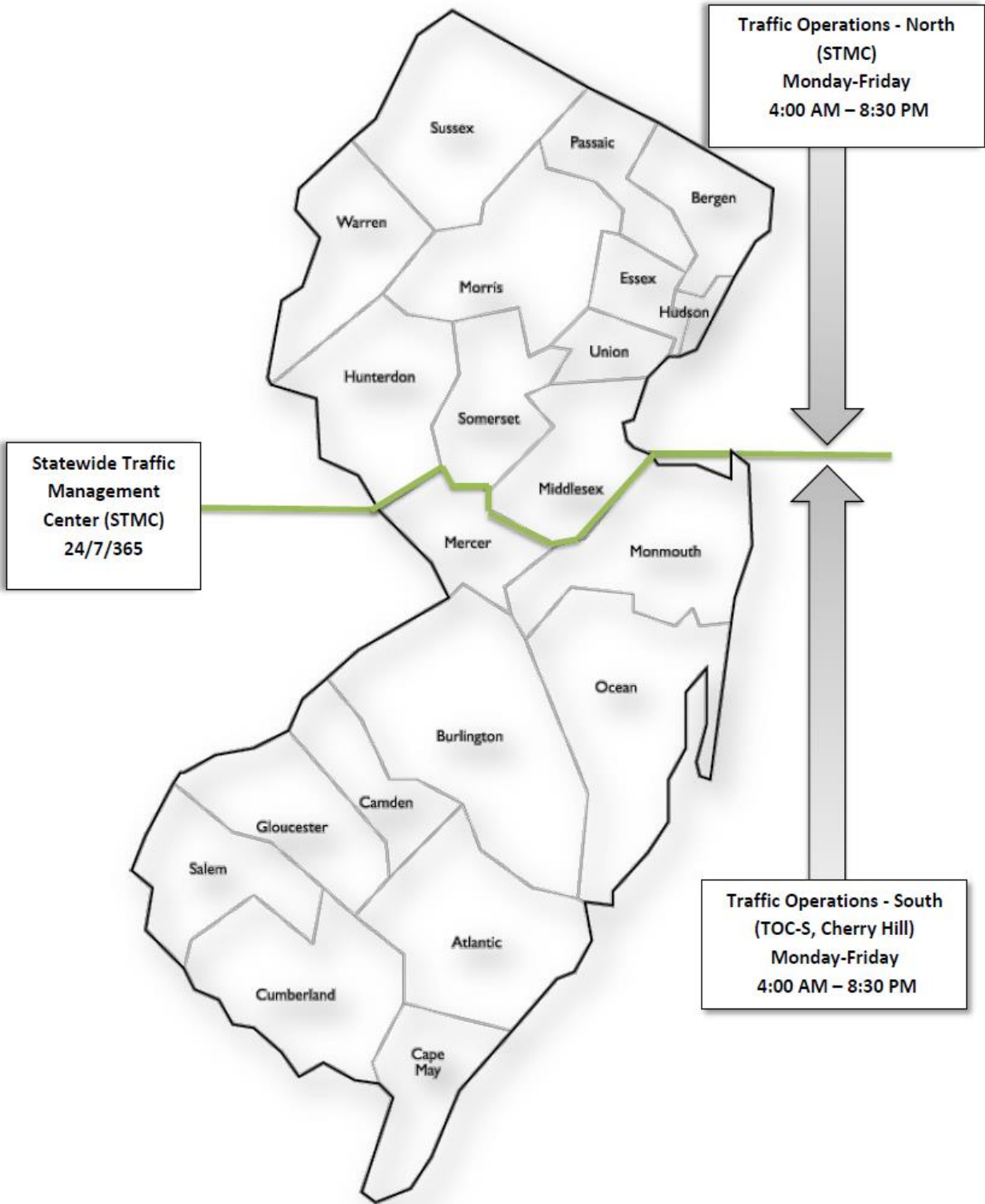


Figure A-2: Traffic Operations Regions

A.4.4. List of ITS Devices and Assets used by TSM

Table A-3 contains a list of devices and assets that are used by TSM, and identifies the unit holding the primary responsibility for operation and maintenance of the devices.

In some cases and as noted in the table, a device is not explicitly owned by MSE; however MSE may use the data from these devices for its own operations or planning purposes. Such cases are explained below the table.

A.4.4.1. Devices used by Permits, Electrical & Claims

Roadway Weather Information Systems (RWIS) are under the realm of Permits, Electrical & Claims. Traffic Operations is not responsible for operating or testing these devices, however they may use data from RWIS (i.e. during snowstorms) for other purposes.

Cameras associated with RWIS are integrated into the Genetec system, and therefore the camera feeds are available for use by Traffic Operations. However, neither Traffic Operations nor MSE can operate or maintain these cameras.

A.4.4.2. Devices used by Transportation Data and Safety

Traffic Volume Stations (TVS) and Weigh-in-Motion Systems (WIMS) are installed and maintained by the Bureau of Transportation Data and Safety (formerly the Bureau of Safety and Data Development) and are not used by TSM. They are noted here because of the similarity of these devices to Intelligent Transportation System devices.

Table A-3: List of assets used by TSM

Abbreviation	Name	Operate	Maintain
CSS	Camera Surveillance System	TO	MSE-SIM
CTSS	Controlled Traffic Signal System	AAM-AMC	MSE-SIM
DMS	Dynamic Message System	TO	MSE-SIM
FTC	Field Terminal Cabinet	MSE-SIM	MSE-SIM
HUB	Hub Building	MSE-SIM	MSE-SIM
OLCS	Overhead Lane Control Signals	TO	MSE-SIM
PTMCCA	Portable Trailer Mounted CCTV Camera Assembly	TO	MSE-SIM
PVMS	Portable Variable Message Sign	TO	MSE-SIM
PVMSRC	Portable Variable Message Sign with Remote Communication	TO	MSE-SIM
RADIO	Radio Links	MSE-SIM	MSE-SIM
RDET	Radar Detector	AAM-AMC	
REPEATER	Radio Link Repeater	MSE-SIM	MSE-SIM
RWIS	Roadway Weather Information Systems	PEC; TO (limited access)	PEC
SDET	System Detection		
TSM	Traffic Signal Master	AAM-AMC	
TSMCCA	Temporary Structure-Mounted CCTV Camera Assembly	TO	MSE-SIM
TSWS	Truck Safety Warning System	TO	MSE-SIM
TTS	Travel Time System (3 Types: TTSA, TTSB, TTSC)	TO	MSE-SIM
TVS	Traffic Volume Station	TDS	TDS
ATR	Automatic Traffic Recorder	TDS	TDS
VID	Video Image Detector	AAM-AMC	MSE-SIM
VSLs	Variable Speed Limit System	TO	MSE-SIM
WIMS	Weigh-in-Motion System	TDS	TDS

TO - Traffic Operations

AAM-AMC – Advanced Arterial Management - Arterial Management Center

MSE-SIM - Mobility and Systems Engineering - Mobility Management/Statewide ITS Maintenance

PEC - Permits, Electrical & Claims

TDS - Transportation Data and Safety (formerly BSDS - Bureau of Safety and Data Development)

A.5. ITS Project Process Overview

Figure A-3 below is a representation of the standard Systems Engineering "V" diagram (blue) with an overlay of the project development process (red outlines) as currently practiced by NJDOT for the design,

construction, and operation and maintenance of ITS facilities work. The systems engineering approach ensures that the project requirements are determined before technology choices are made and the system is implemented. On the left side of the "V", the system definition progresses from a user's conceptual view of the system, through a detailed specification of the system design. The red boxes depict NJDOT's current MSE ITS Project Process processes and how they compare with the general system engineering approach.

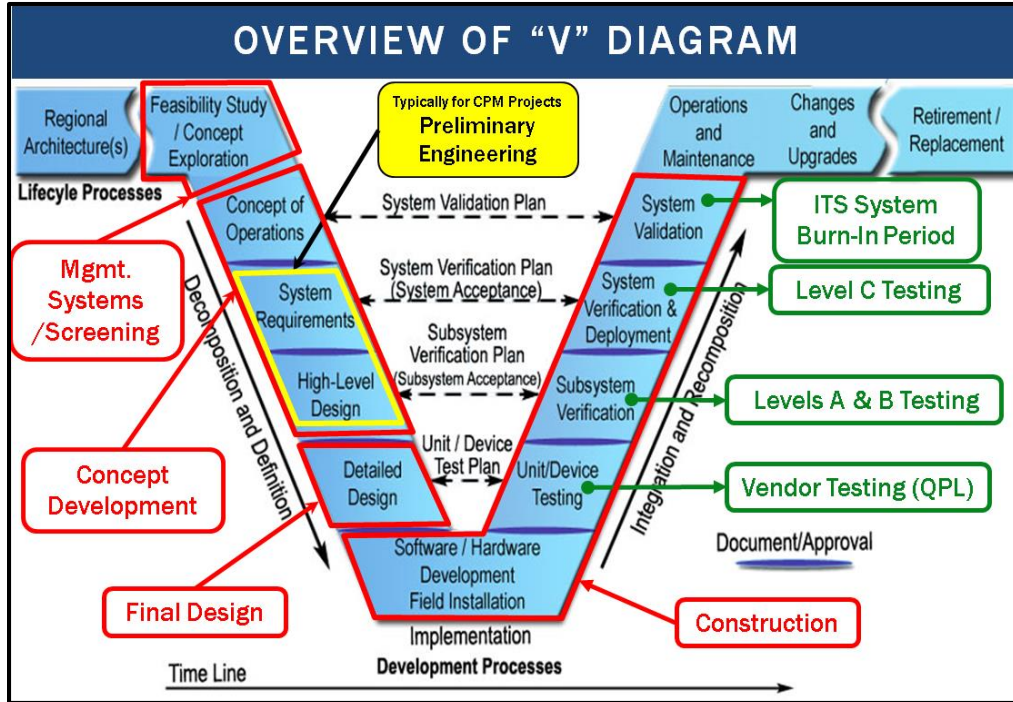



Figure A-3: Overview of the "V" Diagram

The "V" diagram is broken into the following NJDOT phases: Management System/Screening, Concept Development, Final Design, and Construction/Operations. The construction phase is further broken down into sub phases that cover ITS testing levels.

Mobility and Systems Engineering (MSE) lead projects follows the TSM Limited Scope Project Delivery Process only. Any TSM projects that requires the full blown Preliminary Engineering (PE) phase prior to going to FD will need to use the CPM's Project Delivery Process. In such a case, the project may be administered by CPM rather than TSM. The TSM Limited Scope Project Delivery Process is shown via flow chart in Appendix **Error! Reference source not found.** and the activity descriptions are listed in ppendix **Error! Reference source not found.**. If PE is determined to be necessary per MSE, the designer may be directed to utilize the CPM PE process described on NJDOT's website or may ask the designer to customize the process by adding specific PE phase activities to be adopted from the CPM process.

<p>NJDOT REFERENCE:</p>	<p> Capital Project Delivery – Preliminary Engineering http://www.nj.gov/transportation/capital/pd/phase_pe.shtm</p>
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The flow chart in Appendix **Error! Reference source not found.**, also known as network diagram, show he high-level view of how a process works and the activities and the relationships between activities (logic flows). An explanation of each activity, along with successor and predecessor activities is included in Appendix **Error! Reference source not found.**.

Projects led by MSE typically includes the Preliminary Engineering (PE) phase activities as required to be delivered during Concept Development or Final Design. Refer to Section C.1 for detail on the design processes involving ITS.

For MSE projects involving CTSS, also refer to Appendix H.27.

A.5.1. System Engineering Review Form (SERF)



During the Concept Development phase of a project where new installations or functions are planned, a consultant will develop a Scope SERF (Systems Engineering Review Form) as a means for the designer to describe his objectives and intentions for the new installation, and a Systems Engineering analysis, where required (See section B.2.5 and B.2.6).

The SERF contains an overview of the project, the approximate layout of equipment, and the overall objectives. Traffic Operations is responsible for reviewing the SERF, and if accepted, the Operations Manager adds their signature.

SERFs are stored internally in project folders on the Department’s servers. This provides a record of all approvals, comments, and responses.

As a project design progresses, a Final Design SERF (possibly more than one, due to the iterative nature of design) is developed. However, the Final Design SERF does not require Traffic Operations’ approval as it is more technical and less conceptual in nature. The Final Design SERF is reviewed by MSE, who may consult with Traffic Operations if needed.

Submission of a SERF is not required if the project is only replacing existing ITS facilities “in-kind” (i.e. mill/resurfacing projects would require replacing the loop detectors in the pavement for WIMS, Major Access Permit project may require the relocation of a camera), either with the same model or a newer model of the device. Any change in the number of devices or the need and function would have to be described in a SERF.

TSM REFERENCE:		Systems Engineering Review Form –Programmatic ITS – Instructions http://www.nj.gov/transportation/eng/elec/ITS/pdf/serf_instructions.pdf
		Systems Engineering Review Form – Programmatic ITS - Template http://www.nj.gov/transportation/eng/elec/ITS/rtf/serf_programmatic.rtf

A.5.2. FHWA Model System Engineering for ASCT

The FHWA’s Model Systems Engineering Documents (Model Documents) for Adaptive Signal Control Technology (ASCT) are utilized to explore the need for Controlled Traffic Signal Systems (CTSS) (including ASCT) and provide a set of requirements that enable NJDOT to specify, select, implement and test ASCT systems. The Model Documents assist NJDOT in applying the systems engineering process to ASCT. The process will also help NJDOT confirm that its expectations are realistic and achievable before committing to a system.

The Model Documents provides templates to aid the designer to produce the following documents:

Concept of Operations

The Concept of Operations describes the needs and objectives of the ASCT system to determine what functions the proposed system must be capable of fulfilling. Stakeholders should include system managers,

operators and maintenance staff responsible for the system; administrators, decision-makers, elected officials, and other non-technical readers may also be included.

System Requirements

System Requirements must be linked to a corresponding need described in the Concept of Operations. If a requirement cannot be traced to a statement of need defined in the Concept of Operations, then either the Concept of Operations document must be revised or the requirement should be removed. It is essential to describe the functional, performance, non-functional and enabling requirements and the constraints. If the proposed system will interface with another system or requirements are also required at the sub-system level then interface requirements and data requirements may also be required.

Verification Plan



The Verification Plan describes how the system will be tested to ensure that it meets the requirements. It describes and records the activities which verify that the system being built fulfills the requirements described in the requirements documents. It may include the following:

- A plan to initially lay out the specific verification effort
The detailed verification plan that defines a detailed mapping of the requirements to verification cases
- A report on the results of the verification activities

Validation Plan

The Validation Plan describes how the performance of the system will be measured to determine whether or not the needs expressed in the Concept of Operations have been met. It will describe the measures of performance that will be used, the data that will be needed and the type of analysis that will be appropriate. This will include a description of the data and analysis that will need to be available from the proposed system, as well as other data collection and analysis that will be undertaken external to the system. It describes and record the activities which validate that the system being built meets the user needs and scenarios developed in the Concept of Operations.

A CTSS Systems Engineering Analysis Template and FHWA’s Model Systems Engineering Documents can be found on the links below.

MANUAL REFERENCE:		CTSS Systems Engineering Analysis Template Appendices\CTSSSystemsEngineeringAnalysisTemplate.pdf
EXTERNAL REFERENCE:		FHWA’s Model Systems Engineering Documents (Model Documents) for Adaptive Signal Control Technology (ASCT) http://www.ops.fhwa.dot.gov/publications/fhwahop11027/index.htm

A.6. ITS Project Types

NJDOT projects may be run by varying NJDOT units, depending on the primary purpose of the project. Each is managed by a different division within the Department and would follow the division’s respective rules and procedures.

There are seven different types of projects which may require MSE/TSM involvement:

- Transportation System Management (TSM) Projects
- Capital Program Management (CPM) Projects
- Local Aid and Economic Overview Projects
- Major Access Permit projects

- Regional Permit projects
- Maintenance Engineering projects
- External Agency Projects

A.6.1. Transportation System Management Projects

TSM projects are Limited-Scope projects which are led by TSM. Other stakeholder needs are considered, however responsibility for the overall execution of the project remains with TSM.


The progress of TSM projects follows the TSM Limited Scope Project Delivery Process shown in Appendix **Error! Reference source not found.**. Narratives of the tasks and milestones on these diagrams are rovided in the Activity Description document, in Appendix **Error! Reference source not found.**. This process is similar to the CPM process; however it is abridged due to its specialized and limited-scope nature.

A.6.2. Capital Program Management Projects

CPM Projects are governed by the policies of the NJDOT Program Management Office and are described on the Capital Project Delivery website. The Capital Project Delivery process comprises a five-step process, including:

- Problem Screening phase
- Concept Development phase
- Preliminary Engineering phase
- Final Design phase
- Construction phase

The inclusion of MSE in these projects is initiated with the circulation of a Draft Limited Scope document or Project Interference checklist. At this point, MSE determines their requirements and forwards them to the Project Manager. TSM is considered a stakeholder in these projects but does not take a lead in the project design, development, or funding.

NJDOT REFERENCE:		Capital Project Delivery – Home page http://www.nj.gov/transportation/capital/pd/
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A.6.3. Local Aid and Economic Overview projects

The State Aid Program is one method by which the New Jersey Department of Transportation (NJDOT) can work with county and municipal governments (localities) to improve the efficiency and effectiveness of the State’s transportation system. The Transportation Trust Fund (TTF) has provided the opportunity for State assistance to local governments for road, bridge, and other transportation projects.

Following are the State funded programs administered by Local Aid:

- Municipal Aid
- County Aid
- Local Aid Infrastructure Fund (Discretionary Funding)
- Bikeways
- Safe Streets to Transit
- Transit Village
- Local Bridges’ Future Needs

The scope of these projects is as determined by the requesting locality and approved by the applicable Local Aid and Economic Development District Office that administers the project. TSM’s involvement in these projects is limited to specific ITS applications requested by the locality or to mitigate potential

interferences with existing ITS assets. Examples of new ITS requests may relate to Safe Streets, Transit Village, or Bikeway Grant initiatives.

The process for Local Aid and Economic Overview projects is found on the NJDOT Local Aid website.

NJDOT REFERENCE:		Local Aid and Economic Development Overview http://www.nj.gov/transportation/business/localaid/
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A.6.4. Major Access Permit Projects

Major Access Permit (MAP) projects are issued and managed by the Office of Access Design.


When a notification of proposed development is received by the MAP office, MAP must coordinate with MSE to determine what impacts the permit will have on existing or proposed ITS infrastructure. These impacts may include:

- Physical interference with existing ITS assets
- Physical interference with planned ITS assets
- Projected change in traffic volumes that may warrant new ITS assets
- Projected change in traffic patterns that may necessitate reconfiguration of existing ITS assets (such as TTS detector locations or DMS-displayed destinations)

Such impacts will need to be jointly coordinated and mitigated between the Office of Access Design and MSE. Work done under the MAP may require installation or relocation of an impacted ITS asset, modification to the location of the access request, software configuration changes, or simply a denial of the permit.

In general, the costs of a MAP project are assumed by the developer who is applying for the permit. However, where a large development is being proposed, it may not be practical to pass on the entire cost of new ITS infrastructure to the developer. In this case, MSE and MAP must jointly determine which costs must be covered by the developer and which costs become the responsibility of NJDOT.

The process by which TSM and MAP interact are defined in the MSE-MAP Flowchart included in Appendix H.4. Additional information regarding Major Access Permits is located on the NJDOT's Access Management web page.

NJDOT REFERENCE:		NJDOT Major Access Permits http://www.nj.gov/transportation/business/accessmgt/
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A.6.5. Regional Permit Projects

The Operations Permit Office (OPO) issues Highway Minor Access Permits and Highway Occupancy Permits for proposed work that is on the State highway system and that is governed by the relevant New Jersey Administrative Codes. The OPO coordinates the permits statewide for work that is performed in the North, Central and South Regions. The OPO is headquartered in Ewing. If the proposed work for a minor access or occupancy permit either will impact or might impact ITS assets, the OPO gives MSE a set of plans for review and coordinates with MSE to prevent damage to or interference with an ITS asset. The permittee may be required to install or relocate equipment for an impacted ITS asset, or the permittee may be required to redesign the project to eliminate an interference. The physical interference with an ITS asset may be grounds for rejecting a permit application.

A.6.6. Maintenance Engineering Projects

Maintenance Engineering Projects are limited to roadway maintenance activities in which ITS infrastructure is present. This may include items such as conduits or induction loops that are affected by resurfacing projects.

A.6.7. Other Agencies Projects

At times, work may be required on NJDOT property as part of a project that is under the governance of a different agency. As an example, a project run by the Port Authority of NY & NJ (PANYNJ) may impact the NJDOT roads that are in the vicinity of the PANYNJ facility.

While these projects are run by entities other than NJDOT, it is necessary for NJDOT to establish an ad-hoc organization to coordinate with the external agency and ensure that NJDOT's needs and requirements are met. Proper coordination must occur, and these procedures shall be developed on a case-by-case basis.

A.6.8. Additional Resources

In addition to the information contained herein, other Department engineering forms and manuals can be found on the NJDOT Engineering web page.

NJDOT REFERENCE:	 NJDOT Engineering http://www.nj.gov/transportation/eng/
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B.1. Concept Development Overview

Every TSM lead project must go through the Concept Development phase. This process requires a detailed review of the purpose and need for the project with consideration for alternative ITS strategies and solutions. This gives the designer and MSE the opportunity to discover any overarching challenges associated with the project based on the proposed ITS device sites, and to evaluate potential issues that may actually rule out the initially preferred design approach. The final determination of sites is selected based on environmental impacts, constructability, cost effectiveness, time required for construction, and how effectively the alternative addresses the project needs.


The designer shall, in coordination with the project manager, reach out to the respective Traffic Operations region to document the objectives for requested new ITS facilities. A general location and type of each field device may also be provided or recommended by Traffic Operations during scoping. In addition and when appropriate, the designer shall confer with Mobility Management personnel to document how to address the existing ITS facilities within the project limits. Based on this, the designer will prepare preliminary device location sketches for Traffic Operations and Mobility Management review and approval as a preferred alternative. Regardless of this approval, it is the designer's responsibility to recommend and locate the device at a location that meets the need and is safe and cost-effective to deploy and maintain.

Note: Concept Development is a mandatory requirement by FHWA and is conducted in part to give designers the ability to avoid placing proposed ITS equipment in locations that would necessitate ROW Acquisition, Environmental Permitting, or Utility Relocations. Every effort should be made to avoid these potential conflicts, as they may represent fatal flaws in the design. Notify MSE immediately for decisions regarding major ITS infrastructure conflict. If these potential conflicts can't be avoided MSE and Designers should evaluate the need for a Preliminary Engineering (PE) phase if the project will require any ROW takings, Utility Relocation, or major Environmental Permitting. During the limited scope CD phase If it is determined that a PE phase is required in order to achieve the desired purpose and goal, the CD phase may be terminated at that point if any other suitable alternative is not available. In such a case, TSM may request CPM to initiate a CD phase using the CPM Project Delivery Process.

Environmental: ITS devices can frequently be designed in locations that avoid environmentally sensitive areas; therefore Environmental Screening should take place immediately upon Notice to Proceed so the designer knows the areas to avoid. Once device locations are set and included in the official Environmental Screening Report (deliverable to NJDOT) any subsequent location changes must be documented and the Environmental Screening Report updated to reflect the change.

ROW: Frequently, the use of as-builts is not enough to confirm ROW availability. Designers are required to request ROW Engineering Documents, NJDOT jurisdictional maps, utilize private websites (such as State information services and ESRI), township GIS mapping, and tax maps. This activity must take place whether the project goes through Concept Development or directly to Final Design. The ROW sources used as well as the individual doing the ROW review must be noted and documented in the project files. A ROW clearance letter must be included with the FD submission; a sample can be found in Appendix H.8.

If the exact location of ROW line is still in doubt after reviewing the documents as described above, and a proposed ITS device comes within 5' of the assumed ROW line, the Designer should immediately alert MSE that a Title Search is warranted. MSE and the Designer will need to discuss how that activity is to be undertaken. The entire ROW process can be found on NJDOT's website.

<p>NJDOT REFERENCE:</p>	 <p>Right of Way Design Guidelines http://www.nj.gov/transportation/eng/documents/BDC/pdf/ROWDesignGuidelines2012.pdf</p>
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Key Milestones from Concept Development:

- Purpose and Need Statement
- Concept Development Report

PART B - CONCEPT DEVELOPMENT

- Approved Environmental Document Classification
- Approved Device Locations
- System Engineering Review Form (SERF)

ITS design projects are also segregated by the type of ITS devices to be designed and constructed; Programmatic and Non-Programmatic, description of each follows:

Programmatic vs. Non-Programmatic ITS Projects:

- Programmatic:
 - Replacement/Upgrade of existing ITS facilities or systems that will not require further studies
 - Projects that do not involve R.O.W, utility relocation, or environmental studies.
 - Involvement of facilities and systems that do not require further study.
 - Standard ITS Devices previously used in NJ
 - ITS stand-alone project or ITS incorporated into other projects
 - Limited Concept of Operations (CONOPS)
 - Complies with ITS architecture
- Non-Programmatic:
 - Projects that involve R.O.W, utility relocation, or environmental studies.
 - Installation of facilities and systems that require further study.
 - Software or System not previously or frequently used in NJ (e.g. variable speed limit system, active traffic management system, etc.)
 - Detailed CONOPS

Programmatic Concept Development – This process should be followed when proposed ITS devices do not require a detailed Concept of Operations submission before proceeding with the Systems Engineering for the proposed deployment. Project types covered by programmatic approval for compliance with ITS Architecture and 23 CFR 940 include: development and deployment of standard ITS systems, individual components or complete systems, within an ITS stand-alone project or incorporated within other projects, and the operation and maintenance of existing ITS systems. Standard ITS systems include Camera Surveillance Systems (CSS), Dynamic Message Systems (DMS), Weigh-in-Motion Systems (WIMS), Road Weather Information Systems (RWIS), and Travel Time Systems (TTS) such as TRANSMIT, Radar, Microwave, Bluetooth, or third party data, loop detectors, and other established in-pavement based traffic data sensors, and other software or systems previously used in New Jersey. This approach applies when the facilities or systems involved do not require further study, ROW, utility relocation, or environmental studies.

Non-Programmatic Concept Development - This type of Concept Development will require a detailed Concept of Operations prior to the start of the Systems Engineering process that shall be performed during Final Design (FD). Non-programmatic would include ITS systems not previously used nor in current use in New Jersey.

Some Programmatic Projects may also require detailed Concept of Operations that need to be coordinated with MSE Project Manager.

PART B - CONCEPT DEVELOPMENT

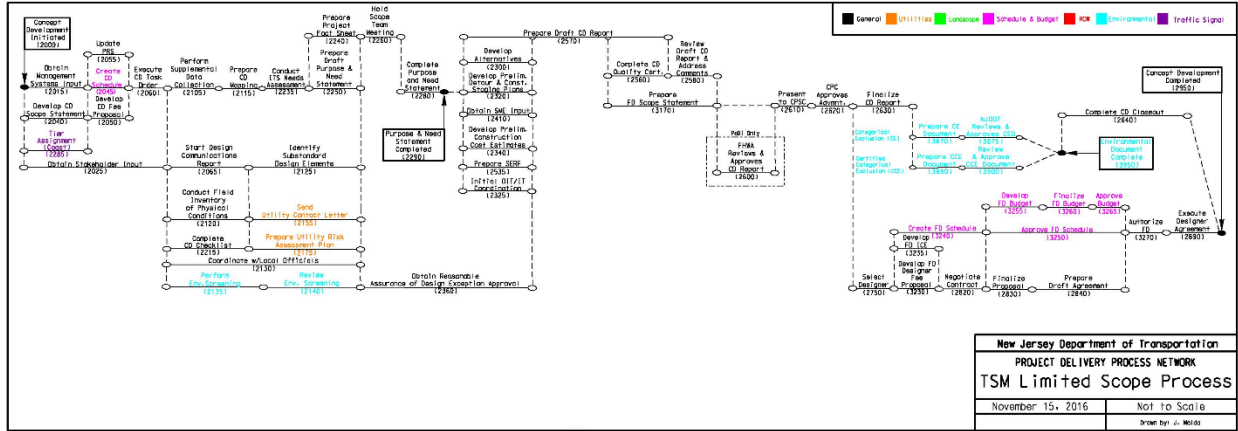


Figure B-1: Concept Development

For a full size view of the above Network Diagram, see Appendix **Error! Reference source not found.**

<p>NJDOT REFERENCE:</p>		<p>Project Delivery Process Network – Preliminary Engineering http://www.nj.gov/transportation/capital/pd/documents/PEPhaseNetworkDiagram.pdf</p>
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B.2. Traffic Operations

B.2.1. Responsibility

Traffic Operations plays a key role in scope development. Based on experience, they are expected to have knowledge of locations where the need for traffic monitoring and other ITS functions are not adequately met by the current infrastructure and require expansion. Traffic Operations will also review the early-stage (concept) design to ensure the proposed design will satisfy these needs.

B.2.2. Scope Development

The Scope Development phase is completed prior to the selection of a CD designer. The actions and deliverables under this section are to be provided by TSM. Specifically, Traffic Operations will develop the scope for ITS devices, while MSE will develop the plan for the communications backhaul (fiber, conduit, etc.) and the system requirements. TSM will also prepare the TSM Limited Scope Project Delivery Process Concept Development Scope Statement, that includes the activities and deliverables for the CD phase.

B.2.2.1. Identify Existing or Planned Assets

Since Traffic Operations are the regular users of ITS devices, the group is considered to have extensive knowledge on the strengths and deficiencies of the Statewide ITS Network. Therefore, Traffic Operations' input is extremely valuable to determining the need for new devices and developing the scope for new projects.

Based on the Problem Statements and records maintained by Traffic Operations and other historical data available from various management systems and input from MPO's and local government and other agencies, Traffic Operations will identify the existing assets in the area by using the online ITS Devices Inventory tool. As this tool only provides information regarding existing, operational devices, the PM must obtain from MSE a list of existing and future devices that are proposed or under construction, as well as a list of devices that are abandoned. Additionally, MSE will identify the nearest available conduit and fiber

optic cable network. The applicable information is then provided by the PM to the designers who shall confirm the accuracy of the provided information and revise the scope statement accordingly.

Designers shall also use the ITS Devices Inventory tool, in particular when looking for specific details of existing assets, however consultation with Traffic Operations and MSE is required as the current tool is not as inclusive as the information available through MSE.



TSM REFERENCE:		ITS Devices Inventory http://www.nj.gov/transportation/eng/elec/ITS/ITSDB.shtm
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During the project scoping process, Traffic Operations, along with MSE, shall also identify any redundancies between devices in the project scope and devices that are incorporated in other projects. This will avoid, for instance, two cameras being installed in the same location under two different projects.

B.2.2.2. Determine the Need for New ITS Devices

Determining a need for new ITS devices should be an ongoing process and does not necessarily need to wait until an active project exists. This information can be used for the development of new capital plans as well as add-ons to authorized projects.

Previously identified needs can be obtained from the ITS Strategic Deployment Plan or from the “proposed” category of devices in the ITS Devices Inventory tool.


TSM REFERENCE:		NJDOT Strategic Deployment Plan / ITS Investment Strategy, 10 Year Program, FY07-16 http://www.nj.gov/transportation/eng/elec/ITS/pdf/10yearplan.pdf
		ITS Devices Inventory http://www.nj.gov/transportation/eng/elec/ITS/ITSDB.shtm

Additionally, three other tools used to gather data to determine the need for new ITS devices are via OpenReach, RIMIS, and via Central Dispatch Logs from the Central Dispatch Unit.

- **OpenReach** is the central, regional operational database that agencies in the region use to enter, monitor, disseminate, and manage roadway activities. “Roadway activities” can be defined quite broadly and may include events such as shoulder closures, construction activities, and incidents such as earthquake damage. Users of OpenReach include NJDOT, NJTA, regional partners, and member agencies. OpenReach is accessed via software installed on the user’s computer. OpenReach is overseen by TRANSCOM.
- **Regional Integrated Multi-modal Information Sharing project (RIMIS)** is a web-based information exchange network connecting highway operation center, transit control centers, and 911 call centers in the Delaware Valley. Contributors to RIMIS include NJDOT, PennDOT, the City of Philadelphia, SEPTA, and the Pennsylvania Turnpike Commission. This database, operated by the Delaware Valley Regional Planning Commission, is similar to OpenReach.
- **Central Dispatch Logs** comprise a record of incidents to which police departments, NJDOT Maintenance, Incident Management Response Team (IMRT), Safety Service Patrol (SSP), or other outside agencies are summoned to respond. The compilation of applicable incidents is accessible via **Plan4Safety**, a Rutgers University-generated database fueled by NJDOT Crash Data.

The following process may be used to determine locations for new CSS or other ITS devices. This process should be followed at regular intervals in order to always have a plan for future ITS deployments:

- Search Accident reports (NJ TR-1, Police Crash Investigation Report) by roadway, milepost, cross-street, and municipality using Plan4Safety.
- Search OpenReach and RIMIS incidents by roadway, milepost, and cross-street for each county. This contains accident reports reported by Traffic Operations.
- Sort the lists by roadway then milepost for each set of data (OpenReach/RIMIS and Plan4Safety).
- Count the number of incidents for each mile. Reduce the list to just a column of single mile increments, and number of incidents per each increment.
- Plot the OpenReach/RIMIS data vs. Plan4Safety data. One year is a recommended timeframe.
- Large gaps in data will emphasize areas that are “blind” to Traffic Operations yet have a heavy police response to MVAs, and are justifiable locations for cameras or other ITS devices.
- Cross-reference the locations that warrant ITS with those which are already existing or planned by checking against the ITS database. Additionally, confirm via email with MSE, as devices which are not currently active many not be in the database.

EXTERNAL REFERENCE:		Rutgers Plan4Safety – Crash Analysis Database http://cait.rutgers.edu/tsrc/plan4safety
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Secondary Functions should also be considered when developing a scope. For instance, certain cameras may be used for analytics purposes as well as ordinary roadway surveillance. Consult MSE to determine whether secondary functions are applicable to a particular project.

Once a need or request for a new ITS device is established, it should be added to the ITS database regardless of whether it will be built under a current project. This placeholder will help to main coordination between two projects which may overlap, and will also document future needs for devices which are not built under current projects.

B.2.2.3. Avoid Interferences

Interference Checklists are developed and distributed throughout the Department for all new NJDOT projects. These checklists are derived from a Limited-Scope template and are circulated Department-wide to see if one project interferes with other planned or completed work.

If Traffic Operations receives an Interference Checklist from another group, they shall verify what assets are currently in the project vicinity and determine if the planned work will interfere with ITS assets. If so, the Checklist would be returned with instructions to either relocate the ITS device or to modify the design to account for the device in its current location.

Similarly, MSE will circulate the TSM Limited Scope CD Checklist when a new ITS device is being proposed to identify potential conflicts from other disciplines to that installation, and the designer will need to include such considerations with various units in the design. Confirm potential interferences with the Advanced Arterial Management unit of MSE as well as outside of TSM. This checklist is similar to the CPM interference checklist, with modifications to fit TSM specific needs.

A sample TSM Limited Scope CD Checklist be found in Appendix H.11. An excerpt of an ITS Engineering Checklist from a Limited Scope CPM project can be found in Appendix H.12.

B.2.2.4. Contribute to Purpose and Need Statement

Traffic Operations’ formal involvement with scoping begins prior to the design being awarded, when an email is received describing the location of a project (which may not be a TSM project) requesting information on existing and desired assets in the project area.

Traffic Operations' response will include requested installations that should be included in the contract, along with justification based on historical or other data. The response will also include information regarding existing assets that may cause interference to the project.

B.2.3. Concept Design

At this stage, the general scope has been defined and a designer (in-house or consultant) has been selected.

B.2.3.1. Design Coordination

Once the design is awarded to a design consultant, the designer shall, in coordination with the project manager, reach out to the appropriate Traffic Operations region to document the objectives for new ITS facilities. A general location and type of each field device may also be provided or recommended by Traffic Operations during scoping. In addition and as when appropriate, the designer shall confer with Mobility Management to document how to address the existing ITS facilities within the project limits. Based on this, the designer will prepare preliminary device location sketches for Traffic Operations and Regional Mobility Management review and approval. Regardless of this approval, it is the designer's responsibility to recommend and pinpoint the device at a location that meets the need and is safe and cost-effective to deploy and maintain.

B.2.3.2. Impacts to Operations Centers

Before any changes or updates can be made, the designer shall coordinate with Traffic Operations to identify what capabilities and capacity restrictions may exist for expansion of existing head-end systems and whether the current software is able to accommodate the change. Since STMC and TOC-S, and in some cases the AMC, have the ability to operate devices, the designer will need to check the infrastructure and the throughput to each of these three nodes. These determinations will be made by the designer and by MSE.

All upgrades or integrations must be planned and coordinated in such a way that they can be implemented without disruption to Traffic Operations. Upgrades will also need to go through an acceptance-testing process to ensure its stability and its compatibility with other existing equipment.

Additionally, the design of new ITS equipment may have an effect on the way conducts their day-to-day duties. Any procedural or staffing changes as a result of the proposed changes should be considered.

The impacts to Operations Centers should be identified and resolved in the SERF.

B.2.4. Communications Network – Overview

The communications network is a keystone in the delivery of successful ITS applications. It is the designer's responsibility to design a robust and reliable communications path from the far end field device to the head end operator workstation and the various applications servers as may be required. The overall reliability, availability, bandwidth and security requirements to adequately support the ITS related application(s) shall be provided by the communications systems. The order of preference for the consideration of design shall be:

1. NJDOT owned fiber optic communications network
2. NJDOT owned copper communications (if sufficient bandwidth for the application, IT/OIT to be consulted)
3. Agency Shared Fiber secured under a Memorandum of Understanding (MOU)
4. Leased High Bandwidth (1000 Mbps +)
5. Leased Medium Bandwidth (100 Mbps +)

6. Broadband Communications, Cable (DOCSIS 3.0, 3.1) or Phone Company - excluding DSL or POTS (plain old telephone system) Wireless “bridges” or direct (Broadband IP, Satellite Or Cellular)
7. Point-to-Point or Point-to-Multipoint Wireless



B.2.5. Programmatic Projects

Programmatic projects, as a result of the lower inherent risk and streamlined project approach, enjoy an abbreviated design and commissioning program. The following sections describe the typical steps for a programmatic type project.

Examples of this project type may include the extension of an existing camera or CCTV surveillance system (CSS) using approved camera, the extension of an existing communication network and existing application software or a signal optimization project which does not implement new hardware or application software.

B.2.5.1. Concept Design Development

The concept design for programmatic projects is abbreviated as compared to non-programmatic projects. It is anticipated that for this project type, existing communications networks will be used or existing networks and/or communications techniques will be extended to the project. It is important to involve the NJDOT ITS Maintenance personnel early in the concept design process to ensure that proposed solutions are suitable for ongoing operations and maintenance. For programmatic projects the Systems Engineering Review Form (SERF) will form the basis of design direction and the CD phase activities shall be selected based on the project specific requirements.

TSM REFERENCE:		Systems Engineering Review Form –Programmatic ITS – Instructions http://www.nj.gov/transportation/eng/elec/ITS/pdf/serf_instructions.pdf
		Systems Engineering Review Form – Programmatic ITS - Template http://www.nj.gov/transportation/eng/elec/ITS/rtf/serf_programmatic.rtf

B.2.5.1.1. Concept Design Initiation

The Concept design initiation for Communications shall commence along with the concept design initiation for the ITS program.

B.2.5.1.2. Field Inventory and Review

In the case of programmatic projects, the designer shall conduct a comprehensive field survey in conjunction with a NJDOT field technician or maintenance personnel and review to determine if existing ports are available and/or if sufficient bandwidth is available within existing communications systems to accommodate the communications payload of the anticipated project. Deficiencies in the existing systems or infrastructure shall be noted and the designated NJDOT project manager shall be informed to provide advice. The designer is required to develop mitigating options for NJDOT to consider. Where network discovery tools can be used to map the network, these may be used under the advice and supervision of NJDOT.

Additionally, existing field conditions observed during field visits are to be documented through photographs and submitted with the report.

Field survey work shall be conducted by qualified staff and shall adhere to all field safety requirements of the National Safety Highway Guidelines as adopted with minor modifications by NJDOT. Field personnel

shall wear required personal protective equipment (PPE). All required traffic management protocols shall be used when required to access equipment within the right of way as required.

B.2.5.1.3. Environmental and ROW Review

Every effort should be made to avoid placing proposed ITS equipment in locations that would necessitate right of way (ROW) Acquisition, Environmental Permitting, or Utility Relocations. If conflicts appear to be unavoidable, MSE should be notified immediately by the designer. A meeting with MSE should be held to determine a final resolution to the conflict and to determine if FD activities associated with ROW, Utility Relocation, and Environmental Impacts must be undertaken.

In the event that ROW issue cannot be avoided and the study does not qualify under the definition of the Limited Scope approach, the Limited Scope Study shall be terminated. In order to proceed with the project, the proposed project will be forwarded to the Capital Program Committee to advance under the CPM's standard project delivery process.

B.2.5.1.4. Concept Design and Cost Estimate

As part of the ITS Concept Development, the designer shall submit a Communications Concept and Analysis Report that should contain at a minimum the following information:

1. Preliminary Bandwidth Requirements
2. Communication Availability Analysis
3. Communication Alternatives Analysis
4. Simplified Communication Concept of Operation Statement
5. The designer is responsible for conducting in-depth concept design report noting communications paths, topology and include a cost-benefit analysis.
6. Testing of selected communications paths for integrity and continuity
7. A Communications System Block Diagram must be submitted and approved by OIT.

As part of each subsequent design phase submission the designer shall submit the following:

1. Systems Block Diagrams
2. Fiber Assignment Diagrams (when fiber network is involved)
3. Detailed Communications Calculations
4. Coordination Documentation
5. Preliminary cost estimates of the options presented
6. In the case of wireless communications, include all wireless network performance parameter analysis as required including bandwidth, path loss/path profiles, Fresnel zones and interference analysis.

B.2.5.1.5. Preliminary Bandwidth Requirements

This shall be an order of magnitude estimate by the designer as to the bandwidth requirements of both the existing traffic transiting the project, if any, as well as the expected traffic to be generated by the project and any future expansion. This will facilitate the design in the proceeding steps of the submission and will identify potential network bandwidth constraints outside of the project scope or physical project limits which may need to be addressed by NJDOT by this or another project.

B.2.5.1.6. Communication Availability Analysis


The designer shall prepare a report detailing any available communication technologies in the area of the project as well as adjacent to the project, also an assessment of the capabilities and limitations of each in

general, to support the final design. This assessment and design shall include the communications means described in Section B.2.4 and shall include but not be limited to:

1. Existing NJDOT communication (fiber, copper or wireless)
2. Cable Provider or Phone Company Broadband
3. Cellular Wireless
4. Satellite Internet

The actual order of preference is provided in Section B.2.4.

New Jersey Office of Information Technology (OIT) terms and standard contract information is available on the NJOIT web site.

EXTERNAL REFERENCE:		New Jersey Office of Information Technology http://www.nj.gov/it/
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In the case of existing NJDOT communications, the designer shall evaluate remaining availability of the communication system and suggest possible upgrades or reconfigurations as part of the Communications Concept and Analysis Report that shall be included in the CD Report.

B.2.5.2. Concept Development Report


The CD Report is required for all TSM projects regardless of the size of the project. This Report will also consolidate and present at a conceptual level the development of the Communication Systems plans to support the IT undertaking and provide NJDOT and NJOIT with sufficient information to understand the design and to approve it prior to the designer moving into the detailed design phase. This report will also list all other NJDOT projects in the pipeline and will document the correspondence with the respective project managers of these projects to alert the final design phase designer of any inclusion/exclusion of construction work and to help determine the stages of work accordingly.

The completed CD Report shall be provided to NJDOT for review, comment and approval. The Final Design phase shall not commence until the CD Report has been approved.

B.2.6. Non-Programmatic Projects

Non-Programmatic projects, as a result of the higher inherent risk of embarking on new, often complex technical projects require additional engineering rigor and a more detailed approach. To a large extent, non-programmatic projects will follow the systems engineering V model as promulgated by FHWA, Systems Engineering for ITS Handbook, Section 3 and illustrated in Figure A-3: Overview of the “V” Diagram

The following sections describe the typical steps for a non-programmatic project type. The basis of design shall be established by the Non-Programmatic Systems Engineering Review Form (SERF). The SERF step equates to the Feasibility Study/Concept Exploration step of the V model at the top left of the diagram.

EXTERNAL REFERENCE:		FHWA: Systems Engineering for Intelligent Transportation Systems, Section 3 http://www.ops.fhwa.dot.gov/publications/seitsguide/section3.htm
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B.2.6.1. Concept Development

B.2.6.1.1. Concept of Operation

Refer to Section A.5.2 for customized CTSS Procedures.

B.2.6.1.2. Concept Design Initiation

The Concept design initiation for Communications shall commence along with the concept design initiation for the ITS program. The purpose of the Concept Design as part of the TSM Concept Development, the designer shall develop a Communications Concept and Analysis Report that should contain at a minimum the following information;

1. Preliminary Bandwidth Requirements
2. Communication Availability Analysis
3. Communication Alternatives Analysis
4. Input into the overall Concept of Operation report
5. Shall support additional requirements which will include the business case, System Architectural Review for network security and provide for a system playbook a detailed further in this section.
6. The project shall also complete a Business Case Review (BCR). Attended by the business sponsor, representatives of NJDOT, The Deputy CTO of the affinity group, Chief of Information Architecture, Chief of Enterprise Architecture, Director of Infrastructure Support Services and a representative of the Program Management Office; the BCR allows the opportunity for NJDOT to work with OIT to gain an understanding of the business need of the proposed project and to assist in the development of a conceptual plan to ensure it aligns with the Enterprise Architecture and Agency business goals.

The Communications Concept and Analysis Report shall be submitted as part of the Concept Development Report

As part of each subsequent design phase submission the designer shall submit:

1. Systems Block Diagrams
2. Fiber Assignment Diagrams (when fiber network is used)
3. Detailed Communications Calculations
4. Coordination Documentation
5. Preliminary cost estimates of the options presented in order of preference as listed in section B.2.4.

B.2.6.1.3. Field Inventory and Review

In the case of non-programmatic projects, the designer shall conduct a comprehensive review of all of the suitable options available to support the proposed ITS applications. A field survey and review to determine if existing physical and logical ports are available and/or if sufficient bandwidth is available within existing communications systems to accommodate the communications payload of the anticipated project especially in cases where existing communications infrastructure exists which may be capable of supporting this new ITS application. Deficiencies in the existing systems or infrastructure shall be noted and NJDOT shall be informed to provide advice. The designer is encouraged to develop mitigating options for NJDOT to consider. Where network discovery tools can be used to map the network, these may be used under the advice and supervision of NJDOT.

Additionally, existing field conditions observed during field visits are to be documented through photographs and submitted with the report.

Field survey work shall be conducted by qualified staff and shall adhere to all field safety requirements and wear required personal protective equipment (PPE) as required by NJDOT. All required traffic management protocols shall be used when required to access equipment within the right of way as required.

B.2.6.1.4. Environmental and ROW Review

Every effort should be made to avoid placing proposed ITS equipment in locations that would necessitate right of way (ROW) Acquisition, Environmental Permitting, or Utility Relocations. If conflicts appear to be unavoidable, MSE should be notified immediately by the designer. A meeting with MSE should be held to determine a final resolution to the conflict and to determine if FD activities associated with ROW, Utility Relocation, and Environmental Impacts must be undertaken.

Environmental: ITS devices can frequently be designed in locations that avoid environmentally sensitive areas; therefore Environmental Screening should take place immediately upon Notice to Proceed so the designer knows the areas to avoid. Once device locations are set and included in the official Environmental Screening Report (deliverable to NJDOT) any subsequent location changes must be documented and the Environmental Screening Report updated to reflect the change.

Right of way (ROW): Frequently, the use of as-builts is not enough to confirm ROW availability. Designers are required to request ROW Engineering Documents, NJDOT jurisdictional maps, utilize private websites (such as State Information Services and ESRI), township GIS mapping, and tax maps. This activity must take place during Concept Development and is always confirmed during Final Design. The ROW sources used as well as the individual doing the ROW review must be noted and documented in the project files. **Note:** In the event that ROW issue cannot be avoided and the study does not qualify under the definition of the Limited Scope approach, the Limited Scope Study is terminated. In order to proceed, the proposed project is returned to the Capital Program Committee to advance under the standard project delivery process.

B.2.6.1.5. Alternatives Analysis

As part of the TSM Concept Development Report submission, the designer shall submit a communications concept and analysis report that should contain at a minimum the following information;

- Preliminary Bandwidth Requirements
- Communication Availability Analysis
- Communication Alternatives Analysis
- A comprehensive Communication Concept of Operation Statement

For Non-Programmatic projects, the designer should be prepared to include up to three viable communications systems options in this analysis. Where three viable options do not exist, the designer shall state what criterion limits the potential options and provide a value engineering analysis for each of the options put forward.

As part of each subsequent design phase submission the designer shall submit:

- Systems Block Diagrams
- Fiber Assignment Diagrams (when fiber optic network is used)
- Detailed Communications Calculations
- Coordination Documentation

B.2.6.1.6. Preliminary Bandwidth Requirements

This shall be an order of magnitude estimate by the designer as to the bandwidth requirements of both the existing traffic transiting the project, if any, as well as the expected traffic to be generated by the project and any future expansion. This will facilitate the design in the proceeding steps of the submission and will identify potential network bandwidth constraints outside of the project scope or physical project limits which may need to be addressed by NJDOT by this or another project.

B.2.6.1.7. Communication Availability Analysis

The designer shall prepare a report detailing any available communication technologies in the area of the project as well as adjacent to the project. Also the designer shall provide an assessment of the capabilities and limitations of each in general, to support the final design. This shall include but not be limited to the services listed in Section B.2.6.1.2. The designer shall also include Inquiry responses from the telecommunications service providers.

In the case of existing NJDOT communications, the designer shall evaluate remaining availability of the communication system and suggest possible upgrades or reconfigurations.

B.2.6.2. Standards

The communications systems technology considered for new systems shall be fit for purpose and shall meet all applicable industry and national standards. For example, data communication technology shall support the IEEE 802 family of specifications as well as supporting NTCIP protocols. All products shall be UL Listed under the appropriate standard to ensure electrical safety to operations and maintenance personnel as well as the general public.

B.2.6.3. Procurement

In general, ITS procurement will be conducted by public bidding process. Designs that would lead to a single vendor solution or a non-standards based solution should be avoided wherever possible, unless an existing PIFF is in place. As a result, designers are encouraged to provide standards-based designs where multiple vendors can supply functionally equivalent products into a fully integrated design.

B.2.6.4. Operational Responsibilities and Staffing

The concept design shall consider the operational responsibilities and staffing requirements of the envisioned solution. For example, can be managed by existing staff and if so, how? If additional operational or maintenance staffing are required or if specialist training is required to support the operations and maintenance of the envisioned system, this is to be communicated as early as possible during the Concept Development phase, ideally as part of the ConOps report but not later than in the Concept Development report

B.2.6.5. Concept Development Report

The CD Report is required for all TSM projects regardless of the size of the project. This Report will also consolidate and present at a conceptual level the development of the Communication Systems plans to support the IT undertaking and provide NJDOT and NJOIT with sufficient information to understand the design and to approve it prior to the designer moving into the detailed design phase. This report will also list all other NJDOT projects in the pipeline and will document the correspondence with the respective project managers of these projects to alert the final design phase designer of any inclusion/exclusion of construction work and to help determine the stages of work accordingly.

B.2.6.5.1. System Architectural Review (SAR)

Projects that include the need to deploy new software applications and/or new physical or virtual server will have to submit the design to NJDOT and NJOIT for a Systems Architectural Review (SAR). The SAR

process is devised between a logical SAR described in section B.2.6.6 and the Physical SAR which is described in section D.2.4.1 of this manual.

B.2.6.5.2. System Playbook

A system playbook will be prepared to describe how to place the system into normal operation and what routine maintenance will be required from an application operations and maintenance perspective. The playbook will also provide information on how to identify faults and to provide fault identification, troubleshooting and rectification information.

B.2.6.6. Concept Development Report Approval

The completed CD Report shall be provided to NJDOT for review, comment and approval. The Final Design phase shall not commence until CD Report has been approved. The designer shall interface with NJOIT as needed to secure system design approval.

The CD Report Approval signals that a logical design is ready. It is at this point that the Logical System Architectural Review (LSAR) shall be carried out. The LSAR shall be attended by the business sponsor, technical subject matter experts from NJDOT, Business and Technical Project Managers and the Architecture Review team that includes representatives from Network, Security, Data Services, Infrastructure, Architecture, GIS, and Business Continuity; the LSAR is the point in which the architecture for the solution gets its basic form. Initial discussions on the network, storage, security, data and access needs are confirmed and detailed discussions that will be needed to establish the physical design are identified.

For all federally funded concept development studies, FHWA must review and approve the CD Report before presenting to CPC.

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C.1. Design Overview

C.1.1. Preliminary Engineering

Generally this design phase is not required for limited scope projects led by TSM, however, Designers must familiarize themselves with the additional activities from the PE phase of the CPM Project Delivery Process that are adopted by TSM and incorporated in to the CD or FD phase of the TSM Limited Scope Project Delivery Process. ITS Designers on CPM lead projects are required to separately submit the Preliminary Intelligent Transportation Systems (ITS) facility design plans produced during PE Activity 3065 (Prepare Preliminary ITS Facility Design) to MSE for their review and approval as well including it into the Preliminary Engineering Report. These plans must show existing and proposed ITS facilities based on the Systems Engineering Review Form (SERF) executed during the Concept Development (CD) phase. If additional ITS facilities are requested after the CD phase, revise the SERF and obtain approval from MSE and Traffic Operations. If there are no new ITS facilities, show all existing ITS facilities on the ITS plan sheets with any proposed construction impacts. Resolve any conflicts associated with the conduit and ITS facility layout. Confirm availability of power and communication services as determined during the Concept Development phase. Identify and resolve any potential utility, right of way, and network conflicts.

Note: Every effort should be made to avoid placing proposed ITS equipment in locations that would necessitate right of way (ROW) Acquisition, Environmental Permitting, or Utility Relocations. If conflicts appear to be unavoidable, MSE should be notified immediately by the designer. A meeting with MSE should be held to determine a final resolution to the conflict and to determine if FD activities associated with ROW, Utility Relocation, and Environmental Impacts must be undertaken.

NJDOT REFERENCE:		Right of Way Design Guidelines http://www.nj.gov/transportation/eng/documents/BDC/pdf/ROWDesignGuidelines2012.pdf
		TSM Limited Scope Project Delivery Process http://www.state.nj.us/transportation/eng/elec/ITS/tsmprocess.shtm

C.1.2. Final Design Overview

During the Final Design Phase, a set of detailed construction plans and specifications are developed for construction of the project (see Appendix H.10 for the final design checklist). MSE's primary goal is to ensure that a quality design is developed so that a quality product can be built.

Unlike a typical CPM lead project, TSM lead projects include an Interim Submission along with the typical Final Design Submission (FDS), and Plans, Specifications, and Estimate (PS&E) Submission. The Interim Submission includes a conceptual layout of the ITS devices, proposed communications and electrical service power confirmation and conduit layout, and a preliminary construction estimate. It does not include specifications, item quantities, structural design, or construction details.

The TSM Limited Scope Project Delivery Process helps ensure all design decisions involve the right Subject Matter Experts, the design will be constructible, the end result will address the original project need, and that nomajor changes are required during the Construction phase.

NJDOT REFERENCE:		TSM Limited Scope Project Delivery Process http://www.state.nj.us/transportation/eng/elec/ITS/tsmprocess.shtm
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PART C - DESIGN

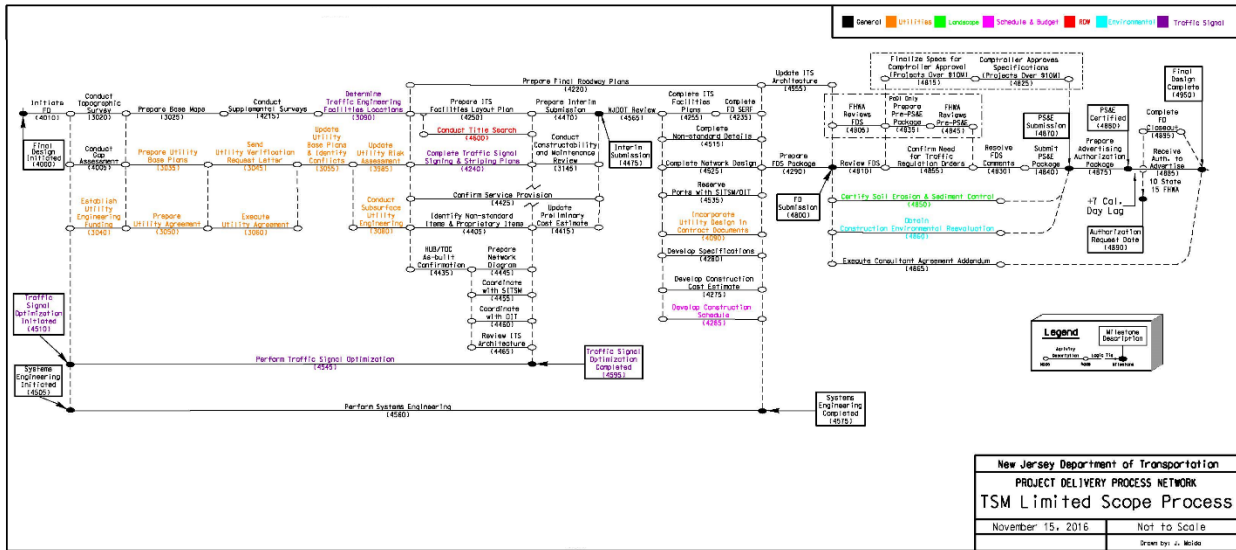




Figure C-1: Final Design

For a full size view of the above Network Diagram, see Appendix Error! Reference source not found..

For samples of plans to be used in the design, refer to the ITS and CTSS Sample Plans.

NJDOT REFERENCE:		ITS Sample Plans http://www.nj.gov/transportation/eng/elec/ITS/plans.shtm
		CTSS Sample Plans http://www.state.nj.us/transportation/eng/elec/ITS/ctss.shtm

Key Milestones from Final Design:

- Initiate Final Design
- Initiate Traffic Signal Optimization, *when applicable*.
- Initiate Systems Engineering, *when applicable*.
- Approved Environmental Document (if this document wasn't completed in an earlier phase)
- Interim Submission (see checklist in Appendix H.9)
- Traffic Signal Optimization Completed, *when applicable*.
- Systems Engineering Completed, *when applicable*.
- Final Design Submission (see checklist in Appendix H.9)
- PS&E Submission (see checklist in Appendix H.9)
- PS&E Certified
- Authorization Request Date
- Receive Authorization to Advertise


Note: Every effort should be made to avoid placing proposed ITS equipment in locations that would necessitate ROW Acquisition, Environmental Permitting, or Utility Relocations. If conflicts appear to be unavoidable, MSE should be notified immediately by the designer. A meeting with MSE should be held to

determine a final resolution to the conflict and to determine if any additional FD activities associated with ROW, Utility Relocation, and Environmental Impacts must be undertaken.


Environmental: ITS devices can frequently be designed in locations that avoid environmentally sensitive areas; therefore Environmental Document prepared during the CD phase should be carefully reviewed by the designer to set the final device locations. Any subsequent location changes must be documented and the Environmental Document must be updated to reflect the change.

ROW: Frequently, the use of as-builts is not enough to confirm ROW availability. Designers are required to review all ROW documents on file that were prepared during the CD phase. A ROW clearance letter must be included with the FD submission; a sample can be found in Appendix H.8.

If the exact location of ROW line is still in doubt after reviewing the documents as described above, and a proposed ITS device comes within 5' of the assumed ROW line, the Designer should immediately alert MSE that a Title Search is warranted. While preparing the Final Design Scope Statement, the PM from MSE and the Designer will need to activate Activity ID 4600 (Conduct Title Search) and discuss how that activity is to be undertaken. The entire ROW process can be found on NJDOT's website.

NJDOT REFERENCE:		Right of Way Design Guidelines http://www.nj.gov/transportation/eng/documents/BDC/pdf/ROWDesignGuidelines2012.pdf
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The flow charts depicted above illustrate the activities typically associated with a TSM lead ITS project. All projects that include Transportation Systems Management and Operations infrastructure or Intelligent Transportation Systems (ITS) devices that are being led by the Division of Project Management will follow the Department's current Project Delivery Process found at the following link:

NJDOT REFERENCE:		Capital Project Delivery – Home page http://www.nj.gov/transportation/capital/pd/
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C.2. Gap Assessment



The designer shall conduct a Gap Assessment to assess the design requirements for TSM project. The designer is required to exercise engineering judgment where necessary to meet the intended goals and objectives outlined in the Gap Assessment procedures. The designer is also required to outline the progression of the field work to be performed and to coordinate with NJDOT's Project Manager for consultation prior to the start of work.

For AAM Projects, the Designer is to lay out the initial proposed CTSS device locations for NJDOT approval prior to starting the Physical Inventory Gap Analysis.

The Physical Inventory Gap Analysis includes an inventory and visual inspection of the existing infrastructure including switches, junction boxes, patch panels, etc. The Conduit Fill Gap Analysis includes an inventory and visual inspection of the conduits (communication & electrical) and cables (communication and electrical). Additionally, existing conditions observed during field visits are to be documented through photographs and submitted with the report.

In addition for AAM Projects, the Physical Inventory Gap Analysis includes an inventory and visual inspection of the traffic signal infrastructure including traffic signals, signal poles, junction boxes, and signal controller cabinets. The Conduit Fill Gap Analysis includes an inventory and visual inspection of the traffic signal conduits, conductors, and cables. As a part of the Physical Inventory Gap Analysis, the Designer will conduct a detailed Field Conditions Memo.

The links below refer to the Gap Assessment for CTSS/Adaptive Projects (Form # MSE 627-001) and a CTSS Gap Analysis Sample

TSM REFERENCE:		Gap Assessment for CTSS Tier 1 (MSE 627-001) Appendices\GapAssessmentCTSS.pdf
		CTSS Gap Analysis Sample Appendices\CTSSGapAnalysisSample.pdf

C.3. Intelligent Transportation Systems (ITS)

NJDOT deploys ITS devices as operational tools to assist in achieving its goals for transportation safety, mobility, reliability, economic competitiveness and resilience, accessibility, and customer satisfaction. This section identifies design considerations for ITS device designs that support strategies implemented by Traffic Operations to monitor and control traffic conditions on State owned and operated highways.

The ITS devices are discussed in terms of warrants for installation, types of device and structural support standards, design considerations for selecting the device locations in the field, typical construction contract pay Items associated with the work, design checklists, and system testing. The following ITS systems are identified in this manual:

1. Dynamic Message Systems (DMS)
2. Variable Speed Limit Systems (VSLS)
3. Camera Surveillance Systems (CSS)
4. Travel Time Systems (TTS)
5. Truck Safety Warning Systems (TSWS)
6. Controlled Traffic Signal Systems (CTSS)
7. Weigh-in-Motion Systems (WIMS)
8. Roadway Weather Information Systems (RWIS)
9. ITS Cabinets
10. Communication Systems
11. Raceway Systems
12. Wiring

Instructions for justifying the deployment of project included ITS technologies are derived from the 2014 NJ Statewide ITS Architecture and the MSE requirements for preparation of a Systems Engineering Review Form (SERF). It is intended that this section serves as a high-level guide to assist designers through the development of construction contract plans for ITS devices.


C.3.1. Common Design Considerations

1. Right of way (ROW) – Acquire existing as-built/construction plans from the Engineering Documents Unit (EDU), and project area property tax maps if they were not included in the CD Report. Also, if the CD Report recommended a title search for any particular existing or proposed device or field cabinet, ensure that a title search is performed if included in the FD scope statement. Compare and confirm conditions illustrating the ROW lines. Special agreement documents such as a Memorandum of Agreement/Understanding (MOA/MOU) will be required for locations crossing jurisdictional boundaries between transportation agencies. Other locations will require other types

PART C - DESIGN

of agreements between NJDOT, the County or Municipality. For projects impacting the NJTA, a formal License to Cross application will be required. Provide construction support services to ensure the NJTA construction as-built record drawings are completed as soon as possible and in accordance with the requirements of the NJTA as stipulated in the License to Cross Agreement. Ensure the work is part of the Construction Support Services consultant scope of work. Pursue Right-of-Entry permits for railroad crossings. In all cases, designers shall notify the PM and find alternate solutions so as to avoid ROW issues. If jurisdictional agreements are necessary, begin the process immediately as this will add months to the delivery of a project and can contribute to a fatal flaw in the design. Identify the company representative(s) responsible for obtaining and verifying this information on behalf of NJDOT and include this information in the FDS package.

2. Utility Conflicts – Ensure compliance with the utility company requirements for utilities located overhead and underground. Avoid any impact to drainage pipes, water and gas lines, etc. Consult MSE for areas of major utility interference. In some cases the Department may elect to engage the utility for potential relocation work. For projects including utility relocations as part of the project scope, coordinate relocations with the utilities unit prior to finalizing the proposed design locations. Verify compliance with Federal Aviation Administration restrictions near airports.
3. Proximity to Utilities – Consider placing the device close to electric and communications services to minimize construction cost, however, maintain a safe distance away from any overhead power lines in accordance with OSHA and utility company high voltage proximity requirements.
4. Constructability – Verify the structural support standard and sign can be lifted and installed at the proposed location without conflict. Evaluate soil conditions, crane positioning and lifting, lane closures, detours, foundation footprint, utilities, etc.) Evaluate utilities for conflict per Item. 2.
5. Maintenance Access – Provide for depressed curb and turf pavers as necessary, and verify clearance from nearby overhead utilities (20') during maintenance operations requiring use of a bucket truck. Make general observations for high and low topography points at the ITS device site. Avoid areas subject to flooding. If placement of equipment in a flood area is unavoidable, include provision for skirts to be installed under controller and equipment cabinets to be mounted on foundations. Bring such information to the attention of the PM.
6. Clear Zone Compliance – Ensure the structure is placed outside of the required clear zone as required by Department standards. Provide guide rail or other Department standard safety barrier as required to ensure safe access to the sign for maintenance personnel.

NJDOT REFERENCE:		<p>NJDOT Road Design Manual Clear Zone (L_c)</p> <p>http://www.nj.gov/transportation/eng/documents/RDM/figure8a.shtm</p>
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7. Environmental Constraints – Verify that all construction work is designed to occur outside of any wetland, riparian zone, etc. and does not violate the NJ register of historic places rules. Complete the required environmental and SHPO processes.
8. Electrical Power Service – Consider utilizing existing NJDOT owned load centers to obtain power when available. Coordinate with the appropriate bureau (MSE, Traffic Engineering, Electrical Maintenance, etc.) to obtain permission to utilize the load center. Verify spacing requirements including space needed for proposed transformers. Confirm the provision of electric service with the electric provider that operates within the project area (JCP&L, PSE&G, ACE, or Rockland Electric Company). Prepare a utility agreement (Utility Engineering Contract Agreement) or Electric Service Inquiry (ESI) request as directed by the Project Manager. Obtain confirmation from the utility provider and include any confirmation numbers and cost estimate in Section 701 of the Special Provisions. Confirm latest changes in meter placement requirement mandated by each company.
9. Communications Service Provider – Select the nearest communications service drop and meet with the service provider representative to confirm availability. Specify the download/upload bandwidth requirements and submit the required forms to the Provider to confirm the service availability so that any potential restraints are evaluated and resolved. Prepare a utility agreement (Utility Engineering Contract Agreement) or Electric Service Inquiry (ESI) request as directed by the Project Manager. Obtain confirmation from the utility provider and include any confirmation

numbers and cost estimate in Section 701 of the Special Provisions. The number of static IP addresses will be the number of ITS devices in the controller, plus the number of switches, plus the PDU, plus any other devices needing addresses such as ISP supplied routers and modems.

10. Slope/Grade - Ensure the device is not located on a fill slope of greater that one vertical to two horizontal (1V:2H).
11. Staging – Coordinate installation of the equipment during the appropriate construction phases to accommodate underground conduit, junction boxes, foundations, guiderail, communications, and utilities etc.
12. Acceptance – Coordinate with MSE and ITS Maintenance to determine if any additional Contract time will be required for system burn-in prior to Acceptance of the project. A time frame of six or more months may be required before Completion of the project can be declared. Add the time frame to the special provisions Section 108.10, and include it in the construction schedule timeline.
13. Testing – Ensure the special provisions include any additional testing criteria for the design to verify acceptable operation of the system components. Modify the language as necessary via supplementary insert.
14. Warranty – Ensure the equipment warranty periods are described in the special provisions to begin on the Completion Date of the construction Contract. Modify the language if necessary via Supplementary Insert.
15. Licensing – Confirm the licensing needs with MSE for systems requiring recurring costs and those purchased up front. Provide special provisions to account for the license requirements as needed. Include costs in the engineers estimate accordingly.
16. Project Coordination - Contact the PM and request project information regarding other projects that may impact design and construction. Identify the work in each project and coordinate the design and construction overlaps.

C.3.2. Dynamic Message System (DMS)

C.3.2.1. Warrants

The use of DMS signs is warranted in each of the ITS Architecture Service Packages and associated Equipment Packages listed in Table C-1. Prepare a SERF document to identify the appropriate Services and Equipment Packages to be provided in the project design, and support them with Design Support Data as outlined in Section C.3.2.1.1. Describe use of the Services as related to the Concept of Operations. The following Packages are listed in alphanumeric order by service:

Table C-1: DMS Services (Permanent Installations)

Service Package	Equipment Package
ATMS04 Traffic Metering	Roadway Traffic Metering Roadway Traffic Information Dissemination TMC Traffic Information Dissemination
ATMS06 Traffic Information Dissemination	TMC Traffic Information Dissemination Roadway Traffic Information Dissemination
ATMS09 Transportation Decision Support and Demand Management	TMC Traffic Management Decisions Support
ATMS16 Parking Facility Management	Parking Management
ATMS20 Drawbridge Management	Multimodal Crossing Control TMC Multimodal Crossing Management

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Service Package	Equipment Package
ATMS21 Roadway Closure Management	MCM Work Zone Management TMC Traffic Information Dissemination Roadway Traffic Information Dissemination Roadway Work Zone Traffic Control
ATMS22 Variable Speed Limits	TMC Traffic Information Dissemination Roadway Traffic Information Dissemination
ATMS23 Dynamic Lane Management and Shoulder Use	Roadway Dynamic Lane Management and Shoulder Use
ATMS24 Dynamic Road Warning	Roadway Warning
EM06 Wide-Area Alert	TMC Traffic Information Dissemination Roadway Traffic Information Dissemination

The following service and equipment packages warrant deployment of portable VMSs:

Table C-2: DMS Services (Construction and Maintenance Services)

Service Package	Equipment Package
MC05 Roadway Automated Treatment	Roadway Traffic Information Dissemination
MC08 Work Zone Management	MCM Work Zone Management MCV Work Zone Support Roadway Work Zone Traffic Control TMC Work Zone Traffic Management
MC10 Maintenance and Construction Activity Coordination	TMC Work Zone Traffic Management

C.3.2.1.1. Design Support Data

For each of the Service Packages identified in the SERF that supports installation of a DMS in the project, obtain the relevant information and data for the items listed below from the appropriate bureaus within the Department to confirm the correct application of the Service Package(s):

1. Average Daily Traffic (ADT) Volumes – identify the areas of high ADT’s.
2. Level of service (LOS) – identify areas of high congestion.
3. Volume to capacity ratio (vehicles per hour/per lane) approaching 1.
4. Areas of recurring incidents and high accident rates.
5. Locations identified for advance warnings for hazardous areas (queues, fog, bridges, tunnels, turn-overs).
6. Evacuation routes.
7. Diversion and decision making points. Note the interchanges, grade separations and intersections of concerns.
8. Special event traffic control needs.
9. Speed control areas suitable for Variable Speed Limit Signs (VSLS).
10. Other needs as identified by the Department.

C.3.2.1.2. Warrant Summary

Prepare a summary of the conditions identified above and justify the selection of the ITS Architecture Service and Equipment Packages. Prepare a list of the high level functional requirements for the system design. Incorporate this information into the SERF.

C.3.2.2. Sign and Structural Support Standard Types

The following DMS sign and structural support standard types are used in the design:

1. Sign Types
 - a. Walk-in enclosure
 - b. Front access
2. Structure Support Standards
 - a. Butterfly
 - b. Cantilever
 - c. Ground Mounted
 - d. Full Span/Overhead

C.3.2.3. Location/Placement Guidelines Placement

C.3.2.3.1. Site Visits

Perform field investigations of the project sites as needed to determine and verify the type and location of the proposed DMS signs. Coordinate with Traffic Operations and Mobility Management together if possible, to obtain approval of the proposed locations. Identify the sources for electrical power and communication service drops, and note maintenance accessibility.

C.3.2.3.2. Selection of Sign and Structural Support Standard Types

In selecting the locations for a proposed DMS sign and support standard, verify that the installation will meet the requirements of the MUTCD Chapter 2L for Changeable Message Signs, and that there is sufficient sight distance to ensure adequate viewing time for the motorist traveling at a given speed as shown in Table C-4. The type of structural support standard will vary with roadway classifications within the project limits. Utilize walk-in type signs in all cases where a sign will be installed over traveled lanes requiring lane closures for maintenance. The following roadway classifications and corresponding structure types shown in Table C-3 are preferred.

Table C-3: Preferred DMS Standard Structures


Roadway Classification	Preferred DMS Standard
Interstates	Cantilever
Freeways and Expressways	Cantilever
Local/Express highways	Butterfly
Principal Arterials	Ground Mount
Minor Arterials, Collectors, and Local Roads	Ground Mount

NOTE: Regardless of the type of structure use for DMS sign installation, it is a standard practice to include a camera and a Travel Time device unless directed otherwise. The designers must confirm this requirement in order to proceed with selecting the appropriate pays items and to calculate the bandwidth requirement for the additional devices.

- Butterfly Standards:** Utilize butterfly structures installed in the roadway median with front access type signs or adjacent to the roadway with adequate ROW. See Division 500 of NJDOT Standard Specifications and BDCs for DMS structural detail requirements.
- Ground Mount Standards:** Utilize ground mount structures with front access type signs. See Division 500 of NJDOT Standard Specifications and BDCs for ground mounted sign requirements. Verify sufficient right-of-way and clearance from overhead and underground utilities.
- Cantilever Standards:** Utilize cantilever structures with the support leg of the structure placed adjacent to the roadway where roadway median widths are too narrow to accommodate support and foundation, and also where the proposed sites lack sufficient right-of-way for butterfly structure overhang. Provide walk-in type signs. See Division 500 of NJDOT Standard Specifications and BDCs for standard DMS structural detail requirements.
- Full Span Overhead Standards:** Utilize full span standards for roadways with more than 3 lanes in one direction. Modify the Department's OHSS standard construction details as required. Provide walk-in type signs. Verify sufficient right-of-way and clearance from overhead and underground

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utilities. Consult MSE and Structure's unit with justification prior to recommending or initiating design of OHSS.

NJDOT REFERENCE:		NJDOT Design Manual for Bridges and Structures http://www.nj.gov/transportation/eng/documents/BSDM/
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For all DMS signs located in the median or off the traveled lanes, provide a 5 degree orientation skew (typical) and adjust as field conditions dictate – see the ITS sample plans. It is important to note that the specific model of the sign correlates to a light emitting diode (LED) cone of vision of which a motorist will pass through as it approaches and leaves the sign proximity. Ensure the cone as designated by the manufacturer for the specified model is oriented for maximum viewing and reading comprehension time.

NJDOT REFERENCE:		ITS Sample Plans http://www.nj.gov/transportation/eng/elec/ITS/plans.shtm
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Ensure adequate sight distance for the proposed sign locations and character height, per Table C-4. Verify the proposed site by field investigation to ensure that roadway alignment, geometry, grade, and other possible obstructions do not impose restrictions from the motorist's point of view. It is important to note that once a driver gets close to the sign, they may reach a point where they are not able to read the message due to the LED cone cutoff point.

Table C-4: DMS Sight Distances

Maximum Viewing Distance	Minimum Character Height	MPH						
		15	25	35	45	55	65	75
300 ft/91m	6 in/152mm	13.7	8.2	5.8	4.6	3.7	3.2	2.7
450 ft/137m	9 in/229mm	20.5	12.3	8.8	6.8	5.6	4.7	4.1
650 ft/198m	12 in/330mm	29.7	17.8	12.7	9.9	8.1	6.8	5.9
1100 ft/274m	18 in/457mm	41.1	24.6	17.5	13.7	11.2	9.5	8.2

This table was taken from Daktronics design documentation. Contact Daktronics for latest updates. Shaded areas indicate adequate viewing time (in seconds) to read at the indicated character height.

EXTERNAL REFERENCE:		MUTCD Chapter 2L: Changeable Message Signs http://mutcd.fhwa.dot.gov/html/2009/part2/part2l.htm
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C.3.2.3.3. Design Considerations

Evaluate the proposed sign/support structure types and locations for DMSs in consideration of the following items. In all cases, document important decisions and concerns through the Department's Design Communications Report (DCR) procedures.

1. See Common Design Considerations of C.3.1.
2. Maintenance Access – Provide a catwalk for maintenance personnel access. If a catwalk cannot be accommodated at the proposed site, discuss with ITS Maintenance and revise the location to one that does.
3. OSHA Compliance – Ensure the DMS signs have walkways installed from the edge of pavement to the sign. Verify that there is no gap between the sign and the platform.
4. Foundation Design – Obtain the soil boring data from NJDOT Geotechnical Bureau for the proposed DMS sites. Develop the structural foundation detail as required by the soil conditions.
5. Decision Time - Evaluate sign selection and placement to account for additional distance that may be required for drivers to change lanes to reach a destination (e.g., interchanges, local off ramps, divergence, convergence, etc.) However, avoid placing DMSs in areas where drivers typically perform lane changing maneuvers on a regular basis due to static sign information, merging, and weaving. Consider placement of the sign regarding sun position, such as a blinding westbound sunset or eastbound sunrise, and out of the cone of vision. See Table C-4.
6. Information Overload - Avoid placing DMSs in areas with high information load on drivers including other message signs, regulation and directional panels, billboards, etc. Consult Traffic Engineering for evaluation and guidance as needed.
7. Traffic Signal Intersections - Avoid placing DMSs near signalized intersections. A minimum distance of 800' is recommended. Confirm with Traffic Engineering if a closer proximity is required.
8. DMS Spacing – Maintain a minimum separation distance of ½ mile between DMSs proposed for the same direction of travel.
9. DMS at Tunnels - Comply with the requirements of National Fire Protection Association (NFPA) 502 Standard for Road Tunnels, Bridges, and Other Limited Access Highways when designing DMS at a tunnel.
10. DMS Coordination with other systems – Include a TTS and a CSS at all DMS sites in the project design with consultation from MSE.
11. Existing Guide Rail – Place proposed DMS behind existing guide rail. Extend guiderail as needed for the application and ensure compliance with guiderail design standard requirements. If there is existing guiderail nearby but not specifically at the proposed device location, the sign may be moved to be installed behind existing guiderail, however, confirm the relocation with ITS Maintenance, and verify other requirements per Department design criteria and standard details for installation of structures.
12. Proposed Guide Rail -- For locations where there is no existing guide rail and device relocation is not feasible as mentioned above, ensure proposed design has guide rail protection for the DMS sign structure.
13. Construction Schedule - The DMS sign and controller are typically long lead items and require approximately six months from the time a purchase order is received by the manufacturer. Allow for contract mobilization, and field office set up, etc. in figuring time frame for the construction scheduling of the DMS delivery to the project site.
14. Structural analysis – Evaluate existing structures for use with proposed DMS. Include recommendation for structural modifications or design requirements in the SERF.

NJDOT has adopted a proprietary set of DMS signs by manufacturer make and model in cooperation with the FHWA that are to be furnished and installed on all State owned and operated roadways; no substitutions are permitted. Address the “No Substitutions” clause in the special provisions. After selecting the general type and size of the DMSs, contact MSE and obtain the manufacturer's make and model numbers for specific signs to be deployed at each site. Include this information on the construction plans – See ITS sample plans. Verify the height, length, width, and weight of each sign and use the information in the design calculations for the DMS structural support standards.

NJDOT REFERENCE:	 ITS Sample Plans http://www.nj.gov/transportation/eng/elec/ITS/plans.shtm
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Specify the side of the DMS sign case of the Walk-in DMS model for the location of the maintenance access door and note the requirement on the construction Contract drawings. Verify the model number corresponds to the required door opening side.

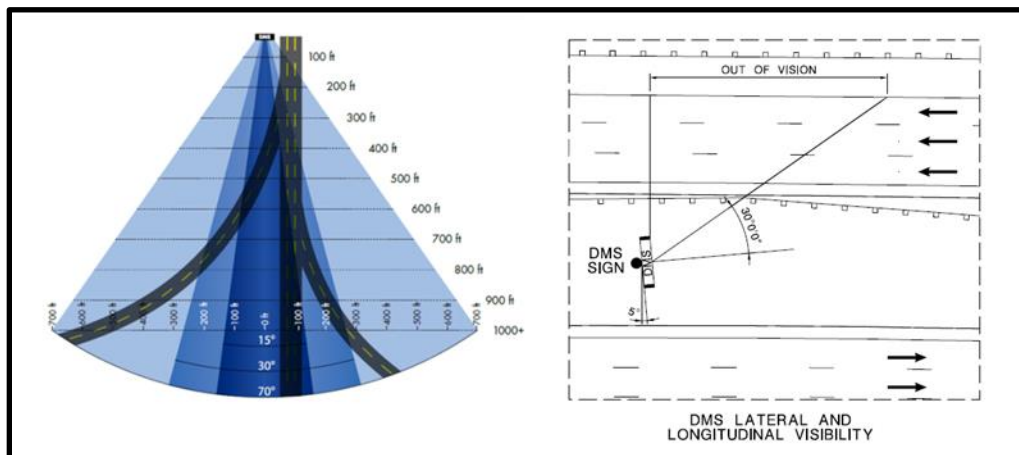


Figure C-2: Horizontal Cone of Vision

Note: The cone of vision graphic (left) was taken from Daktronics design documentation. Contact Daktronics for latest updates.

C.3.2.4. Pay Items

The following construction contract pay Items typically provide for the DMS work, however, this list is not all inclusive. Review and consider these Items as well as additional pay Items as required.

DMS Sign Support Standards:

- BUTTERFLY SIGN SUPPORT, STRUCTURE NO. ____
- CANTILEVER SIGN SUPPORT, STRUCTURE NO. ____
- OVERHEAD SIGN SUPPORT, STRUCTURE NO. ____
- DMS GROUND MOUNTED STRUCTURE NO. _____

Note: Refer to Division 500 Bridges and Structures for additional foundation and structural installation pay Items.

DMS Signs and Controllers/Electric Service:

- DMS SIGN
- CONTROLLER, DMS
- FOUNDATION ITS, TYPE D
- FOUNDATIONS, TYPE D-MC
- FOUNDATION ITS, TYPE MC
- METER CABINET, ITS

Additional pay items when a CSS or TTS is required on the same structure:

- CAMERA
- CONTROLLER, CAMERA
- TTS DETECTOR TYPE C

CONTROLLER, TTS

Ground Mounted, Butterfly, Cantilever and Overhead Structures Foundations:

- REINFORCEMENT STEEL, STRUCTURE NO. _____
- REINFORCEMENT STEEL, EPOXY COATED, STRUCTURE NO. _____
- CONCRETE FOOTING, STRUCTURE NO. _____
- EXCAVATION, UNCLASSIFIED, STRUCTURE NO. _____
- TEMPORARY SHEETING, STRUCTURE NO. _____

Note: Refer to Division 500 Bridges and Structures for additional foundation and structural installation pay Items and Section 202 for Excavation.

Maintenance Access:

TURF PAVERS

Safety Barriers:

- BEAM GUIDE RAIL
- RUB RAIL
- FLARED GUIDE RAIL TERMINAL
- TANGENT GUIDE RAIL TERMINAL
- CONTROLLED RELEASE TERMINAL
- CONTROLLER RELEASE TERMINAL ANCHORAGE
- BEAM GUIDE RAIL ANCHORAGE
- RESET BEAM GUIDE RAIL WITH EXISTING POSTS
- REMOVAL OF BEAM GUIDE RAIL
- NON-VEGETATIVE SURFACE, POROUS HOT MIX ASPHALT, ___THICK

Integration

SYSTEM INTEGRATION

Note: Review Section 609 Beam Guiderail for additional guide rail pay Items that may be required.

C.3.3. Variable Speed Limit System (VSLS)

C.3.3.1. Warrants

VSLS systems utilize traffic speed and volume detection, weather information, and road surface condition technology to determine appropriate speeds at which drivers should be traveling, given current roadway and traffic conditions. The use of VSLS devices is warranted in each of the ITS Architecture Service Packages and associated Equipment Packages listed in Table C-5. Prepare a SERF document to identify the appropriate Services and Equipment Packages to be provided in the project design, and support them with Design Support Data as outlined in Section C.2.2.1.1. Describe use of the Services as related to the Concept of Operations. The following Service Packages are listed in alphanumeric order.

Table C-5: VSLS Service Packages

Service Package	Equipment Package
ATMS09 Transportation Decision Support and Demand Management	TMC Traffic Management Decision Support

ATMS22 Variable Speed Limits	Roadway Variable Speed Limits TMC Variable Speed Limits
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C.3.3.1.1. Design Support Data

For each of the Service Packages identified in the SERF that supports installation of a VSLS in the project design, obtain the applicable information and data for the items listed below from the appropriate bureaus within the Department to confirm the correct application of the Service Package(s):


1. Average Daily Traffic (ADT) Volumes – identify the areas of high ADTs.
2. Level of service (LOS) – identify areas of high congestion.
3. Areas of recurring incidents and high accident rates.
4. Locations applicable for advance warnings for hazardous areas (queues, fog, bridges, tunnels).
5. Evacuation routes.
6. Diversion and decision making points. Note the interchanges, grade separations and intersections of concerns.
7. Special event traffic control needs.
8. Speed Control (VSLS) areas.
9. Other needs as identified by the Department.

C.3.3.1.2. Warrant Summary

Prepare a summary of the conditions identified above and justify the selection of the ITS Architecture Service and Equipment Packages. Prepare a list of the high level functional requirements for the system design. Incorporate this information into the SERF.


C.3.3.2. Sign and Structural Support Standard Types

Contact MSE to obtain the make and model number of the VSLS sign and controller. Prepare a Patented/Proprietary Items on Federally Funded Projects (PIFF) form as directed by MSE. Include make and model number on the construction plans – See ITS sample plans. Verify the height, length, width, and weight of each sign and use the information in the design calculations for the VSLS structural support standards.

NJDOT REFERENCE:		ITS Sample Plans http://www.nj.gov/transportation/eng/elec/ITS/plans.shtml
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The following VSLS structural support standard types are available for use in the design for independent “stand-alone” VSLS signs:

- NJDOT Standard Electrical Detail for Traffic Signal Standard “T”

NJDOT REFERENCE:		NJDOT Standard Electrical Details 2007 http://www.nj.gov/transportation/eng/CADD/v8/index.shtml#StandardDetailsEnglish
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C.3.3.3. Location/Placement Guidelines Placement

C.3.3.3.1. Site Visits

Perform field investigations of the project sites as needed to select and verify the location of the proposed VSLS signs. Coordinate with Traffic Operations and Mobility Management together if possible, to obtain

approval of the proposed locations. Identify the sources for electrical power and communication service drops, and note maintenance accessibility.

C.3.3.3.2. Selection of VSLs Structural Support Standard

In selecting the support standard and location for a proposed VSLs, coordinate the design with the installation of DMSs. The type of structural support standard varies by whether it is mounted to a DMS sign structure or if it is to be installed as a separate stand-alone device.

Comply with the requirements of the MUTCD Section 2B.13 Speed Limit Sign (R2-1), to locate the VSLs so that they display changes to the speed limit at the proper times. Comply with MUTCD Section 2H.03 Traffic Signal Speed Sign (I1-1), for traffic signal coordination applications.

Comply with MUTCD Section 2A.19 Lateral Offset, for stand-alone installations of the VSLs signs to determine the horizontal offset from the edge of pavement to the inside edge of the sign. Table C-6 summarizes the installation offset requirements by roadway classification:

EXTERNAL REFERENCE:		MUTCD Chapter 2B: Regulatory Signs, Barricades, and Gates http://mutcd.fhwa.dot.gov/html/2009/part2/part2b.htm
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Table C-6: Minimum VSLs Installation Offsets

Roadway Classification	VSLs Sign Standard offset horizontal offset from the edge of pavement to the inside edge of the sign
Interstates, Freeways and Expressways, Ramps	6 ft. minimum; but not less than 10' from edge of a traveled lane. 4 ft. minimum from back of beam guide rail element to sign post.
Principal Arterials	2 ft. minimum is desirable. A minimum offset of 1 ft. from the face of the curb may be used in areas where the sidewalk width is limited or where existing poles are close to the curb.
Minor Arterials, Collectors, and Local Roads	6 ft. minimum desirable from edge of shoulder, but 12 ft. minimum desirable from edge of traffic or auxiliary lane.

Where VSLs are designed to be installed behind guiderail, provide a 4' minimum distance from the back of the beam guide rail element to the sign support standard. Verify the existing locations of underground conduit and cabling and include these utilities in the contract plans to show existing conditions.

Ensure the minimum distance above the edge of pavement to the bottom of the VSLs panel is 7'.

Verify that the VSLs placement and support structure designs meet the requirements of Section 13.2 of the NJDOT Roadway Design Manual for the Ground Mounted Sign Supports, Small Highway Signs (total panel areas less than 50 square feet).

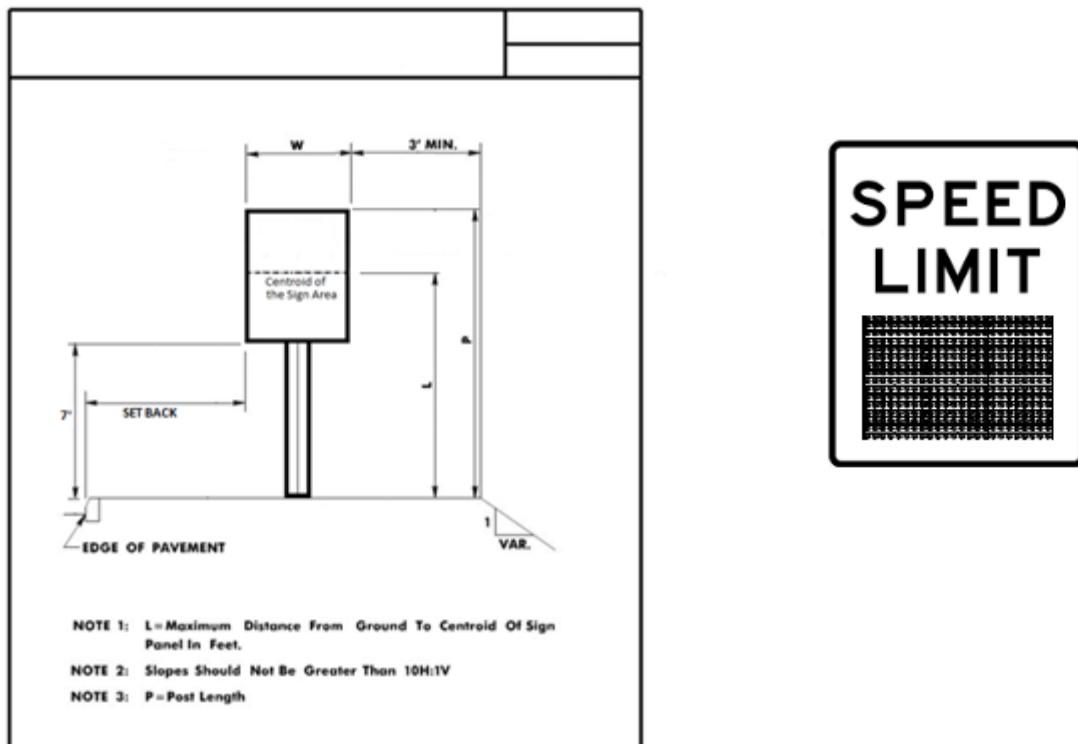



Figure C-3: VLS Placement

NJDOT REFERENCE:		NJDOT Roadway Design Manual, Section 13 http://www.nj.gov/transportation/eng/documents/RDM/sec13.shtm
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C.3.3.3.3. Design Considerations

1. See Common Design Considerations of Section C.3.1.
2. VLS with other Systems - Utilize existing sign structures for mounting VLS when feasible as a cost savings measure. If the location of the pole mounted VLS presents a potential conflict with the lowering device operation and safety of the maintenance personnel bring this to the attention of the Mobility Management Manager for further direction.

C.3.3.4. Pay Items

The following construction contract pay Items typically provide for the VLS work, however, this list is not all inclusive. Review and consider these Items as well as additional pay Items as required. VLSs mounted on DMS Sign Support Standards do not require additional pay Items for the standards. However, specifications and mounting details will be required in the design for the attachments, conduit, and wiring, etc.

VLS Signs and Controllers/Electric Service:

VLS SIGN
 CONTROLLER, VLS
 FOUNDATION TYPE C
 FOUNDATION TYPE C-MC
 FOUNDATION ITS, TYPE MC

METER CABINET, ITS

VSLs Sign Support Standard:

VSLs STANDARD TYPE A
FOUNDATION ITS, TYPE VSLs

Maintenance Access:

TURF PAVERS

Integration

SYSTEM INTEGRATION

C.3.4. Camera Surveillance System (CSS)

C.3.4.1. Warrants

The use of CSS cameras is warranted in each of the ITS Architecture Service Packages and associated Equipment Packages listed in Table C-7. Prepare a SERF document to identify the appropriate Services and Equipment Packages to be provided for in the project design, and support them with Design Support Data as outlined in Section C.3.4.1.1. Describe use of the Services as related to the Concept of Operations. The following Service Packages are listed in alphanumeric order.

Table C-7: CSS Services

Service Package	Equipment Package
ATMS01 Network Surveillance	Collect Traffic Surveillance
ATMS03 Traffic Signal Control	Collect Traffic Surveillance
ATMS04 Traffic Metering	Collect Traffic Surveillance
ATMS08 Traffic Incident Management System	TMC Incident Dispatch Coordination/Communication Roadway Incident Detection TMC Incident Detection
ATMS21 Roadway Closure Management	Collect Traffic Surveillance
ATMS22 Variable Speed Limits	Collect Traffic Surveillance
ATMS23 Dynamic Lane Management and Shoulder Use	Collect Traffic Surveillance
ATMS24 Dynamic Road Warning	Collect Traffic Surveillance
EM02 Emergency Routing	TMC Incident Dispatch Coordination/Communication
EM03 Mayday and Alarms Support	Center Secure Area Surveillance
EM05 Transportation Infrastructure Protection	Center Secure Area Surveillance TMC Incident Dispatch Coordination/Communication

Service Package	Equipment Package
EM06 Wide-Area Alert	TMC Incident Dispatch Coordination/Communication
EM07 Early Warning System	TMC Incident Detection Center Secure Area Surveillance
EM08 Disaster Response and Recovery	TMC Incident Dispatch Coordination/Communication
MC06 Winter Maintenance	TMC Incident Dispatch Coordination/Communication

C.3.4.1.1. Design Support Data

For each Service Package identified in the SERF that supports installation of a CSS, obtain the appropriate information and data for the categories listed below from the relevant Department bureaus to confirm the application of the selected Service Package(s):

1. Areas of degraded level of service (LOS) due to congestion. Locations exhibiting 60% congestion (volume/capacity ratio) for 25% of the time. These are generally identified as rush hours.
2. Interchanges and major intersections.
3. Areas of recurring incidents and high accident rates.
4. Areas of non-recurring incidents and high congestion.
5. Bridges, tunnel facilities, and bottlenecks. Utilize the VPP suite to evaluate bottleneck behaviors.
6. Computerized Traffic Signal Systems.
7. Active Traffic Management (ATM) corridors.
8. Monitoring environment conditions (flooding, ice, snow, fog.)
9. Gaps in existing ITS system identified by Traffic Operations Center manager.
10. Other needs as identified by the Department.

Retrieve relevant data via search of accident reports by roadway, milepost, cross-street, and municipality for each county from the NJDOT Plan4Safety accident data. Reference the NJ State Police NJ TR-1 reports (which are included in the Plan4Safety database). Provide a comparison of the OpenReach data vs. Plan4Safety data noting “gaps” on the order of 50 incidents per year in a given mile. Confirm findings with MSE and Traffic Operations.

C.3.4.1.2. Warrant Summary

Prepare a summary of the conditions identified above and justify the selection of the ITS Architecture Service and Equipment Packages. Prepare a list of the high level functional requirements for the system design. Incorporate this information into the SERF.

C.3.4.2. Camera and Structural Support Standard Types

The following CSS camera enclosure and structural support standard types are available for use in the design:

1. Camera Enclosure Types
 - a. Dome – typically preferred
 - b. Positional – utilized for locations needing an uphill view where a dome would not accomplish.
2. Structure Support Standards
 - a. Type A – 75’ high steel pole with lowering device
 - b. Type B – 55’ high steel pole with lowering device

- c. Type C – 40’ high steel pole
- d. Type D – reserved for miscellaneous pole heights for specific/isolated needs (by project application). Consult MSE for additional instruction when Types A, B, and C cannot meet a project need.

C.3.4.3. Location/Placement Guidelines

C.3.4.3.1. Site Visits

Perform field investigations of the project sites as needed to determine and verify the type and location of the proposed CSS cameras. Coordinate with Traffic Operations and Mobility Management together if possible, to obtain approval of the proposed locations. Identify the sources for electrical power and communication service drops, and note maintenance accessibility.

C.3.4.3.2. Selection of Camera and Structural Support Standard Types

In selecting the locations for a proposed CSS camera and support the type of structural support standard will vary with roadway classifications within the project limits. The following roadway classifications and corresponding structure types are preferred:

Table C-8: Preferred CSS Standards

Roadway Classification	Preferred CSS Standard
Interstates	Type A
Freeways and Expressways	Type A
Principal Arterials	*Type A
Minor Arterials, Collectors, and Local Roads	*Type B and C

* Evaluate for local community aesthetic and privacy intrusion concerns.

C.3.4.3.3. Design Considerations

Evaluate the proposed camera/support standard types and locations for CSSs in consideration of the following items. In all cases document important decisions and concerns through the Department’s Design Communications Report (DCR) procedures.

1. See Common Design Considerations of Section C.3.1.
2. Clear Zone Compliance –Provide guiderail protection for all camera locations, even if proposed device is outside of clear zone.
3. Field of View – Rent a bucket truck and MPT safety equipment (include direct expenses funding in the design scope of work and cost proposal) and verify the field of view for each proposed camera site. Revise the layout of the cameras if necessary due to the presence of topographic features that present low points in elevation, and occlusions such as overhead sign structures, large trees, buildings, bridges, etc. If possible, obtain and review available Geographic Information System (GIS) Light Detection and Ranging (LiDAR) terrain data files as an initial assessment of the proposed sites. Take note of a field of view that may be prone to public concerns for invasion of privacy and modify accordingly.

4. Foundation Design – Obtain the soil boring data from NJDOT Geotechnical Bureau for the proposed CSS sites. Modify the construction foundation detail if required as a result of the soil conditions described by the data.
5. Lowering Device - Provide for a lowering device for support standard types A and B. Use 40' mounting height in areas of height restrictions (e.g. near airports). If a 40' standard height is desired for a specific location consult MSE for further direction. Ensure the lowering devices are aligned in such a way that the support standard maintenance access hand-hole, or pole mounted cabinets (if so installed) are accessible from the opposite side of the lowering device. Ensure the “blind spot” is designated for the least important field of view. Confirm the equipment orientations with ITS Maintenance.
6. Dual Mounted Cameras - For some locations, such as at the intersection of two State highways it may be suitable to design the CSS with two cameras mounted on one standard. This strategy is also used where the surveillance is critical and need a back-up camera in case of breakdown of one camera. Include the correlated standard construction details (available upon request from MSE) for the dual lowering device into the project for this type of installation.
7. Camera system capacity – Verify the existing Genetec system licensing contract for proposed video with ITS Maintenance and MSE to determine if additional licenses are needed to add cameras to the system.
8. Traffic Signal Detection Cameras - When a project includes traffic signal intersections within the limits of the work and these intersections are equipped with image detection cameras, include the cameras in the CSS design and provide for transmission of the video signals to the control center and integrate into the Departments existing Genetec operating system. Verify with Traffic Operations and MSE on a case by case basis.
9. Construction Schedule - The CSS support standard is typically a long lead item and requires approximately 3 months from the time a purchase order is received by the manufacturer. Allow for contract mobilization, and field office set up, shop drawing submittal and review, etc. in calculating the time frame for the construction scheduling of the CSS support standard deliveries to the project site.
10. CSS Coordination with other ITS devices - Utilize existing sign structures for mounting cameras when feasible as a cost savings measure. Include a TTS device at all CSS sites in the project design after consulting with MSE – Note: CCTV's installed in very close proximity to one another may not require separate TTS's due to the range of the TTS radios; verify coverage. If the location of the pole mounted TTS presents a potential conflict with the lowering device operation and safety of the maintenance personnel consult Mobility Management Manager for further direction.

C.3.4.4. Pay Items

The following construction contract pay Items typically provide for the CSS work, however, this list is not all inclusive. Review and consider these Items as well as additional pay Items as required:

CSS Support Standards:

CSS STANDARD TYPE A
CSS STANDARD TYPE B
CSS STANDARD TYPE C
CSS STANDARD TYPE D
FOUNDATION, CSS

Also when TTS is requested, include the following pay items:

TTS DETECTOR TYPE C
CONTROLLER, TTS

CSS and Controllers/Electric Service:

CAMERA
CONTROLLER, CAMERA
FOUNDATION, TYPE D or D-MC

FOUNDATION ITS, TYPE MC
METER CABINET, ITS

Maintenance Access:
TURF PAVERS

Safety Barriers:
BEAM GUIDE RAIL
RUB RAIL
FLARED GUIDE RAIL TERMINAL
TANGENT GUIDE RAIL TERMINAL
CONTROLLED RELEASE TERMINAL
CONTROLLER RELEASE TERMINAL ANCHORAGE
BEAM GUIDE RAIL ANCHORAGE
RESET BEAM GUIDE RAIL WITH EXISTING POSTS
REMOVAL OF BEAM GUIDE RAIL
NON-VEGETATIVE SURFACE, POROUS HOT MIX ASPHALT, ___THICK

Integration
SYSTEM INTEGRATION

Note: See Section 609 Beam Guiderail of NJDOT Standard Specifications for additional guide rail pay Items as may be required.

C.3.5. Travel Time System (TTS)

C.3.5.1. Warrants

The use of a TTS is warranted in each of the ITS Architecture Service Packages and associated Equipment Packages listed in Table C-9. Prepare a SERF document to identify the appropriate Services and Equipment Packages to be provided for in the system design, and support them with Design Support Data as outlined in Section C.2.5.1.1. Describe use of the Services as related to the Concept of Operations. The following Packages are listed in alphanumeric order by service:

Table C-9: Vehicle Detection System Services

Service Package	Equipment Package
AD1 ITS Data Mart	Traffic and Roadside Data Archival
AD2 ITS Data Warehouse	Traffic and Roadside Data Archival
ATMS01 Network Surveillance	Roadway Basic Surveillance
ATMS03 Traffic Signal Control	Traffic and Roadside Data Archival Roadway Signal Controls
ATMS04 Traffic Metering	Roadway Basic Surveillance
ATMS08 Traffic Incident Management System	Roadway Incident Detection

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Service Package	Equipment Package
	TMC Incident Detection
ATMS16 Parking Facility Management	Parking Management
ATMS19 Speed Warning and Enforcement	MCM Speed Monitoring and Warning
ATMS21 Roadway Closure Management	Roadway Basic Surveillance
ATMS22 Variable Speed Limits	Roadway Basic Surveillance
ATMS23 Dynamic Lane Management and Shoulder Use	Roadway Basic Surveillance
ATMS24 Dynamic Road Warning	Roadway Basic Surveillance
EM02 Emergency Routing	TMC Incident Dispatch Coordination/ Communication
EM03 Mayday and Alarms Support	Center Secure Area Surveillance
EM05 Transportation Infrastructure Protection	Center Secure Area Surveillance TMC Incident Dispatch Coordination/Communication
EM07 Early Warning System	TMC Incident Detection

The following service and equipment packages warrant deployment of portable work zone detection equipment only:

Table C-10: TTS Services (Construction and Maintenance Services)

Service Package	Equipment Package
ATIS09 In Vehicle Signing	MCV Vehicle Safety Monitoring
MC09 Work Zone Safety Monitoring	MCM work Zone Safety Management MCV Vehicle Safety Monitoring Roadway Work Zone Safety

C.3.5.1.1. Design Support Data

For each of the Service Packages identified in the SERF that supports installation of a TTS in the project, obtain the relevant information and data for the items listed below from the appropriate bureaus within the Department to confirm the correct application of the Service Package(s):

1. Project planning data collection.
2. Travel time calculation and display.
3. Traffic signal system design.
4. Areas of recurring incidents.
5. Areas of non-recurring incidents.
6. Border crossing monitoring.

7. Coordination of alternative diversion route monitoring.
8. Active traffic management implementation.
9. Areas of extreme weather impacts to traffic.
10. Critical queue detection locations.
11. Secure area/infrastructure vulnerability.
12. Emergency pre-emption.
13. Disaster detection, evacuation routes.
14. Special event traffic control needs.
15. National highway system data reporting.
16. Work zone safety.
17. Other needs as identified by the Department.

C.3.5.1.2. Warrant Summary

Prepare a summary of the conditions identified above and justify the selection of the ITS Architecture Service and Equipment Packages. Prepare a list of the high level functional requirements for the system design. Incorporate this information into the SERF.

C.3.5.2. Detector and Support Standard Types

The following detector and support standard types are available for use in the design. They are categorized by type of application:

C.3.5.2.1. Detection Devices

1. Type A: TRANSMIT Devices – TRANSMIT antennas and readers are not installed unless specifically requested by MSE. Coordinate with MSE to prepare the necessary waiver documents to obtain approval to specify proprietary products in the design.
2. Type B: Remote Traffic Monitoring Sensor (RTMS) – RTMS devices may be considered, but only as approved by MSE. Depending on the particular application (Service Package) these devices may be utilized to expand existing systems, or in some cases may be the only alternative. Coordinate with MSE to prepare the necessary waiver documents to obtain approval to specify proprietary products in the design.
3. Type C: Bluetooth – Traffic Operations incorporates the use of Bluetooth devices into the project design for use in Travel Time System (TTS) calculations. Much of the real-time vehicle speed and volume data retrieved is provided by private industry probe data provider subscriptions. This includes data collected and distributed by TRANSCOM agency through their Data Fusion Engine, which was designed to collect and process similar (and redundant) data for roadways from different data sources (as available). With this system TRANSCOM is able to report the most accurate (and operational) real-time data available for a given roadway network segment (link). As a result of having various data sources from which to choose, for the purposes of traffic operations the Department has elected to install a minimum number of TTS devices statewide at this time. Currently, the preferred TTS technology deployed by the NJDOT is Bluetooth.

C.3.5.2.2. Detector Support Standards

Detectors are installed in a various configurations depending on the specific conditions of the site and the scope of the project.

1. TRANSMIT antennas are typically installed on existing overhead structures or bridges. They are aligned with the direction of travel, placed directly above the dividing lanes of the highway. Coordinate all design with TRANSCOM personnel. Arrange for site visits and locate the devices per TRANSCOM's oversight and guidance.
2. RTMS devices are "side fire" devices installed at the side of the roadway behind the curb facing perpendicular to the traveled way. They are typically mounted on an NJDOT aluminum standard at a height of 17 – 22 feet. They have a target range of approximately 200 linear feet and are aimed at the roadway to cover one or both directions of travel.

3. Bluetooth devices are mounted to sign structures and camera support standards, existing or proposed. Incorporate the standard ITS construction details for these devices into the construction plans as necessary. Stand-alone TTS (not installed at a structure or CCTV site) require additional approval and coordination with MSE and ITS Maintenance.

C.3.5.3. Location/Placement Guidelines

C.3.5.3.1. Site Visits

Perform field investigations of the project sites as needed to determine and verify the type and location of the proposed detection device. Coordinate with Traffic Operations and Mobility Management together if possible, to obtain approval of the proposed locations. Identify the sources for electrical power and communication service drops, and note maintenance accessibility. Placement of detectors varies by application and site.

C.3.5.3.2. Traffic Operations

Determine the placement of a TTS detection device in coordination with the manufacture. Typically the Bluetooth radio range is on the order of a 200' radius of the antenna. Verify the radio signal range with the manufacturer to ensure the necessary coverage is achieved at the proposed site location. Only one Bluetooth detector is required per site as they are omnidirectional. Evaluate placement of the device relative to the signal reception envelope and its overlap onto adjacent roadways, in order to minimize the collection of unnecessary data.

Antennas may be installed separately from the reader electronics within a certain distance as permitted by the manufacturer for special cases. Ensure the cabling and operational requirements conform to the manufacturers' instructions.

Bluetooth devices typically utilize wireless cellular communications, can be connected via cable TV drop, or hardwired to New Jersey's Garden State Network. Evaluate and determine the optimum communications medium for each site and ensure the requirements are included in the special provisions. Obtain and confirm communications provider service availability during the conceptual phase of the project development, or as soon as possible from notice to proceed.

The device mounting height is typically 12' – 15' but may vary depending on the equipment's make and model. Verify mounting heights and radio ranges with the manufacturers to accommodate available products and roadway area coverage.

C.3.5.3.3. Design Considerations

Evaluate the proposed detection types and locations for TTSs in consideration of the following items. In all cases document important decisions and concerns through the Departments DCR procedures.

1. See Common Design Considerations of Section C.3.1.
2. Layout – Ensure that the proposed detection zones do not contain obstacles, such as chain link fence, that will produce inaccurate data.
3. Spacing and Lane Coverage – Detectors are ordinarily spaced 0.5 to 1.5 miles apart. Generally, all lanes of travel are covered by detector(s) at each detection point.
4. Cost – Co-locate detectors on existing structures (e.g. CCTV poles) where possible to minimize need for new structures.
5. Accuracy – Speed data must be accurate within a range of approximately 5 mph. Preferred accuracy of volume and occupancy is 5%.
6. Configuration – Devices capable of auto configuration are preferred.
7. Queue Detection – Install devices sufficiently upstream of expected queues.

8. Avoided Locations – Avoid locations where double parking is likely to occur. Also, generally avoid any locations with anomalous traffic, geometric or other irregular conditions unless specifically required. Confirm with MSE.
9. Tunnels – Comply with all requirements of National Fire Protection Association (NFPA) 502 - Standard for Road Tunnels, Bridges, and Other Limited Access Highways. If detectors or ancillary equipment are to be exposed to harsh cleaning solvents, verify equipment is impervious to build up or penetration of soot and other common exhaust particles. Avoid microwave radar sensors in tunnels due to spurious wave reflection data.
10. Bridges – Do not place loop detectors on a bridges to avoid invading the deck structure. Install lower depth magnetometers in the under deck configuration so as to not compromise the deck, per manufacturer instructions.
11. Traffic Signal Detection Cameras – When a project includes traffic signal intersections within the limits of the work and these intersections are equipped with image detection cameras, include the cameras in the CSS design and provide for transmission of the video signals to the control center. Verify with Traffic Operations and MSE on a case by case basis.

C.3.5.4. Pay Items

The following construction contract pay Items typically provide for the TTS work, however, this list is not all inclusive. Review and consider these Items as well as additional pay Items as required:

TTS Support Standards:

TTS STANDARD
FOUNDATION, TTS

TTS Detectors and Controllers/Electric Service:

TTS DETECTOR TYPE A
TTS DETECTOR TYPE B
TTS DETECTOR TYPE C
CONTROLLER, TTS
FOUNDATION ITS, TYPE MC
FOUNDATION TTS, TYPE A
METER CABINET, ITS

Maintenance Access:

TURF PAVERS

Integration

SYSTEM INTEGRATION

C.3.6. Truck Safety Warning System (TSWS)

This system is currently under construction for pilot testing. Contact MSE for further guidance if this system is required in your project.

C.3.6.1. Warrants

C.3.6.2. System Types

C.3.6.3. Location/Placement Guidelines

C.3.6.4. Pay Items

C.3.7. Controlled Traffic Signal System (CTSS)

C.3.7.1. Warrants

The use of CTSS is warranted in each of the ITS Architecture Service Packages and associated Equipment Packages listed in Table C-11. Prepare a SERF document to identify the appropriate Services and Equipment Packages to be provided for in the project design, and support them with Design Support Data as outlined in Section C.3.7.1.1. Coordinate with MSE to determine if the preparation of a Systems Engineering Analysis is required. Describe use of the Services as related to the Concept of Operations. The following Service Packages are listed in alphanumeric order:

Table C-11: CTSS Services

Service Package	Equipment Package
APTS07 Multi-modal Coordination	TMC Multimodal Coordination
APTS09 Transit Signal Priority	Roadway Signal Priority On-board Transit Signal Priority TMC Signal Control Transit Center Signal Priority TMC Multimodal Coordination
ATMS03 Traffic Signal Control	Roadway Signal Controls TMC Signal Control Traffic Equipment Maintenance
ATMS04 Traffic Metering	Traffic Equipment Maintenance
ATMS07 Regional Traffic Management	TMC Regional Traffic Management TMC Signal Control
ATMS09 Transportation Decision Support and Demand Management	TMC Traffic Management Decision Support
ATMS08 Traffic Incident Management System	TMC Incident Dispatch Coordination/Communication Roadway Incident Detection TMC Incident Detection
ATMS13 Standard Railroad Grade Crossing	Standard Rail Crossing
AVSS05 Intersection Safety Warning	Roadway Intersection Safety Warning

Service Package	Equipment Package
AVSS10 Intersection Collision Avoidance	Roadway Intersection Safety Warning
EM02 Emergency Routing	Roadway Signal Preemption TMC Signal Control
MC07 Roadway Maintenance and Construction	Traffic Equipment Maintenance

C.3.7.1.1. Design Support Data

Refer to Appendix H.27 for the CTSS Project Guidelines. For each Service Package identified in the SERF that supports installation of a CTSS, obtain the appropriate information and data for the categories listed below from the relevant Department bureaus to confirm the application of the selected Service Package(s):

1. Areas of degraded level of service (LOS) due to congestion. Locations exhibiting 60% congestion (volume/capacity ratio) for 25% of the time. These are generally identified as rush hours.
2. Existing system limitations.
3. Overcome jurisdictional boundaries.
4. Areas of recurring incidents and high accident rates.
5. Areas of changing traffic patterns.
6. Manage queues in critical locations.
7. Accommodate transit more efficiently.
8. Smooth traffic flow along coordinated routes.
9. Maximize throughput along coordinated routes.
10. Maximize interception efficiency.
11. Areas of non-recurring incidents and high congestion.
12. Gaps in existing ITS system identified by Traffic Operations Center Manager.
13. Other needs as identified by the Department.

Retrieve relevant data via search of accident reports by roadway, milepost, cross-street, and municipality for each county from the Department’s Plan4Safety accident data. Reference the NJ State Police NJ TR-1 reports (which are included in the Plan4Safety database). Provide a comparison of the OpenReach data vs. Plan4Safety data noting “gaps” on the order of 50 incidents per year in a given mile. Confirm findings with MSE and Traffic Operations.

C.3.7.1.2. Warrant Summary

Prepare a summary of the conditions identified above and justify the selection of the ITS Architecture Service and Equipment Packages. Prepare a list of the high level functional requirements for the system design. Incorporate this information into the SERF and prepare a Systems Engineering Analysis when required.

C.3.7.1.3. Detection Devices

1. Controlled Traffic Signal System
 - a. Non-intrusive detectors
 - o Image Detector, CTSS – Image Detection is the preferred method for vehicular presence detection installed at traffic signalized intersections. This technology is also used for supplementary transmission of images for use in incident management. Coordinate with the Bureau of Traffic Engineering (BTE) for material and construction specifications and details specific for the traffic signal detection requirements, and also

coordinate with MSE and Traffic Operations to integrate the video streams into the existing Statewide Video Management System at the relevant Traffic Operations Center and STMC. Verify with MSE for any related CTSS video needs, including required licensing.

- System Detector, Radar (speed, lane, direction) – During the design of a CTSS, it is necessary to identify the need for “midblock” system detection. Side-fired vehicle based radar detection is one technology currently utilized by the Department for midblock data collection applications. Radar detection for CTSS is integrated into the traffic signal controller through the back panel or an SDLC cable as well as the Traffic Management System. The preferred method of communications is fiber-optic communications. Wireless communications may be utilized when hardwired communications are precluded from the design. Refer to other designated design manual sections dedicated for ITS traffic signal system design and traffic signal optimization for the type of control system, operational mode, timing plans, coordination, etc. for the appropriate detection system design criteria.
- b. In-Pavement Sensors
 - Loop detectors are no longer utilized by the Department for CTSS design, except for special circumstances such as in control set data collection. Coordinate with BTE and obtain approval for installation of this technology.
 - Radio device magnetometers may be utilized for CTSS design, under certain circumstances with MSE approval. Coordinate with BTE and Pavement Management to obtain approval for installation of this technology. Radio device magnetometer detection for CTSS is integrated into the traffic signal back panel as well as the Traffic Management System.

C.3.7.2. Detector Support Standards

Detectors are installed in various configurations depending on the specific conditions of the site and the scope of the project.

1. Image Detectors are presence detectors, installed on traffic signal mast arms and traffic signal standards, in coordination with the Department’s Structural Design requirements.
2. Midblock detectors are system detectors, mounted to new NJDOT aluminum breakaway traffic signal or lighting standards or other ITS device supports. When hardwired power cannot be obtained, solar power is used at midblock installations. For solar powered installations, provide electrical and structural calculations. For wireless communications, provide structural calculations for the antennas and radios. Ensure radar, solar panel, and antenna mounting details are included in the construction plans as required by MSE.

C.3.7.3. System Types

Prior to the inception of a CTSS project, the tier assignment is identified depending on the anticipated level of treatment that a corridor requires and potential conflicts. A tier label between T1 through T6 is assigned to a corridor. The following are the descriptions of each of the six (6) tiers:

- Tier 1 (T1) – Adaptive Signal Control Technology (ASCT)
- Tier 2 (T2) – Responsive System, inbound and outbound timing plans
- Tier 3 (T3) – Optimized with corridors that have communications, upgrading and optimizing time of day plans.
- Tier 4 (T4) – TOD plans with local communication.
- Tier 5 (T5) – Optimized with existing infrastructure.
- Tier 6 (T6) – Isolated intersection

Following the tier assignment, it will be determined whether a corridor will be considered for a CTSS project. If the corridor is not selected, MSE will log it into a corridor database for future consideration. If Tier 1 through 3 are assigned to a corridor, the project is recommended as a new CTSS project. If the corridor is assigned Tiers 4 through 5 the project will follow the Traffic Signal Optimization Process detailed in Part F and coordination with conflicting projects will continue through the life of the project. If assigned T6, the intersection may be improved through hardware or timings upgrades but the intersection will not be part of a coordinated system.

C.3.7.4. Location/Placement Guidelines

C.3.7.4.1. Site Visits

Refer to Section **Error! Reference source not found.** for guidelines regarding the performance of a Gap assessment. The Gap Assessment field investigations of the project sites are required to determine and verify the type and location of the proposed detection devices. Coordinate with Traffic Operations and Mobility Management, together if possible, to obtain approval of the proposed locations. Identify the sources for electrical power and communications, and note maintenance accessibility. Refer to Section C.3.11 for Communication System guidelines. Placement of detectors varies by application and site.

C.3.7.4.2. Design Considerations

Evaluate the proposed equipment types and locations for CTSS devices in consideration of the following items. In all cases, document important decisions and concerns through the Departments Design Communications Report (DCR) procedures.

In addition to the Common Design Considerations found in Section C.3.1, evaluate the following:

1. Image Detectors – Locate to minimize vehicle occlusion. Coordinate with NJDOT Structural Engineering and perform structural load and fatigue analysis. Provide for transmission of the video signals to the control center and integrate into the Departments existing Genetec operating system. Install for TS-1 or TS-2 type set-up, as required and as discussed with the PM. Verify with Traffic Operations and MSE on a case by case basis. Image Detector data should be integrated into the existing Department Traffic Management System for real-time and historical data management.
2. System Detectors – Midblock System Detectors are typically side-fire radar based systems that collect and transmit volume, speed, classification, travel time, and occupancy data. Locations downstream of confluence points that are likely to contribute notable traffic volumes should be considered for System Detectors. System Detectors should also be located downstream of major traffic generators/land uses (shopping malls, schools, etc.) as well at the beginning and end of coordinated signal zones. System Detectors should be located beyond the intersection dilemma zones and should not be located in areas of frequent vehicle queuing (this may be determined through modeling or observation in the field). Integrate the midblock system detector data into CTSS operation to trigger events, routines, adjustments to offsets, and forceoffs. Refer to the CTSS - Sample Force Off Parameters for Midblock System Detectors included within Appendix H.27. Additionally, the system detectors should be integrated into the applicable traffic signal cabinet back panels and the existing Department Traffic Management System for real-time and historical data management. Install for TS-1 or TS-2 type set-up, as required and discussed with the PM. Verify with Traffic Operations and MSE on a case by case basis.
3. Electrical Power Service – When hardwired electric cannot be provided for midblock system detectors, solar power with battery backups may be provided. Follow NEC guidelines and requirements.
4. Foundation Design – Obtain the soil boring data from NJDOT Geotechnical Bureau for the proposed CTSS sites. Modify the construction foundation detail if required as a result of the soil conditions described by the data.
5. CTSS Coordination with other Systems – Ensure CTSS traffic signal controllers are integrated into the Department's applicable existing centralized signal control system. See other designated design manual sections dedicated for CTSS design and Signal Optimization for type of control

system, operation mode, timing plans, coordination, etc. for determining the appropriate traffic signal controller functional requirements.

6. FHWA Requirements – Reference FHWA guidelines in regards to compliance with updated ADA and MUTCD requirements for traffic signal infrastructure, intersection facilities, and traffic signal timing. Coordinate with Bureau of Traffic Engineering through the PM.
7. Staging - Stage the CTSS system turn-on in phases (groups of intersections).
8. Testing - Ensure the special provisions include the Verification Plan requirements from the Systems Engineering Analysis and reference the applicable CTSS and/or Adaptive Testing Forms and procedures from the Department's website for the design to verify acceptable operation of the system components. Modify the language as necessary via supplementary insert in the Special Provisions.
9. ITS Integration - Provide for Overall System Integrator to ensure all subsystems and individual components are integrated in accordance with the contract plans and specifications. Ensure integration with existing Department systems. Ensure that all ITS network drawings are prepared and certified by the Systems Integrator.

C.3.7.5. Pay Items

The following construction contract pay Items typically provide for the general communications, traffic signal controller, and vehicle detection installation for CTSS work, however, this list is not all inclusive. Review and consider these Items as well as additional pay Items as required:

CTSS and Controllers/Electric Service:

CONTROLLER, ____ PHASE
 CONTROLLER, CTSS TURN-ON
 CONTROLLER MODIFICATIONS, CTSS TYPE ____
 FOUNDATION, TYPE P-MC
 METER CABINET, ITS
 METER CABINET, TYPE TL
 CONCRETE SIDEWALK, 4" THICK
 CONTROL CENTER SYSTEM, LOCATION NO. ____
 MODIFY EXISTING LOAD CENTER

Detection

IMAGE DETECTOR
 SYSTEM DETECTOR, TYPE ____
 SOLAR POWER SYSTEM, TYPE ____

Communications

JUNCTION BOX ITS, TYPE ____

Support Standards

TRAFFIC SIGNAL STANDARD, ALUMINUM
 FOUNDATION, TYPE A

Maintenance Access:

TURF PAVERS

Integration

ITS INTEGRATION

C.3.8. Weigh-in-Motion System (WIMS)

C.3.8.1. Warrants

The use of a WIMS is warranted in each of the ITS Architecture Service Packages and associated Equipment Packages listed in Table C-12. Prepare a SERF document to identify the appropriate Services and Equipment Packages to be provided for in the system design, and support them with Design Support Data as outlined in Section C.3.8.1.1. Describe use of the Services as related to the Concept of Operations. The following packages are listed in alphanumeric order by service:

Table C-12: WIMS – Service Packages

Service Package	Equipment Package
AD1 ITS Data Mart	MCM Data Collection CV Data Collection Government Reporting Systems Support Traffic Data Collection Traffic and Roadside Data Archival ISP Data Collection ITS Data Repository
AD2 ITS Data Warehouse	Government Reporting Systems Support ISP Data Collection ITS Data Repository CV Data Collection MCM Data Collection Traffic and Roadside Data Archival Traffic Data Collection
AD3 ITS Virtual Data Warehouse	Virtual Data Warehouse Services ITS Data Repository
CVO01 Carrier Operations and Fleet Management	Fleet Administration
CVO03 Electronic Clearance	On-board CV Electronic Data
CVO06 Weigh in Motion	Roadside WIM On-board CV Electronic Data

C.3.8.1.1. Design Support Data

For each of the Service Packages identified in the SERF that supports installation of a WIM in the project, obtain the relevant information and data for the items listed below from the appropriate bureaus within the Department to confirm the correct application of the Service Package(s):

1. Project planning data collection.
2. State highway system data reporting.
3. Commercial weight monitoring.
4. Law enforcement support for commercial vehicle credential verification.

5. Over-height/overweight vehicle routing.
6. Other needs as identified by the Department.

WIMS data at NJDOT is primarily used for Federal Aid reporting of vehicle classifications per type of roadway as defined by the FHWA. In addition, it is used to augment law enforcement inspection for commercial vehicle credential verification. Vehicle count and classifications data is also utilized for transportation planning programs for pavement design, arterial maintenance and rehabilitation programs. Used in conjunction with OHVD systems, WIM system data also contributes in the tracking of truck traffic in restricted areas due to over height and overweight violations of specified roadways.

C.3.8.1.2. Warrant Summary

Prepare a summary of the conditions identified above and justify the selection of the ITS Architecture Service and Equipment Packages. Prepare a list of the high level functional requirements for the system design. Incorporate this information into the SERF.

C.3.8.2. Data Collection Device Types

The Department utilizes devices for Weigh-in-Motion (WIM) systems to ensure compatibility with the existing systems and accuracy of the data collected for use in the Highway Performance Monitoring System (HPMS) in preparation of required Federal Aid reports. Permanent loop detectors and piezo devices are the preferred devices to be installed. The WIM systems count vehicles, measure speeds, provide vehicle weights, and functionally classify the data per FHWA requirements. WIMS also deploy vehicle warning systems to detect trucks approaching low clearance bridges and structural members when such sites are included within a project's limits. Over Height Vehicle Detection System (OVDS) devices are not standardized by the Department at this time, and are therefore open for evaluation of the latest technology applications available. For promising new developments in the product line, obtain special permission from MSE to deploy prototype installations on a pilot project basis. Coordinate with MSE to prepare the necessary waiver documents to obtain approval to specify proprietary products in the design if necessary.

1. Data Collection Device Types
 - a. Pavement devices
 - Inductive Loop Detectors (volume, speed, axle spacing measurements)
 - Piezo Pavement Sensors (vehicle weight)
 - b. Devices installed on support standards
 - Video Cameras (vehicle identification)
 - Infrared Beam or Visible High Intensity Light Source (vehicle height)
2. Structure Support Standards
 - a. Cameras and Infrared Beam detectors – NJDOT aluminum standards type "T" or type "C" as required.

Utilize CCTV cameras to identify vehicles in cooperation with local and state law enforcement police departments operating commercial vehicle regulations. Install video devices as directed by TDS. Ensure the camera images are recorded and that the recording is made in synchronization with the measurement of vehicle weights which exceed regulations, and that the image and weight data is archived and transmitted to the proper authority as directed by TDS. Ensure the camera images are integrated into the Department's existing video control Genetec system.

C.3.8.3. Location/Placement Guidelines

Contact the Bureau of Transportation Data and Safety (TDS) to obtain the device location and placement requirements. Verify the feasibility of the proposed deployment sites before developing the design. Install WIMS across all travel lanes per the standard details and as directed by TDS.

WIM detection devices (induction loops and piezo sensors) are embedded into the roadway base course (preferred) or surface. Incorporate the standard ITS construction details for these devices into the construction plans as required. Provide design provisions to ensure the construction of the devices is staged for installation into the roadway base course prior to the application of the final surface course.

Reference the American Society for Testing and Materials (ASTM), *Standard Specification for Highway Weigh-In-Motion (WIM) Systems with User Requirements and Test Methods* (ASTM Designation E 1318-02). Verify the geometric design requirements/parameters for minimum horizontal curvature, maximum roadway grade, roadway cross slope and lane widths.

C.3.8.3.1. Design Considerations

1. See Common Design Considerations of Section C.3.1.
2. Controller Placement – Place the controller in the immediate vicinity of the support standard. Make general observations for high and low topography points at the ITS device site. Avoid areas subject to flooding. If placement of equipment in a flood area is unavoidable, include provision for skirts to be installed under controller and equipment cabinets to be mounted on foundations.
3. Pavement Conditions – Determine if current pavement conditions are acceptable and find a suitable location for the system pavement components. Notify the PM and determine if replacement of deteriorating pavement is necessary. Install pavement sections per ASTM E 1318-02.

C.3.8.4. Pay Items

The following construction contract pay Items typically provide for the WIMS work, however, this list is not all inclusive. Review and consider these Items as well as additional pay Items as required:

WIM Detectors and Controllers/Electric Service:

- WIM ROADWAY DEVICES ___ LANES
- CONTROLLER, WIM
- FOUNDATION ITS, TYPE MC
- METER CABINET, ITS

Maintenance Access:

- TURF PAVERS

Integration

- SYSTEM INTEGRATION

C.3.9. Roadway Weather Information System (RWIS)

C.3.9.1. Warrants

The use of RWISs are warranted in each of the ITS Architecture Service Packages and associated Equipment Packages listed in Table C-13. Prepare a SERF document to identify the appropriate Services and Equipment Packages to be provided for in the system design, and support them with Design Support Data as outlined in Section C.3.9.1.1. Describe use of the Services as related to the Concept of Operations. The following packages are listed in alphanumeric order by service:

Table C-13: WIMS – Service Packages

Service Package	Equipment Package
ATIS01 Broadcast Traveler Information	Basic Information Broadcast
ATMS08 Traffic Incident Management System	Emergency Response Management

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ATMS21 Roadway Closure Management	Emergency Response Management
ATMS24 Dynamic Roadway Warning	Roadway Warning TMC Roadway Warning
ATMS26 Mixed Use Warning Systems	Roadway Warning TMC Roadway Warning
EM07 Early Warning System	Emergency Environmental Monitoring
EM08 Disaster Response and Recovery	Emergency Response Management MCM Roadway Maintenance and Construction
EM10 Disaster Traveler Information	Emergency Response Management
MC03 Road Weather Data Collection	MCM Environmental Information Collection MCV Environmental Monitoring Roadway Environmental Monitoring TMC Environmental Monitoring
MC04 Weather Information Processing and Distribution	TMC Environmental Monitoring MCM Environmental Information Processing Emergency Environmental Monitoring
MC06 Winter Maintenance	MCM Winter Maintenance Management
MC07 Roadway Maintenance and Construction	MCM Roadway Maintenance and Construction
MC10 Maintenance and Construction Activity Coordination	Emergency Response Management
MC11 Environmental Probe Surveillance	Vehicle Environmental Probe Support MCM Environmental Information Collection
MC12 Infrastructure Monitoring	Vehicle Environmental Probe Support

C.3.9.1.1. Design Support Data

For each of the Service Packages identified in the SERF that supports installation of a RWIS in the project, obtain the relevant information and data for the items listed below from the appropriate bureaus within the Department to confirm the correct application of the Service Package(s):

1. Data collection for construction project planning
2. Data collection for maintenance operations planning, for staffing and material resource allocation.
3. Areas of recurring weather related incidents including ice, dense fog, flooding, and high winds.
4. Cold climate areas subject to snow accumulations (winter maintenance).
5. Roadway systems comprised of structurally elevated segments such as viaducts, and bridges subject to high.
6. Areas of latent freeze-thaw effects that shorten roadway service life.
7. Areas with high rates of pavement deterioration.
8. Areas along disaster recovery and evacuation routes.
9. Areas in which advanced warning systems are feasible.
10. Other needs as identified by the Department.

C.3.9.1.2. Warrant Summary

Prepare a summary of the conditions identified above and justify the selection of the ITS Architecture Service and Equipment Packages. Prepare a list of the high level functional requirements for the system design. Incorporate this information into the SERF.

C.3.9.2. Sensor Types

The system includes sensing devices for air temperature, humidity, subsurface temperature, wind speed and direction, precipitation, visibility, and roadway salinity. The equipment is manufactured and supported by Vaisala and monitored through Rutgers University.

- a. Weather station sensors (road and air temperatures, precipitation, wind, humidity, visibility/verification) – Coordinate with the NJDOT Regional Operations and Bureau of Electrical Maintenance for the design and construction needs for RWIS equipment.
- b. Cameras – Confirm field of view. See Section C.3.4.3.3 Design Considerations No.3.

C.3.9.3. Location/Placement Guidelines

Contact the Permits, Electrical & Claims (PEC) Manager and Regional Operations Manager to obtain specific device location and placement requirements. The NJDOT maintains a statewide deployment list and map of the existing RWIS sites and gaps in coverage. Coordinate with Rutgers University for current data and information as directed by PEC and the Regional Director responsible for operations within limits of the project. Verify the need for new or updated requirements to existing facilities and include the findings and recommendations in the SERF.

RWIS field equipment devices are installed as a lump sum unit encompassing all detection devices required for the system operation. Coordinate with the NJDOT Bureau of Electrical Maintenance for the design and construction needs for RWIS equipment.

C.3.9.3.1. Design Considerations

1. See Common Design Considerations of Section C.3.1.
2. Interoperability – The existing RWIS operating system that has been adopted by the NJDOT is supported by Vaisala Inc. Ensure the design for new deployments and upgrades is coordinated with the authorized representative of the manufacturer to ensure compatibility of components.
3. Controller Placement - Place the controller within the fenced in area of the RWIS site. Make general observations for high and low topography points at the ITS device site. Avoid areas subject to flooding. If placement of equipment in a flood area is unavoidable, include provision for skirts to be installed under controller and equipment cabinets to be mounted on foundations.
4. Pavement Conditions
 - o Determine if current pavement conditions are acceptable and find a suitable location for the system pavement components. Notify the PM and determine if replacement of deteriorating pavement is necessary. Install pavement sections per ASTM E 1318-02.
 - o Coordinate with Permits, Electrical and Claims (PEC) and Regional Operations to ensure designs for in-pavement devices are scheduled in synch with milling and paving operations.
5. Evaluate topography, as the natural and/or manmade environment around the proposed RWIS and potential affects tower mounted sensors (i.e., wind speed sensor) that may provide misleading data. The specialized field equipment units are installed at varying heights on 30-foot high, ground mounted pole or tower assemblies, which need be erected in open-air areas, preferably at high points along a route and near structurally elevated roadway structures so that pavement sensors can be deployed on them as well. Typically, and when possible, wireless pavement sensors are deployed for monitoring structurally elevated roadways so that lateral saw cutting travel lane pavements will not be required.

6. Cameras - Design for transmission of the RWIS video images to the traffic operations control center and integrate into the Department's existing Genetec operating system. Verify with Traffic Operations and MSE on a case by case basis.

C.3.9.4. Pay Items

The following construction contract pay Items typically provide for the RWIS work, however, this list is not all inclusive. Review and consider these Items as well as additional pay Items as required. Note that the pay Item for WEATHER STATION is all inclusive of the equipment required for the system to be installed behind the curb including the various sensors, tower, controller, fence, and concrete pad. For the work to be completed in the roadway, the pay Item WEATHER STATION ROADWAY DEVICES ____ LANES provides for all of the sensors, wiring, roadway cutting, epoxy, conduit, etc.

RWIS Detectors and Controllers/Electric Service:

WEATHER STATION
WEATHER STATION ROADWAY DEVICES ____ LANES
FOUNDATION ITS, TYPE MC
METER CABINET, ITS
____" RIGID METALLIC CONDUIT

Maintenance Access:

TURF PAVERS

Integration

SYSTEM INTEGRATION

C.3.10. ITS Cabinets (Controllers and Electrical Service)

C.3.10.1. Warrants

Cabinets are warranted for all ITS devices. Preference is given to utilization of existing cabinets in order to co-locate equipment of multiple systems when possible. Consult MSE for final approval of the recommended approach.

C.3.10.2. Cabinet Types

1. Controller
2. Meter
3. Fiber Optic Cross Connect
4. ITS

C.3.10.3. Location/Placement Guidelines

Cabinets of the various types are located per site as described below. Coordinate with MSE to obtain the latest standard construction detail as appropriate. Incorporate important design considerations into the SERF in support of safety, high level design requirements, and communications concepts.

C.3.10.3.1. Design Considerations

Evaluate the proposed cabinets types and locations in consideration of the following items. In all cases document important decisions and concerns through the Department's DCR procedures.

1. See Common Design Considerations of Section C.3.1.
2. Controller (cabinet) Placement – Make general observations for high and low topography points at the ITS device site. Avoid areas subject to flooding. If placement of equipment in a flood area is

unavoidable, include provision for skirts to be installed under controller and equipment cabinets to be mounted on foundations.

- a. DMS – Place the controller at approximately 50' in front of the sign (minimum of 25' for ground mounted signs). Avoid placing it in a way that would obstruct the motorist's field of view of the DMS. Position the cabinet door for the maintenance personnel to face the sign when operating the controller electronics. Verify the length of communication cable needed between the sign and the controller with the sign manufacturer. Provide for the appropriate cable length and characteristics in the contract documents.
 - b. VSLs - Place the cabinet in the immediate vicinity of the support standard. When near a DMS, co-locate the controller equipment within the DMS controller cabinet.
 - c. CSS - Place the cabinet in the immediate vicinity of the support standard. Avoid areas subject to flooding. When near a DMS, co-locate the controller equipment in the DMS controller cabinet.
 - d. TTS - Co-locate the controller equipment with the DMS or CCTV controller cabinet when possible. Consider replacing the existing controller cabinet if there is not adequate room to add the detector equipment. For stand-alone detection devices, place the proposed controller cabinet in the immediate vicinity of the support standard.
 - e. CTSS – Place the controller cabinet so as to avoid potential turning radius knockdowns, and other such vulnerable layouts.
 - f. WIMS– Place the controller cabinet adjacent to the loop detector/piezo sensor layout per the construction details provided by the Bureau of Transportation Data and Safety (BTDS).
 - g. RWIS – Place the controller cabinet within the enclosed fence protection per the standard ITS construction details.
3. Meter Cabinet – Request and confirm shared use of existing NJDOT owned load centers with other bureaus such as Bureau of Traffic Engineering (BTE), Electrical Maintenance, and BTDS, etc. Present recommended load center use to the MSE PM for approval. Ensure the meter cabinet is placed in a location that is safe from vehicular damage and provides safe access for maintenance personnel.
 4. Uninterruptable Power Supplies – discuss the need for UPS devices with MSE and ITS Maintenance for the project devices. Select and size batteries by amount of time required by maintenance personnel at the device location.
 5. Disconnect Switches – Include a separate disconnect switch between the meter cabinet and the ITS device controller when the load center powering the device is not in plain sight of the ITS device.
 6. Cabinet Size – Refer to the standard construction details for the controller and meter cabinet pay items.
 7. Cabinet Orientation – Position the controller and meter cabinets to allow maintenance personnel to have view of the oncoming traffic while standing at the open door of the cabinet. Include concrete sidewalk pads for maintenance cabinet access doors. Ensure cabinets with front and back access doors have concrete pads for each door. Provide bollard protection as required in areas subject to close vehicle proximity (i.e. parking lots). Ensure not to infringe upon vehicle clear zones with bollards.
 8. Cabinet Skirt – Include provisions for a standard 18" cabinet skirt at all locations subject to potential water penetration at the base.
 9. Foundations – Refer to the standard construction details for the controller and meter cabinet pay items.
 10. Cabinet Mounting – When ground mounting is not feasible, consider structure or pole mounting
 11. Labeling – Verify that the contract provisions for standard labeling are included in the construction contract documents.
 12. Cross connect cabinets – Place Fiber Optic Cross Connect Cabinets at major intersections and interchanges which may be considered as fiber optic arterial communication paths in the future. Design the installation of the cabinets in lieu of junction boxes.
 13. Existing Cabinets – Utilize existing ITS cabinets when possible as a cost savings measure. Modify or replace the controller pay item as necessary in consideration of economic feasibility. Side of cabinet penetrations may be permitted for special circumstances. Present the proposed design to the PM for approval.

When co-locating controller equipment of different devices in an existing controller ensure the appropriate CONTROLLER MODIFICATION pay Item is included in the construction contract. Include special provisions for additional heating, cooling, lighting, wiring (ratings), etc. if needed.

C.3.10.4. Pay Items for ITS Cabinets

The following construction contract pay Items typically provide for the ITS cabinet work, however, this list is not all inclusive. Review and consider these Items as well as additional pay Items as required:

Controllers of the Various Types:

CONTROLLER, CSS
CONTROLLER, DMS
CONTROLLER, VSLS
CONTROLLER, TTS
CONTROLLER, CTSS
CONTROLLER CABINET, TYPE P-TMS
CONTROLLER, ITS
CONTROLLER MODIFICATION, TYPE____
FOUNDATION, CSS TYPE____
FOUNDATION, TYPE P
FOUNDATION, ITS TYPE____

Fiber Optic Terminations:

FIBER CROSS CONNECT CABINET
FOUNDATION, ITS TYPE A

Electrical Services:

METER CABINET, ITS
FOUNDATION ITS, TYPE MC

Maintenance Access:

TURF PAVERS

Integration

SYSTEM INTEGRATION

C.3.11. Communication System

C.3.11.1. Warrants

Communication systems are warranted for all ITS devices in order to provide for remote operations and control. However, the type of communications will vary by individual site.

C.3.11.2. Communication Types

C.3.11.2.1. Fixed Point Communications

The following list illustrates the types of communications (shown in order of preference) typically considered for use in field-to-field, field-to-center, and center-to-center communications. Evaluate the project device locations and recommend the appropriate medium as available and economically feasible, per site.

1. Fiber optic cable (NJDOT owned) – Utilize MSE standard Type G cable for all backbone cabling, and assign the devices to be spliced into it via termination cable (Type E or as otherwise required) per the following table:

Table C-14: Fiber Optic Cable Designations

Bundle	Device
Blue	ITS Devices
Orange	ITS Devices
Green	Gigabit port fibers reserved for NJDOT Network backbone routing (Hub to Hub to TMC)
Brown	CTSS
Slate	CTSS
White	Shared with other agencies
Red	TSWS
Black	Spare

Note: See Sample Plans – Fibers #1 and #2 in the blue and orange bundles are used for all ITS devices connected in series except for CTSS which utilizes the brown and slate bundles, and the case of exceptions as directed by MSE.

NJDOT REFERENCE:		ITS Sample Plans http://www.nj.gov/transportation/eng/elec/ITS/plans.shtm
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Table C-15: Cable Types

Cable Type	Number of Fibers
A	48
B	36
C	24
D	18
E	12
F	6
G	96

- Fiber optic termination cable (NJDOT owned) –Assign the devices to the fibers in the cable bundles per the following table:

Table C-16: Type E Cable

Fiber	Assignment
Blue	Transmit (switch)*

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Orange	Receive (switch)*
Green	Spare*
Brown	Spare*
Slate	Spare*
White	Spare*
Red	Return Blue
Black	Return Orange
Yellow	Return Green
Violet	Return Brown
Rose	Return Slate
Aqua	Return White

*See Sample Plans. Maximum of 8 switches in series or 8 miles total distance, whichever comes first.

NJDOT REFERENCE:		<p>ITS Sample Plans</p> <p>http://www.nj.gov/transportation/eng/elec/ITS/plans.shtm</p>
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3. Fiber optic cable shared with other public agencies (i.e. NJTA Network, County or Municipalities systems, etc.). For ITS site locations proposed within a generally close proximity to other transportation agencies, evaluate the design for potential redundant communications links via shared communication medium resources. Discuss with MSE for concurrence and further consideration to interconnect agencies at the site. Prepare Memorandum of Agreement, License to Cross, or other written agreement document when sharing resources and responsibilities.
4. Broadband cable provider. Determine the suitable location and coordinate with the service provider to verify availability and to obtain download/upload link rates and costs. At the minimum, services packages are to include 50 Mbps download/25 Mbps upload. Coordinate with for confirmation of the Department's participation in the proposed data rate monthly cost payments.
5. Wireless provider of cellular Internet Protocol (IP) packet data circuits. Coordinate with the service provider to obtain download/upload link rates and costs. The number of static IP addresses will be the number of ITS devices in the controller, plus the number of switches, plus the PDU, plus any other devices needing addresses such as ISP supplied routers and modems. Submit the list of devices requiring service with the FDS and include confirmation from the utility company. Coordinate with MSE for confirmation of the Department's participation in the proposed data rate monthly cost payments.
6. Wireless line of sight (unlicensed frequency). Utilize the MSE standard material specifications for the communications link design. Standard unlicensed frequencies are 2.4 GHZ and 5 GHZ bands. Perform frequency analyses to verify line of sight, existing communications throughput, and signal to noise ratios. Include cost provisions in the design services proposal to perform the study and determine the existing wireless signal feasibility conditions.
7. Wireless (licensed frequency). Evaluate use of frequencies other than 2.4 GHZ or 5 GHZ when analysis reveals interference or heavy through put volume traffic on standard frequencies. Complete FCC required license frequency application on behalf of NJDOT. For the FCC licensing process, coordinate with NJDOT Bureau of Equipment.

Cable Tagging – Verify that the contract provisions for MSE standard cable tagging requirements are included in the construction contract documents.

Include provisions to replace splice enclosures when existing splices are required to be opened.

Perform a cost comparison of the available types as applicable for the individual site. Include the required quantities in the estimate for construction, and verify the estimated cost for provider services by bandwidth, data rates, and cost of electronics. Show a 10-year outlook. Note the following in the analyses:

1. Medium type
2. Required bandwidth
3. Construction costs
4. Operation costs
5. Maintenance costs

Summarize the cost analysis and note specific design concerns. Record important decisions and concerns through the DCR process. Formulate the communication system recommendations and incorporate the information into the SERF Part 4 for alternatives analysis.

C.3.11.2.2. Systems Block Diagram

Upon approval of the SERF, develop the system block and network diagrams. Ensure the diagrams illustrate all equipment to the level of detail described in the device pay item. Include the interconnections from field device(s) thru all intermediate points to the head end control devices. Include all splice and termination points.

C.3.11.2.3. Calculations

Prepare calculations for the following criteria subjects and included with each design submission:

1. Bandwidth - For new system design, allow for 60% maximum allocation of any given communication link's total bandwidth.

For integration into an existing communications system consult MSE for approval to use up to 80% of bandwidth capacity. If approved, ensure that 20% capacity remains for unforeseen maintenance management needs in the future for emergencies.

Table C-17: Minimum Bit Rates

Device Controller	Bit Rate (bps)
DMS	9600
VSLs	9600
CCTV	768K
TTS	9600
CTSS	9600
WIMS (TSWS)	9600
RWIS	9600

2. Transmitter and Receiver Power (fiber optic) – The Department utilizes Cisco products as a standard proprietary product in cooperation with the FHWA. When determining optical

communications power needs, specify the required SFP module laser intensity per optical link. Ensure the selected modules are appropriate for the type of fiber (single/multi-mode) and link distance. Calculate the total link budget including fiber cable, splices, connectors, and potential future splices. Select the SFP with the available power at approximately 80% of capacity of the SFP available power. For example, a link with a calculated budget of 6.8 dB would result in an SFP selection with an available power of 8.5 dBm. Use the following budget loss values:

Table C-18: Optical Budget Losses

Device	Optical Budget Loss
Cable	0.4 dB per km
Splice	0.05 dB per splice as measured with the splice machine
Connector	0.75 dB x 2 = 1.5 dB per pair
Future splices	0.05 dB per splice

3. Conduit Fill – Comply with the NEC requirements. Account for ambient temperature corrections in the wire sizing, ampacity calculations and circuit protection sizing.


C.3.11.3. Location/Placement Guidelines

C.3.11.3.1. Design Considerations

Evaluate the proposed communication medium types and locations in consideration of the following items. In all cases document important decisions and concerns through the Department's DCR procedures.

1. Wireless Links:
 - a. Verify line of sight between transmitters and receivers and radio frequency availability (spectrum analysis and signal-to-noise ratio) by performing site tests and surveys for each location. Ensure use of appropriate test equipment, bucket truck and safety for maintenance and protection of traffic are included in the design budget for this purpose. Provide for tree trimming as necessary in the contract special provisions. Confirm extent of tree trimming with MSE. Extensive line of sight clearing work may also require landscape plantings. Ensure repeater sites are placed within existing ROW and that they do not encroach upon environmental restrictions determined during the environmental screening process.
 - b. Utility Conflicts – Avoid utility conflicts and ensure compliance with the utility company requirements for utilities located overhead and underground. Avoid drainage pipes.
 - c. Maintenance Access – Provide for depressed curb and turf pavers as necessary, and verify clearance from nearby overhead utilities. Make general observations for high and low topography points at the ITS device site. Avoid areas subject to flooding. If placement of equipment in a flood area is unavoidable, include provision for skirts to be installed under controller and equipment cabinets to be mounted on foundations.
 - d. Environmental Constraints – Verify that all construction work is designed to occur outside of any wetland, riparian zone, etc. and does not violate the NJ register of historic places rules. Complete the required environmental and SHPO processes.
 - e. Federal Aviation Administration (FAA) Requirements – If any wireless links are located near an airport or above 200 feet, register the link with the FAA.

2. Temporary Communications – Provide for the design of temporary communications to maintain existing communications and system operations. There are various ways in which this may be accomplished depending on the extent of work and capacity of bandwidth needed. This may involve complete redundant/parallel paths via overhead or aerial cabling (fiber optic, copper, coax, etc.), by wireless link, or underground in conduit or direct burial. If possible, provide for the temporary layout to become the permanent installation thereby avoiding a period of temporary transfer.
3. Interoperability – Evaluate communication devices for compliance with NJDOT adopted standards to ensure components are compatible and can be integrated together into the complete system. Provide for design in compliance with the latest NJ Regional ITS Architecture update to facilitate sharing of ITS data and information.
4. Proposed Fiber Optic Cable – If a new fiber optic cable is being placed into an existing broadband corridor, design for the existing devices to be integrated into new fiber.
5. Shared use of fibers between devices – At locations where devices are co-located and they utilized the same controller (cabinet) for equipment installation, it may be necessary to assign the fibers for the devices to share the same bundle(s) as per Table C-14. Obtain approval from MSE, if necessary to deviate from the table.
6. Equipment Hubs – Confirm rack space, port assignments, and power availability/access in equipment hubs. Fill out the ITS Facilities Daily Access Request Form to access hubs that require any modifications.

NJDOT REFERENCE:		NJDOT ITS Facilities Daily Access Request Forms http://www.nj.gov/transportation/eng/elec/ITS/access.shtm
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When co-locating controller equipment of different devices in an existing controller cabinet, ensure the appropriate CONTROLLER MODIFICATION pay item is included in the construction contract. Provide special provisions as necessary to describe the specific modifications.

C.3.11.4. Pay Items

The following construction contract pay Items typically provide for the general communications work, however, this list is not all inclusive. Review and consider these Items as well as additional pay Items as required:

Communications Medium:

- FIBER OPTIC CABLE, TYPE ____
- WIRELESS LINK (non-standard, may be created with MSE approval)
- FIBER OPTIC CROSS CONNECT CABINET

Support Standards:

- WIRELESS LINK STANDARD TYPE A (non-standard, may be created with MSE approval)
- FOUNDATION, WIRELESS LINK (non-standard, may be created with MSE approval)

Controller Equipment:

- CONTROLLER MODIFICATIONS, DMS
- CONTROLLER MODIFICATIONS, CAMERA
- CONTROLLER MODIFICATIONS, TTS
- CONTROLLER MODIFICATIONS, TYPE ____
- COMMUNICATION HUB MODIFICATIONS
- CONTROL CENTER SYSTEM, LOCATION NO. ____
- CONTROLLER, WIRELESS LINK
- FOUNDATION ITS
- CONTROLLER ITS
- METER CABINET ITS
- MODIFY METER CABINET

FOUNDATION ITS, TYPE MC

Maintenance Access:
TURF PAVERS

Integration
SYSTEM INTEGRATION

C.3.12. Raceway System

C.3.12.1. Warrants

Raceway systems are warranted for all ITS devices in order to provide for power and communication. However, the type of raceway system will vary by individual site.

C.3.12.2. Raceways Types

1. ITS Conduit
 - Type A - (2) 2" and (1) 3" Diameter Flexible Nonmetallic Conduits
 - Rigid Metallic Conduit
 - Rigid Metallic Conduit Exposed
 - Rigid Metallic Conduit Exposed (PVC Coated)
 - Fiberglass Conduit
 - Rigid Non-Metallic Conduit
 - Multi-duct
2. Junction Boxes
 - Type A: For fiber optic cable communications
 - Type B: For power or communications (separate installations)
 - Type C: For electrical power and non-fiber communication wiring
 - Type D: Combined for electrical power & communications cables
 - Junction Box, Exposed (stainless steel)

C.3.12.3. Location/Placement Guidelines

Raceway systems of the various types are located per site as described below. Coordinate with MSE to obtain the latest standard construction detail as appropriate. Incorporate important design considerations into the SERF in support of safety, high level design requirements, and communications concepts.

C.3.12.3.1. Design Considerations

Evaluate the proposed raceway systems and locations in consideration of the following items. In all cases document important decisions and concerns through the Department's DCR procedures.

1. See Common Design Considerations of Section C.3.1.
2. Meter Cabinet – Request and confirm shared use of existing NJDOT owned load centers with other bureaus such as TE, Electrical Maintenance, and TDS, etc. Present recommended load center use to the MSE PM for approval.
3. Foundations – Refer to the standard construction details for the controller and meter cabinet pay items.
4. Conduit Requirements
 - Center median - 5' min off road edge and 3' offset from guide rail
 - Edge of road - 5' min offset, 3' off guide rail
 - Under shoulder pavement

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- Expansion and deflection fittings – provide for expansion and deflection on bridges. Evaluate strip joints, finger joints, modular joints, and expansion pier vertical risers for appropriate expansion methods. Account for both expansion and deflection movements.
 - Provide a schedule 80 RMC conduit sleeve around conduit when crossing existing or proposed guiderail. Ensure the casing is included in the specifications under the Method of Payment clause as included in the conduit item(s). There should be no separate payment for this work.
5. Road/Bridge Crossings
- a. When conduit is to cross a roadway, include conduit encased in a rigid metallic conduit sleeve where ROW is available for jacking or directional drilling. See no. 18 in this section for additional design considerations for jacking and directional drilling. Specify the sleeve dimension and strength characteristics. Directional drilling should not be planned for more than 500 LF. When ROW is restricted, propose FNMC of adequate size or continue ITS Type A conduit with directional drilling.
 - b. Open cut of the roadway is not allowed for any conduit installations crossing under an existing roadway unless approved by NJDOT.
 - c. For bridge design work, it is the Department's policy to install ITS conduit on new bridge structures during any structure/deck rehabilitation projects for future use. Contact MSE for type, size, and location of conduits required. Refer to the latest BDC for design requirements. Include expansion fittings for bridge expansion and contraction movements and note this requirement on the plans. Include deflection fittings if required depending on the combination of vertical and horizontal movements such as on a bridge pier which may be planned for mounting conduit risers.
6. Junction Box Requirements
- a. Fiber optic communication conduit runs - Utilize the ITS Junction Box Type A in earth and Type B for in-roadway placements and locations sited for future widening of geometric revision which would land the box in the roadway.
 - b. Communications and electrical power (in earth) - Utilize the Junction Box Type D.
 - c. Split electrical power wiring and communications cables between separate Type A and Type C junction boxes when necessary. Evaluate the options and obtain concurrence from MSE and ITS Maintenance before finalizing the design. Include the necessary construction detail drawings in the plan set.
 - d. At ramp and street crossings, avoid placing pull boxes for the purpose of only crossing the street, and keep the alignment of conduit as straight as possible.
7. Maximum distances between junction boxes:
- a. Electrical Power – 250LF. For large diameter cables, reduce to 150LF maximum.
 - b. Communications – 2,500LF. For locations where directional drilling is required in the design, utilize a maximum spacing of 500LF.
8. ITS conduit in the bridge parapet. Include the ITS standard detail in the construction plan set. Ensure pull boxes are provided in each section of the bridge where the conduit crosses an expansion joint in order to reduce or eliminate loss of air pressure in the conduit run when blowing drag lines.
9. Provide exposed junction/pull boxes as appropriate for the design application.
- a. Top penetrations of the top of the box are not permitted in area subject to wet conditions or condensation.
 - b. Specify conduit hubs to ensure watertight seals via the special provisions or notes on the drawings.
 - c. Utilize NEMA 3R for standard applications. Utilize NEMA 4x rated as required for specific needs. Size to be determined by designer for the application.
 - d. Include special requirements for junction box and conduit mounting hardware (i.e. stainless steel material, struts, clamps, etc).
10. Conduit-fill calculation requirements. Adjust calculations for the necessary temperature factors as required by NEC.
11. Conduit bends.

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- a. Design for fiber optic communication raceways to be constructed without any conduit bends between pull/splice points, except as a gradual sweep per the ITS standard construction details.
 - b. When conduit bends are required, ensure the loaded (pulling tension during installation) minimum radius design of the conduit bends is maintained at 20 times the diameter of the cable.
 - c. Obtain concurrence from MSE to plan for cumulative conduit bends to exceed 180 degrees between boxes.
12. Electrical and communication wire co-location conduit raceways – Keep electrical and communications wires and cabling in separate conduit (and junction box) systems. If necessary, shared use conduit may be permitted by MSE. Evaluate the conditions and propose alternatives to MSE for approval prior to finalizing the design. Consider the NEC provisions for separation of the different wiring systems, shielding requirements for copper communications, grounded shielding of Ethernet cables, and fiber optic concerns. Consider short circuit potential and the resulting fire implications on the co-located cables and wires.
 13. Install RMC, PVC coated conduit only in areas subject to corrosion and salt. Obtain concurrence from MSE for planned locations.
 14. Do not design for PVC or PVC-coated conduit installation indoors.
 15. Do not exceed maximum number of conduit entries for Junction Boxes (NEC). Perform the necessary calculations and include in the design backup documents.
 16. Do not plan for use of intermediate metal conduit (IMC) in wet locations or high corrosive areas. Otherwise, NFPA 70 Article 342 fully applies.
 17. Directional Drilling and Jacking – Evaluate and specify the preferred method for the application.
 - a. When designing for directional drilling operations, ensure the contractor's equipment set up can be performed within NJDOT ROW (constructability). This operation may require 75' to 100' of space behind the drilling entry pit in order to provide for the conduit material feed.
 - b. Verify the depth of the conduit and bending radius required based on the type of material, diameter, and supplied lengths i.e. RMC/PVC/HDPE. Verify the location of underground utilities and show them on the plans. Include construction notes for utility markout and confirmation.
 - c. If specifying the jacking method, limit the use to short run installations such as crossing a ramp. Ensure there is adequate room for the Contractor to set up the jacking pit and conduit piece feeds.
 - d. Investigate directional drilling as an option to longitudinal trenching installation of conduits of all types.
 18. Install spare conduits for future use when advisable and discuss with MSE for concurrence.
 19. Minimum size of conduits for ITS facilities. Use 2" diameter conduit as a minimum.
 20. Ensure the design provides space needed for cables, splice enclosures, and slack. Add boxes necessary or include other provisions in this regard.
 21. Existing Raceways – Raceways no longer in use are abandoned or removed. Ensure the pay Item for CLEARING SITE is included in the construction contract. Ensure to designate the work on the plans as abandon or remove.
 - a. Underground systems are left in place and abandoned; however, ensure all cables are removed via specific instruction in the design documents.
 - b. Above ground/exposed systems are removed and discarded by the Contractor. Note the specification reference in the plans.
 22. Fasteners – Specify conduit fasteners that are stainless steel and include isolation padding around non-metallic conduit at locations subject to vibrations.
 23. Include special provisions for “dead end” conduit in the design.
 24. Building entrance – Include specific construction details for conduit designed to enter a building to ensure proper seating and seal through floors and walls from water, fire, and rodent intrusion. Verify building code compliance and discuss with MSE, any potential for Division of Consumer Affairs approval that may also be required for wiring and cabling, power distribution, grounding etc.
 25. When adding devices in the area of existing conduit network, utilize the existing conduit network by dropping a junction box if the conduit is located in the berm area. Avoid conduit home runs for the proposed device as much as possible. Consult MSE for site specific conflicts.

C.3.12.4. Pay Items

The following construction contract pay Items typically provide for the conduit work, however, this list is not all inclusive. Review and consider these Items as well as additional pay Items as required.

Conduits:

- ___" RIGID METALLIC CONDUIT
- ___" RIGID METALLIC CONDUIT, PVC COATED
- ___" RIGID NONMETALLIC CONDUIT
- ___" FLEXIBLE NONMETALLIC CONDUIT
- ___" FIBERGLASS CONDUIT
- ITS CONDUIT, TYPE A

Junction Boxes:

- JUNCTION BOX ITS TYPE ___
- ___ METAL JUNCTION BOX
- STAINLESS STEEL JUNCTION BOX

C.3.13. Wiring

C.3.13.1. Warrants

Wiring is warranted for all ITS devices in order to provide for electrical power and communications. However, the size of wires will vary by individual site and application. Follow the NEC for all electrical work. Conduct detailed investigation with ITS Maintenance for specific wiring and power distribution needs during preparation of the SERF document.

C.3.13.2. Wiring Types

Wire and wiring methods follow the NJDOT standard specifications, the NEC, and local utility company and building code requirements for all installations.

1. Electrical Wiring
 - a. Service Entrance Wiring (multiple lighting wire)
 - b. Ground Wire
2. Communication Cable
 - a. Coax
 - b. Ethernet
 - c. Fiber Optic Cable

C.3.13.3. Location/Placement Guidelines

Ensure the design provides for all wiring to be installed in metallic or non-metallic raceway system. Incorporate important design considerations into the SERF in support of safety, high level design requirements, and communications concepts.

C.3.13.3.1. Design Considerations

Evaluate the proposed wiring in consideration of the following items. In all cases document important decisions and concerns through the Department's DCR procedures.

1. See Common Design Considerations of Section C.3.1.

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2. National Electrical Code (NEC) Requirements – Ensure that proposed wiring complies with NEC requirements
 - a. Power Calculations – Ensure that the feeder wire size will be protected against overcurrent (NEC 2014: 215.3, T.450.3(B), and T.310.15(B)(16)). Also, ensure that ground wire is adequate for the overcurrent (NEC 2014: T.250.122).
 - b. Voltage Drop – Ensure that feeder wire is sized according to voltage drop. Also, ensure that ground wire is sized proportionally if feeder wire is sized up (NEC 2014: 250.122(B)).
 - c. Service Wire – Use No. 2 AWG service wire. Use larger sized service wires if warranted according to power calculations and voltage drop.
 - d. Circuit Breaker – Ensure that wire size will work with the provided circuit breakers, disconnect switches, and transformers.
 - e. Additional performance characteristics for wire and cables to be installed in subway areas, substations, tunnels: stringent flame retardant, low smoke, low toxicity, good circuit integrity (per UL 2196) during a fire are required. All cables for these applications shall be a minimum #12 AWG and rated 90 C for wet and dry applications. Designations of these cables: XHHW-2 for indoor and USE-RHH-RHW-2 for outdoor installations.

Utilize the following values in calculating electrical requirements:

Table C-19: Power Requirements

Device and Controller (Controller, Heater, Network Switch, light, fan, auxiliary, UPS, misc.)	Approximate Power Requirements (kW)
CSS	1
DMS	5
TTS	1
RWIS	1
WIM	1

3. Utility Company Requirements – obtain latest copies of the utility company design manuals to ensure compliance with their requirements.
4. Cable identification – Ensure all wires are identified by circuit in all cabinets, boxes, wiring troughs, and other enclosures and at all terminal points, i.e., receptacle, etc. Include notes on the plans or in the Special provisions as necessary.
5. Verify cable jacket specifications for use in buildings per code requirements.
6. Ethernet Cables – Ensure the design for outdoor cabling specifies outdoor rated cables suitable for the proposed application.
7. Transformers – Design for transformers as needed to modify available electric power. Verify ratings for voltage and KVA. If placing the transformer in a standard equipment cabinet, ensure there is sufficient space. Design for use of dry-type models.
8. Grounding – Add special provisions for grounding such as signal reference ground for computer systems, and specific resistance to ground values based on ITS device manufacturer's requirements that exceed NEC, local, or utility company requirements, and instructions for placement of additional grounding electrodes. Bond lightning air terminals, surge suppression hardware and grounding electrodes to drain excess energy to the surrounding soil. Ensure support structures and controllers are grounded - in close proximity, these may be bonded.
9. Lighting Protection – Include lightning protection systems when conductors originate outside of a controller cabinet. Add special provisions for delivery of a Master Label Certificate by the Contractor per UL 96 and UL 96A. The provision of lightning rods is preferred for deployments involving heights where devices “stand out” among the surrounding landscape and vegetation. Ensure the terminals are of robust material to survive the strike. The use of lightning air terminals are typically omitted for deployments involving relatively low heights and where taller structures are present nearby.

10. Circuit protection – Include provisions for transient voltage surge suppression. Verify the capacity of existing systems (load centers) to be utilized for ITS devices. Confirm models and sizes of panelboards with the manufacturer. Verify space requirements for the load center cabinet layout design. Include a pay Item to MODIFY LOAD CENTER as necessary. Include provisions for specifying circuit breaker/panel board systems with monitoring status capability when required by MSE or BTE for critical system operation.
11. Solar power – Typically limited to serving devices requiring 100Watts or less on a continuous operational basis. Verify tentative ITS device site locations sunlight availability (defined as at least three 8-hour sunlit periods per week) using the latitude and longitude data from the NASA Surface Meteorology and Solar Energy (SSE) division. Specify solar panel inclination by relative latitude of their proposed locations. For example, the latitude of 40.7° N would require the panel be aimed at approximately 40.7 degrees from the azimuth, facing south. Include the aiming data on the contract drawings.
12. UPS – Recommend electrical power line conditioning equipment in areas of known re-booting issues, brown-outs and intermittent power loss.
13. Battery backup – Specify batteries by calculating needs based on equipment operational time requirements and power consumption. Confirm with backup needs with ITS Maintenance early in the design process. Include special provisions to isolate batteries from extreme ambient temperatures for prolonging their life.

C.3.13.4. Pay Items

The following construction contract pay Items typically provide for the ITS wiring work, however, this list is not all inclusive. Review and consider these Items as well as additional pay Items as required.

Power wires:

- MULTIPLE LIGHTING WIRE, ____
- COMMUNICATION CABLE
- MODIFY LOAD CENTER

Ground Wires:

- GROUND WIRE, ____

Service Wires:

- SERVICE WIRE, ____

C.3.14. Standby Engine Generator

C.3.14.1. Warrants

The Standby Engine Generator is warranted for all ITS Hubs in order to provide for emergency electrical power for the communications equipment. A standard Natural Gas Standby Engine Generator adequately sized to supply power to the essential electrical loads in any Hub as shown on the contract drawings.

C.3.14.2. Location/Placement Guidelines

Ensure that the location of the Standby Engine Generator with respect to the Hub and consider the following when selecting the location:

- a. Environmental constraints
- b. Location of the utility meter and the main electrical panel
- c. Location of the Automatic Transfer Switch, Indoor type or Outdoor type
- d. Location of the Standby Engine Generator disconnect switch
- e. Location of Standby Engine Generator foundation with respect to the Hub

- f. Availability of natural gas the ease of bringing to the site
- g. Requirements of the Department of Consumer Affairs (DCA)

C.3.14.2.1. Design Considerations

Evaluate the proposed Standby Engine Generator in consideration of the following items. In all cases document important decisions and concerns through the Department's DCR procedures.

The Standby Engine Generator:

The Standby Engine Generator shall comprise of a Natural Gas Combustion Engine sized for alternator suitable for 120/240 VAC, 60 Hertz system and sized as shown on the contract drawings. The "Standby Engine Generator" shall comprise of a Natural Gas Engine mechanically attached to an Alternator, the Generator Circuit Breaker, the battery charger and the starting battery, microprocessor-based controls, and all other electrical devices, wiring, programming, configuration, communication and electrical connections including the grounding.

Considerations should be made as to how the natural gas service shall be brought to the Standby Engine Generator and how the gas pressure shall be maintained per utility company and requirements. Design the gas line from the gas meter termination point to the Standby Engine Generator.

Foundation:

Design the Standby Engine Generator foundation as recommended by the Standby Engine Generator manufacturer to accommodate the support structure of the Standby Engine Generator. Foundation anchor bolt locations and sizes shall meet the requirements and footprint of the Standby Engine Generator.

Generator Safety Disconnect Switch:

The Generator Safety Disconnect Switch shall be general duty, non-fusible, lockable in the "Connected" and "Disconnected" positions, Quick-make, Quick-break type, with ampacity, voltage ratings and terminals size for the Standby Engine Generator as shown on the contract drawings. The subject safety switch shall be United Laboratories Listed, enclosed in a NEMA 3R rated enclosure and shall meet federal Specification WS-865C.

C.3.14.3. Pay Items for the Standby Engine Generator

- Standby Engine Generator Lump Sum

C.3.15. Automatic Transfer Switch

Evaluate the proposed Automatic Transfer Switch in consideration of the following items. In all cases document important decisions and concerns through the Department's DCR procedures.

C.3.15.1. Warrants

The Automatic Transfer Switch (ATS) is warranted for all ITS Hubs in order to provide for emergency electrical power for the communications equipment. The ATS switches electrical power from a "Normal Source" i.e. the Utility to the Standby Engine Generator.

C.3.15.2. Location/Placement Guidelines

Ensure that the location of the Automatic Transfer Switch with respect to the Hub and consider the following when selecting the location:

- a. Location of the utility main electrical panelboard
- b. Location of the emergency electrical panelboard
- c. Type of the Automatic Transfer Switch to be used, i.e. Indoor type or Outdoor type

- d. Location of the Standby Engine Generator disconnect switch
- e. Location of Standby Engine Generator with respect to the Hub
- f. Clearance space available as required by the National Electrical Code.

C.3.15.2.1. Design Considerations:

Evaluate the proposed Automatic Transfer Switch in consideration of the following items. In all cases document important decisions and concerns through the Department's DCR procedures.

1. Rating - The Automatic Transfer Switch shall be 2 Pole, 240 Volt, 60Hz, with Ampere ratings as shown on the contract drawings. Each Automatic Transfer Switch shall consist of an inherently double throw Power Transfer Switch mechanism and a microprocessor controller to provide automatic operation. The Automatic Transfer Switch and its controllers shall be the products of the same manufacturer.

Main contacts shall be rated for 600 Volts AC minimum.

Transfer Switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -15 to +50 degrees Celsius, relative humidity up to 95% (non-condensing).

The Transfer Switch and its upstream protection shall be coordinated.

The Automatic Transfer Switch equipment shall be UL1008 listed, labeled as suitable for use in emergency, legally required, and optional standby installations and shall certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

The Automatic Transfer Switch installation and application and the Transfer Switch assembly shall conform to the requirements of the following codes and standards:

- ANSI 37 - Low-Voltage Power Circuit Breaker Standard
 - IEC947-6-1- Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment
 - NFPA 70 - National Electrical Code
 - NFPA 110 - Emergency and Standby Power Systems
 - IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - NEMA - Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
 - UL 489 - Standard for Molded Case Circuit Breakers
 - UL 508 - Industrial Control Equipment
 - UL 1008 - Standard for Transfer Switch Equipment
 - UL 1087 – Standard for Molded Case Switches
 - UL 2200 - Stationary Engine Generator Assemblies
1. Configuration - Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of both sources, AC powered operator, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.
 2. Warranty - The Standby Engine Generator manufacturer shall be the manufacturer of the Automatic Transfer Switch and shall warrant Automatic Transfer Switch to provide a single

source of responsibility for all the products provided. Technicians specifically trained, tested and certified to support the product, and employed by the Standby Engine Generator supplier, shall service the Transfer Switches.

C.3.15.3. Pay Items for the Automatic Transfer Switch

- Automatic Transfer Switch Lump Sum

C.3.16. Uninterruptible Power Supply (UPS)

Evaluate the proposed Uninterruptible Power Supply (UPS) in consideration of the following items. In all cases document important decisions and concerns through the Department's DCR procedures.

C.3.16.1. Warrants

The Uninterruptible Power Supply (UPS) is warranted for all ITS Hubs in order to provide for emergency electrical power for the critical load such as the communications equipment in case the power from a "Normal Source" i.e. the Utility Service, is lost and the Standby Engine Generator takes few minutes to come online to start supplying power. The UPS provides power to the essential communications equipment during this "ride through" period.

C.3.16.2. Location/Placement Guidelines

Ensure that the location of the rack-mounted Uninterruptible Power Supply (UPS) unit with respect to the Hub and consider the following when selecting the location:

- a. Location of the utility main electrical panelboard
- b. Location of the emergency electrical panelboard
- c. Type internal by-pass switch, internal type or external type.
- d. Location of essential load panelboard or the Power distribution Units (PDUs).
- e. Space required for the external UPS batteries.
- f. Clearance space available as required by the National Electrical Code.

C.3.16.2.1. Design Considerations:

Evaluate the proposed Uninterruptible Power Supply in consideration of the following items:

When a power outage occurs, the UPS device must immediately provide uninterrupted power to the critical load. This requires the UPS device to be always connected to the critical load circuit and have enough capacity to supply the connected load at all the times, regardless whether the source of power is the utility or the standby engine generator. Evaluate the UPS device based on the following:

1. Rating - UPS shall be rated for single phase 120/240VAC (voltage range from 175VAC to 275VAC), 3-wire hard-wired input and single phase 3-wire hard-wired output, double-conversion online with continuous completely regulated and filtered AC output, Zero Transfer Time between AC and battery operation and sized as shown on the contract drawings. The UPS shall have pure sine wave output with +/-2-3% voltage regulation in either Battery or Utility Mode/Standby Engine Generator and the frequency regulation of between +/- 0.1 or less in Battery Mode and +/- 3 Hz or less in Utility Mode.
2. Dimensions- Ascertain the rack space as well as the real estate available for a rack-mounted UPS device, together with all the clearances required by the National Electric Code.

3. Other features- Automatic bypass on overload or UPS failure, network-grade AC and data line surge and noise suppression, alarm contacts for remote alarm annunciation, Monitoring software to be able to be monitored via RS232 port and Ethernet SNMP interface for simultaneous detailed monitoring of equipment load levels, self-test data and mains power, provisions for Emergency Power Off (EPO), LED lights for battery charge status, input and output voltages and output current, display as a minimum for line power, online mode, on-battery mode, overload, battery low, replace battery, fault status information, load and battery charge levels, alarms as a minimum for startup, power-failure, low-battery, overload, UPS fault and remote shutdown conditions, operating temperature range of 32 to 104 degrees Fahrenheit and a storage (non-operating) temperature range of 5 to 120 degrees Fahrenheit, Tested and certified by the Underwriter Laboratories and must meet FCC Part 15 Category "A" (EMI).
4. Must carry a minimum of 2-year warranty
5. The UPS internal and external batteries shall have the following characteristics:
 - a. Compatible with the UPS and shall be approved by the UPS manufacturer for use with the UPS supplied.
 - b. Preferably rack mountable. Floor mounted batteries are acceptable only if floor space is available.
 - c. Shall have heavy gauge cable harness with high current DC connector for safe, simple installation and connection to the UPS.
 - d. Supplied with the daisy chain connector for connection of additional compatible external battery packs.
 - e. Shall have a minimum battery life of 4-6 years.
 - f. Shall be Valve Regulated Lead Acid batteries or approved equal.
 - g. Hot swappable and easily accessible internal batteries as well as external battery packs.
 - h. Internal battery to support full load run time of 12 minutes minimum and half load run time of 30 minutes minimum. Battery full charge time should be 4 hours or less. Run time should be extendable with multiple external battery modules.

C.3.16.3. Pay Items for the Uninterruptible Power Supply

- Uninterruptible Power Supply & External Batteries Lump Sum

C.4. Maintainability

Ensuring maintainability of an ITS device is critically important to the successful, ongoing operation of the device or system. In addition to functional or operational needs, the placement of a device and the development of the area around it must consider the following maintenance aspects:

- Accessibility to Statewide ITS Maintenance personnel
- Efficiency in performing maintenance
- Safety of work crews and vehicular traffic
- Minimization of traffic impacts

While it is not always possible to fully achieve all of the maintenance goals, the functional objectives, and the budgets relating to devices being installed, they must be weighed against each other on a case-by-case basis that best satisfies the objectives and constraints unique to each situation.

This section defines some of the more general maintenance-focused design considerations. Design requirements that are specific to particular ITS devices are described in Section C.1 of this manual.

C.4.1. Accessibility by Maintenance Personnel

In order for a device to be maintained, it must be accessible to Statewide ITS Maintenance (SIM) crews. Easy access to a site will permit a much more rapid response and will require fewer resources and less coordination than those locations with more difficult access.

It is important to realize that access is not limited to vehicular access on the ground. Devices and infrastructure on overhead gantries, poles, bridges, and other elevated structures also will need a means for access.

Off-pavement vehicular access to devices is always preferred over access requiring shoulder- or lane-closures. The following design features may be implemented in order to meet this accommodation:

- Provide depressed curbs or curb cuts, if a curb is present.
- Install gaps in guide rail to permit maintenance vehicles to safely exit the paved roadway, and provide sufficient space behind the guide rail.
- Use turf pavers to provide a solid surface on which to park a vehicle, particularly one equipped with a lift or bucket. If the maintenance vehicle requires use of outriggers, the surface should be wide enough to accommodate this.
- Limit design of device installation at heights which are impractical or impossible for Statewide ITS Maintenance to reach using standard equipment. In most cases, the reach of a standard bucket-truck is 50 feet above ground. Beyond that limit, consider use of lowering devices, maintenance platforms, alternate device locations, or other means.
- Ensure adequate space, at a level grade, is available to access all sides of the device. This is particularly applicable to structures installed on or near bridge abutments or steep embankments. Fifteen feet of clearance in front of and behind a DMS is preferable.
- Contact local utility company to obtain information on proposed overhead power lines. Do not rely solely on existing conditions. Maintain adequate clearance for both the permanent installation and for maintainers to the equipment. Ensure ITS devices can be maintained by MM and ITS Maintenance personnel in accordance with OSHA and NEC guidelines regarding high voltage proximity.

C.4.2. Efficiency

With the rapidly increasing deployment of ITS devices throughout the State, the availability of the Statewide ITS Maintenance technicians is limited. As such, the design of a device should make the best use of the technician's time so that repairs can be diagnosed and performed in a single visit, in the shortest time possible, and with limited personnel attending to the repair.

Some considerations which can improve maintenance efficiency include the following:

- Minimize the need for bucket-trucks. Use of these vehicles always requires multiple people for safe and proper operation.
- Locate controller cabinets in front of a DMS at such a position that will permit readability of the sign face by technicians working in the cabinet (typically 25 feet for ground-mounted DMS, 50 feet for overhead signs)..
- Place the load-center in a location that is accessible, by foot, to the device it feeds. If such placement is not possible (such as on an Interstate highway), install a local power disconnect switch to turn off power to a controller cabinet during maintenance.
- Minimize the need for lane closures. If lane-closures or shoulder-closures are needed, a Lane Closure Request must be submitted to, and approved by, Operations prior to any work being performed on the site. Additionally, safety precautions, such as Truck Mounted Attenuators, work area signage, and other traffic-control devices must be in place prior to beginning any maintenance.
- Provide a means by which camera images can be viewed locally, rather than requiring coordination with Traffic Operations.

C.4.3. Safety


The NJDOT Safety Bureau requires certain safety precautions to be followed by maintenance personnel working on or near New Jersey roadways. These precautions are based on the New Jersey Public Employees Occupational Safety and Health act (PEOSH, N.J.S.A. 34:6A-25 et seq.) and are legally binding. Fixed accommodations during the design and construction phase can ease the burden of complying with these requirements while maintaining or improving upon the safety guidelines therein.

The NJDOT Safety Manual is available on the NJDOT Intranet.

In addition to the suggestions in the previous paragraphs regarding off-pavement access, device height, and level ground, one of the best ways to incorporate permanent infrastructure to enhance workers' safety is by use of guide rail to physically separate vehicular traffic from maintenance activities. Guide rail may also serve the function of protecting ITS devices from vehicles which leave the road.

Section 8 of the NJDOT Roadway Design Manual defines warrants for Guide Rail and Median Barriers. Installation of new guide rail to protect ITS devices and maintainers is a permissible consideration and may be justifiable for devices outside of a safe zone, but is not a requirement. However, placement of new ITS devices behind guide rail that is installed for other purposes is an excellent way to offer additional safety protection for maintenance workers.

In particular, placement of a device behind existing guide rail can provide this protection without added cost. As such, it is always preferable to take advantage of existing guide rail whenever possible. It is important, however, that guide rail is not installed to the extent that it completely "encapsulates" an ITS device and becomes a hindrance. Gaps should be provided at safe and practical locations to allow maintenance vehicles to leave the roadway to access devices. This is of particular concern for devices installed in a median, where a technician may need to access a device from the left (passing) lane of traffic.

EXTERNAL REFERENCE:	 NJDOT Roadway Design Manual, Section 8 http://www.nj.gov/transportation/eng/documents/RDM/sec8.shtm
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Additional considerations for the safety of maintenance crews may include:

- Provide an adequately-sized level surface for maintainers to stand while working in equipment cabinets. Avoid drop-offs behind the cabinets, or provide a railing or fence to prevent falls while backing away from cabinets.
- Equipment cabinets should be placed such that maintainers are facing oncoming traffic, with doors hinged such that an open door does not obstruct the maintainer's view of traffic.

C.4.4. Minimization of Traffic Impacts

Any maintenance work which will require occupancy of, or in some cases above, an active roadway or shoulder will have an impact on the regular flow of traffic. This will present several complications:

- Increased travel delays and frustration for motorists
- More dangerous conditions for workers
- Prior lane-closure requests and approvals, which will delay the overall time to repair (note that, during certain times and travel directions, lane closures may not be permitted)
- Additional protection set-up and break-down, which requires additional time and manpower

For these reasons, it is always best to allow for ITS maintenance activities to occur without any interference to traffic. However, it may not always be possible to design new ITS installations in such a way that lane closures can be avoided entirely. In these cases, the following are suggested:

- Shoulder-closures are preferable to full travel-lane closures

- Avoid placing devices which may require lane closures around curves or in areas of limited visibility
- Consider placement of devices in locations with more than one means of access. Particularly where devices placed in a roadway median require a lane closure, the Department prefers to set up the closure in the off-peak direction.

In situations where lane closures are unavoidable, devices should be selected which minimize the amount of time and effort to perform a needed repair. For instance, the Department no longer installs traffic detection devices, such as loops or sensors, in the pavement. Alternately, image detectors are installed directly above travel lanes. While maintenance of both devices require a lane closure, the overhead installation can be maintained more easily as it does not require any sort of destructive or reconstructive work to the road surface.

C.4.5. Additional Maintenance-Related Design Aspects

While it is incumbent on a designer to consider the tools and abilities that the in-house Statewide ITS Maintenance staff has to maintain equipment, the amount and type of equipment that can be included in a contract is extremely limited. Federally funded projects prohibit the inclusion of test equipment (such as OTDRs), tools (such as laptops or splice kits), or spare parts among contractor deliverables.

Maintenance training should be included in installations of new systems. Topics included in the training may include both physical maintenance procedures, as well as the overall system architecture of the devices being installed.

C.4.6. Design Review

During design, all three of the MSE submissions (Interim Submission, Final Design Submission, and PS&E) should be reviewed by Statewide ITS Maintenance to ensure maintainability. Refer to Section C.1 for information on the design process and to Appendix H.9 for the ITS Submission Checklists.

C.5. Network

The final design shall commence only once the concept development report has been received and approved by the MSE Project Manager with the concurrence of OIT.

C.5.1. Confirmation of Communications Services

Prior to advancing the communications systems design, the designer is to confirm the preferred communications system option with NJDOT. Once direction is provided, the designer shall confirm that the preferred communications system option continues to be available and meets all of the project's technical requirements including factors such as, network availability/reliability, bandwidth and physical locations.

C.5.1.1. Final Plan Development (PS&E)

Upon review and approval of the Conceptual design by NJDOT, the designer shall commence the final plan development resulting in the PS&E also known as the final Plans, Specifications and Estimates. The designer shall supply, as part of the design both an ITS System Block Diagram (see Appendix H.14) and a Fiber Assignment Diagram (if fiber is used). These diagrams shall detail all equipment and connection from the far end field location through all intermediate points to the head end facilities. These diagrams shall clearly show all connections, splices and fiber allocations.

C.5.1.1.1. Calculations

The designer responsible for submitting calculations for the following topics with each design submission:

Bandwidth

The designer shall submit calculation breakdowns of each cabinet’s bandwidth requirements, along with a summing of each communication element’s project wide bandwidth usage by percent used. For new system design, allow for 60% maximum allocation of any given communication link’s total bandwidth. For integration into an existing communications system consult MSE for approval to use up to 80% of bandwidth capacity. If approved, ensure that 20% capacity remains for unforeseen maintenance management needs in the future for emergencies.

Cable Loss Budgets

Cable loss budgets shall be established for fiber or copper communications and shall show loss on the cable from connection point to connection point. The total link loss budget shall not exceed the total link loss capacity of transmitting and receiving device less (-) 10% throughout the specified operating temperature range.

Coordination Documentation

The designer shall submit a report that indicates that they have contacted and coordinated with the Office of Information Technology (OIT), respective Traffic Operations Center and ITS Maintenance. If no coordination is required with either of these departments it should be stated in that letter. The designer shall also issue a letter stating that they have contacted TRANSCOM, coordinated with them for expansion, replacement, integration or location of the transmit system in the project area.


EXTERNAL REFERENCE:	 TRANSCOM http://www.xcm.org/
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C.5.1.1.2. Fiber

Projects using fiber for communication must include a Fiber Assignment Diagram along with a System Block Diagram regardless of the number of devices to be installed and even if the only connections are to existing facilities. In the case of fiber optic communication, the Department has created a statewide fiber optic standard to assign fiber on main line cables. Refer to Section C.3.11 of this manual and to the Sample Plans.

C.5.1.1.3. Wireless

Wireless systems can be designed around licensed or license-exempt technology. In either case, the designer shall ensure that the system as designed meets all of the FCC regulations for the class of service intended and meets all of the technical and regulatory requirements. For license exempt systems, compliance to FCC Part 15 rules is required. All wireless systems shall provide for secure communications and license exempt radio systems shall be strongly encrypted and shall use dynamic frequency selection or other interference mitigation techniques.

EXTERNAL REFERENCE:	 FCC Part 15 – Radio Frequency Devices http://www.ecfr.gov/cgi-bin/text-idx?SID=35c0e97b359cc32e2f20badf77ffdb8&node=pt47.1.15&rgn=div5
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Structures

All wireless support structures shall conform to the latest structural standards contained in ANSI/TIA-222G (or the latest version), *Structural Standard for Antenna Supporting Structures and Antennas* as well as the latest version of ANSI/TIA 1019, *Standard for the Installation, Alteration and Maintenance of Antenna Supporting Structures and Antennas*. Both documents are available for purchase from the Telecommunications Industry Association (TIA) directly but are not available for free online.


Obstruction Evaluation / Airport Airspace Analysis (OE/AAA)

Any party proposing to construct or alter a structure that may affect the National Airspace System (NAS) is required under the provisions of Title 14 Code of Federal Regulations (14 CFR part 77) to notify FAA by completing the Notice of Proposed Construction or Alteration form (FAA Form 7460-1).

Any temporary or permanent structure, including all appurtenances, that exceeds an overall height of 200 feet (61m) above ground level (AGL) or exceeds any obstruction standard contained in 14 CFR Part 77, should normally be marked and/or lighted. However, an FAA aeronautical study may reveal that the absence of marking and/or lighting will not impair aviation safety. Conversely, the object may present such an extraordinary hazard potential that higher standards may be recommended for increased conspicuity to ensure safety to air navigation. Normally, outside commercial lighting is not considered sufficient reason to omit recommended marking and/or lighting. Recommendations on marking and/or lighting structures can vary depending on terrain features, proximities to airport departure and arrival flight paths, weather patterns, geographic location.

In administering Title 14 of the Code of Federal Regulations (14 CFR) Part 77, the prime objectives of the FAA are to promote air safety and the efficient use of the navigable airspace. To accomplish this mission, aeronautical studies are conducted based on information provided by proponents on an FAA Form 7460-1, Notice of Proposed Construction or Alteration. Advisory Circular 70/7460-1K, Obstruction Marking and Lighting, describes the standards for marking and lighting structures such as buildings, chimneys, antenna towers, cooling towers, storage tanks, supporting structures of overhead wires, etc.

EXTERNAL REFERENCE:		Title 14 of the Code of Federal Regulations (14 CFR) Part 77 http://www.faa.gov/airports/engineering/airspace_analysis/
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EXTERNAL REFERENCE:		Advisory Circular 70/7460-1K, Obstruction Marking and Lighting https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/74452
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Point-to-point

During the Final Plan development stage, the following shall be completed for communications links being established using point-to-point wireless technology:

- Path loss
- Link availability and fade margin (due to environmental factors such as rain fade, snow fade, thermal Inversion). For high availability applications the designer may consider frequency and/or spatial diversity.
- Confirmation of first Fresnel zone path clearance
- Carrier-to-Interference ratio of the proposed link with the surrounding known RF environment. The existing RF environment can be determined based on FCC license data base reports as well as RF site survey activities.
- Adequate bandwidth

Point-to-Multipoint

During the Final Plan development stage, the following shall be completed for communications point-to-multipoint area networks being established using point-to-point wireless technology:

- Path loss
- Link availability and fade margin (due to environmental factors such as rain fade, snow fade, thermal Inversion)
- Confirmation of first Fresnel zone path clearance

- Carrier-to-Interference ratio of the proposed link with the surrounding known RF environment. The existing RF environment can be determined based on FCC license data base reports as well as RF site survey activities.
- Adequate bandwidth for the application


Note: The strongest signals are those which travel on the direct radio frequency line-of-sight between transmitter and receiver and always lie within the first Fresnel zone. This zone is described as an elliptical volume of rotation centered on the radio frequency line of sight between the sites. Radio signals reflected from points along the path of this ellipsoid are delayed by ½ of a wavelength and cause signal cancellation and thereby weaker received signal strength.

C.5.1.1.4. Leased Services

Where the use of leased services is required, the designer shall ensure that the contemplated leased service meets the security, bandwidth and availability requirements of the application. Further, the designer shall ensure that the leased service is being provided by an entity that has a standing offer agreement in place with the State.

Security Requirements and Review

Systems deployed on behalf of NJDOT application must comply with State of New Jersey IT Circular 14-01-NJOIT, version 2.0, published January 7, 2014 or the latest version of this circular to be in force. A security compliance plan will be developed by the designer and shall be approved by NJDOT OIT prior to the implementation of the system

EXTERNAL REFERENCE:		<p>State of New Jersey IT Circular 14-01-NJOIT, version 2.0</p> <p>http://www.nj.gov/it/ps/14-01-NJOIT_171_Minimum_System_Security_Requirements.pdf</p>
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C.5.1.1.5. Wired ISP

In the case of cable modem technology, the system shall be secured with a NJDOT approved router appropriately configured and secured at both ends of the link unless NJDOT approved ACL management is available on the ISP provided router or modem.

C.5.1.1.6. Wireless ISP

In the case of carrier based wireless services, the system shall be secured with a NJDOT approved router appropriately configured and secured at both ends of the link unless approved ACL management is available on the NJDOT approved ISP provided router or modem. In addition, physical security shall be established to prevent the theft of Subscriber Identity Module cards or similar network access authorization from the devices in the field.

C.5.1.1.7. Fiber Optics

Dedicated fiber networks are intrinsically safer than other communications media and are typically by nature, high capacity used for backhaul networks and other critical applications. As a result, the physical security of fiber networks is important. The designer shall provide designs where physical access to the fiber network is secure. The use of physical network security features such as metallic conduit and vault cover locking systems shall be implemented according to NJDOT requirements.

C.5.1.1.8. Agency Shared Communications Systems (MOUs)

In the case of systems shared under an MOU, any security requirements of the MOU shall be observed by the designer. All due diligence shall be exercised in securing the portion of the network allocated to NJDOT project while respecting the security and access of other sharing agencies. The plans for shared MOU

networks shall be reviewed by NJDOT and the sharing agency to ensure that minimum security requirements can be achieved.

While always important, accurate labeling and record keeping of elements of the shared plant shall be prominently visible at all cable splice and termination locations.

C.5.1.2. Final Design Checklist

NJDOT shall provide to the designer a Final Design Checklist. This checklist shall be reviewed by the designer and the final checklist to be applied to the project shall be mutually agreed by NJDOT and the designer. Once the project specific Final Design Checklist is agreed upon, it shall be used to verify that the design is complete and acceptable to NJDOT.

C.5.1.3. Final Design Approval

Once the Final Design Checklist has been signed off without reservation by NJDOT and its agents, the designer has completed the Final Design and may consider the design approved. NJDOT then reserves all rights to use the Final Design for the purposes of bidding the work out or using it for direct award as allowed by NJDOT procurement rules. The intent of the Final Design is to provide comprehensive construction documents such that a competent contractor can construct, configure and commission the required systems.

C.5.2. Bid Period Assistance and Review

During the Bid Period, NJDOT may call upon the designer to provide clarification of intent or specific details of the design documents as required supporting the competitive bidding process. The designer shall be available to conduct a bid analysis using FHWA Guidelines. Include cost calculation and back up documents.

C.6. Work Zones

Intelligent Transportation Systems (ITS) can and should be used to improve the efficiency and/or safety of surface transportation systems. ITS can improve transportation safety, mobility, and societal productivity through the integration of advanced communications technologies into the transportation infrastructure and in vehicles. Today's ITS encompasses a broad range of wireless and wire line communications-based information and electronics technologies. NJDOT's Transportation Systems Management (TSM) is responsible for maintaining safe and efficient traffic flow on State highways. Construction projects can hinder traffic flow, and as such, Real-Time Work Zone Traffic Systems (RTWZTS) need to be analyzed to see if implementation will help mitigate congestion and improve safety through the work zone.

TSM Operations Bulletin OB 2.006B refers to Real Time Work Zone Traffic Systems.


ITS deployment can have substantial benefits in work zones and has been successfully used in work zones for several purposes, including:

- Traffic monitoring and management
- Traveler information
- Incident management
- Safety enhancement
- Capacity enhancement
- Enforcement
- Performance-based contracting
- Work zone planning

RTWZTS is now evolving from being a developmental strategy for improving safety, operations, and productivity to more of a “mainstream” tool. It is available to the work zone planners/designers and developers of transportation management plans (TMPs) to mitigate specific safety and mobility challenges that can exist on a project.

C.6.1. Time Frame for Determination of the Use of RTWZTS

As per NJDOT’s 2014 Traffic Mitigation Guidelines, the need for Traffic Mitigation should be analyzed during the very earliest phases of the project. If the project is being delivered via Capital Program’s Project Delivery process, this would entail analyzing the need for RTWZTS in the Concept Development phase.

NJDOT REFERENCE:		NJDOT 2014 Traffic Mitigation Guidelines http://www.nj.gov/transportation/eng/documents/TMG/
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TSM’s Operations Bulletin 2.006B should also be used when warranting RTWZTS. The exact mitigation strategies should then be selected during Preliminary Engineering. If the project skips this phase, the mitigation strategy should also be determined during concept development. When warranted, the need for a RTWZTS should be communicated by MSE in writing to the appropriate Project Manager in the Division of Capital Project Management. The Director of MSE shall be copied on the notification.

Designers should add the RTWZTS pay Item into the contract. All ITS devices connected to the RTWZTS shall be paid for under this pay Item as lump sum except for Portable Variable Message Sign W/ Remote Communication which will be paid for separately. A PVMS strictly utilized by the contractor and not connected to RTWZTS or traffic operations center should be paid for separately under the pay item: “Portable Variable Message Sign” (PVMS).

The MSE Engineer and/or Designer will be responsible to provide the number of PVMS and Portable Trailer Mounted CCTV that need to be installed for the system to provide useful information to motorists and assist in their travel decisions. This can be accomplished by placing PVMS at key decision points and providing travel time information to downstream destination points. The following information will be required for each PVMS:

Route	Direction	Milepost	Physical Location	Messages to be displayed
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Messages for specific situations should be consistent along the roadway corridor and adjacent corridors, and may require coordination among different agencies.

Messages should be displayed on one panel (preferred) or two panels (maximum).

In most circumstances the system should be a turn-key set up, fully operated and maintained by the contractor. The use of permanent NJDOT PVMS as part of the system shall only be incorporated after consultation with the Director of MSE.

C.6.2. Operations

An MSE representative shall verify the accuracy of the travel times or queue detection when the system is turned on. Discrepancies shall immediately be brought to the attention of the Resident Engineer for corrections.

An ITS Systems Device Integration Form should be filled out for each RTWZTS once it is operational to allow for integration into the Department’s Traffic Operations Center(s) and 511NJ website. This form can be found in Appendix H.13.

C.6.3. Criteria for Determining the Use of RTWZTS

Due to the cost and complexity of these systems, it is important that systems are installed only in appropriate situations and are properly designed and deployed. The following scoring system should be used to determine if a RTWZTS is warranted:

Table C-20: NJDOT RTWZTS Chart with Scoring Criteria

No.	Condition	Scoring Criteria	Score
1	Will there be a long term loss of travel lane continuously for three or more months due to the proposed work zone? (See note 1)	Yes – 10 No – 0	
2	Will there be a temporary loss of travel lane continuously for three or more months due to the proposed work zone? (See note 2)	Loss for 6 hours of the day – 10 Loss for 5 hours – 9 Loss for 4 hours – 8 Etc.	
3	Does the section of the highway with proposed work zones consist of parallel local and express lanes?	Yes – 10 No – 0	
4	Are there viable alternate routes available to motorists to avoid the work zone?	Freeway – 10 US Route – 7 State Route – 5 Local Road – 3 None – 0	
5	Does the one way AADT or ADT exceed 60,000 in the direction of the proposed work zone? (See note 3)	If yes, each 10,000 above 60,000 scores 1	
6	Does the traffic volume per lane exceed 1,500 vehicles per hour during any time of the day? (See note 4)	If yes, each 100 above 1,500 scores 1	
7	Will the traffic volume exceed 1,500 vehicles per hour per lane in the remaining number of lanes if the answer to question No 1 is affirmative? (See Note 5)	If yes, each 100 above 1,500 scores 1	
8	Is the highway section with the proposed work zone a known location of congestion per Congestion Management System (CMS)?	Top 10 per CMS – 10 Top 20 per CMS – 9 Etc.	
9	Is the section of the work zone in close proximity to major traffic generators? (See note 6)	Based on severity – 0-5 If Seasonal – 10	
10	Is the work zone proposing a temporary bridge, contraflow lanes, or cattle chute?	Based on complexity – 0-5	
		TOTAL SCORE →	

Notes

PART C - DESIGN

1. This includes the conditions where a traveled lane is lost permanently due to the proposed work zone on a continuous basis for an extended period of time. (Loss of highway continuously for three months)
2. This includes the condition where the loss of highway lane is temporary and limited to peak periods of the day only for an extended period of time. (Loss of highway lane only during certain hours of the day for an extended period of time)
3. If AADT is not available, determine the ADT based on the nearest section of the highway where 24 hours volume was recorded. The information must be based on an average of at least three regular weekdays during the months when schools are in session. If the information is not available, use 10 for the score.
4. Divide the highest volume of any peak hour during the day (6:00AM – 8:00 PM) by the number of highway lanes in the section of the work zone if per lane volume information is not available.
5. If the proposed work zone will reduce the number of lanes, divide the highway volumes through the work zone by the number of remaining available lanes.
6. If the roadway section is in close proximity to major traffic generators such as Malls, Offices, Stadium, etc. For recreational or seasonal traffic generators, use 10 for the score.

Total score < 35 pts.	No - Do NOT deploy RTWZTS
35 ≤ Total Score ≤ 45	Review - Should be reviewed by the Director of Mobility and Systems Engineering
Total score > 45 pts.	Yes - Deploy RTWZTS

C.6.4. Types of RTWZTS & Criteria Considerations

Listed below are criteria that should be used in determining the type(s) of systems that may be of benefit in construction work zones:

Travel Time & Travel Delay Information – Deployment Criteria Considerations:

- For Travel Time Information:
 - The work zone may cause 15 or more minutes of additional travel time.
 - The work zone causing the delay is within 10 miles of the DMS or PVMS location.
- For Travel Delay Information:
 - The work zone may cause 15 minutes or more of additional travel time.
 - The work zone causing the delay is located more than 10 miles beyond the DMS or PVMS location so multiple alternative routes are available.
 - The work zone queue is estimated to slow traffic at least 20 mph below the posted speed limit.
- Speed Advisory Information:
 - The work zone may cause additional delay due to unexpected decrease in speed in the work zone.
 - The work zone queue is estimated to slow traffic at least 20 mph below the posted speed limit.

Queue Detection/Warning – Deployment Criteria Considerations:

- Queue lengths may encroach upstream beyond a motorist’s reasonable expectations for stopped traffic, and there is a possibility that the geometrics (horizontal and vertical curves) may cause poor visibility of end-of-traffic queues, causing short reaction times and panic stopping.
- The queue is estimated to stop downward of the last DMS or PVMS in the system.

- Queues initiated on crossroads are estimated to cause traffic conflicts and/or delays on the mainline road, such as back-ups beyond the length of ramps, through or around turns in intersections, or other hazardous congestion situations.

Performance Measurements – Considerations

- To monitor work zone safety and mobility, use any of the proposed or existing ITS, including CSS and TTS, to monitor work zone queue length and duration.
- For performance-based contracting, RTWZTS can be used to monitor.

General Considerations when implementing RTWZTS

- Arterials with Computerized Traffic Signal Systems (CTSS) near and around construction areas must include incident management timing plans. The CTSS should be evaluated as part of the RTWZTS implementation.
- RTWZTS systems should be coordinated/integrated into the 511NJ system.
- Existing ITS systems along or near the project limits are to be analyzed before devices are placed and utilized for work zones.
- Operators must be allowed to override traffic time system messages on PVMS and DMS as needed.

C.6.5. RTWZTS Guidance on System Setup

A number of mature systems are now available to provide traffic monitoring and meet specific traveler information dissemination needs. Most commonly, these systems are implemented to mitigate safety concerns that arise from non-recurrent congestion developing because of the work zone, to provide real-time travel time and delay information, and to improve motorist awareness and reduce anxiety about travel conditions ahead. These systems will typically be set up by the supplier or vendor. Listed below are general guidelines for system setups; each may be slightly different so this information should be used as a rule of thumb.

- For Travel Time System:
 - Place non-intrusive detection devices to assure the system gets functional data. Generally radar type devices can be spaced approximately 0.5 miles from each other while probe readers can be spaced farther.
 - PVMSRC indicating estimated trip time should be placed up to 10 miles from destination.
 - PVMSRC can be replaced with static warning sign equipped with two (2) PVMS characters in dynamic mode, displaying real-time travel time in the work zone downstream.
 - Consider posting alternative route and travel time for additional driver information.
 - The PVMSRC may be supplemented with other informational devices, such as PTMCCA.
- For Travel Delay System:
 - Place non-intrusive detection devices to assure the system gets functional data. Generally radar type devices can be spaced approximately 0.5 miles from each other while probe readers can be spaced farther.
 - Place PVMSRC near alternative routes, with signs indicating location of roadwork approximately 800 feet in front of PVMSRC.
 - PVMSRC can be replaced with static warning sign equipped with two (2) PVMSRC characters in dynamic mode, displaying real-time travel delay in the work zone downstream.
 - Consider posting alternative route and travel time for additional driver information.
 - The system may be converted to a Travel Time system within 10 miles of the destination location.

- The PVMSRC may be supplemented with other informational devices, such as PTMCCA.
- Speed Advisory Information:
 - Place non-intrusive detection devices along route, extending beyond limits of work zone congestion.
 - Place PVMSRC 1-3 miles before slow traffic queue.
 - Displayed speed is average speed entering the work zone location.
 - PVMSRC can be replaced with static warning sign equipped with two (2) PVMSRC characters in dynamic mode, displaying average speed at the work zone downstream.
 - Place advisory signs through work zone if length of work zone is long and speeds vary throughout.
- Queue Detection/Warning:
 - Place non-intrusive detection devices along route, extending beyond limits of work zone congestion.
 - Place PVMSRC near alternative routes, with signs indicating location of roadwork approximately 800 feet in front of PVMSRC.
 - After final alternative route, place either PVMSRC or static signs, spaced incrementally warning driver to prepare to stop.
- Dynamic Lane Merge:
 - Place non-intrusive detection devices along route, from the merge taper to beyond the estimated queue length
 - Place first advanced warning sign before estimated queue beginning
 - Place PVMSRC at the following places:
 - At the point of merge.
 - Beyond the estimated queue length at the time when system activation will occur.
 - Beyond the estimated maximum queue length.
 - This can be used in conjunction with Real-Time Traveler Information and Queue Detection/Warning.
- Performance Measurements – Procedure:

In order to collect the type of work zone data necessary for performance measurements, systems must be set up in the field prior to the start of construction for a minimum of 4 weeks. An MSE representative shall verify the accuracy of the travel times and queue detection when the system is turned on. Discrepancies shall immediately be brought to the attention of the Resident Engineer for corrections.

To measure work zone safety, obtain the following information prior to and during the construction project:

- Obtain work-zone crash rate using the number of work-zone crashes, serious injuries, and fatalities, per 1000 work-zone hours
 - Obtain total hours of nonrecurring delay due to nonrecurring sources, like snow, incidents, construction, events, etc.)
 - Obtain 511NJ total number of visitors per quarter/calendar year on their TripCheck website
- To measure work zone mobility, obtain the following:
 - Vehicle-hours of delay
 - Total per project during lane closure activity
 - Average per hour of (daytime, nighttime, weekend) lane closure

- Percent that occurred when delays exceeded a certain amount of minutes per vehicle during (daytime, nighttime, weekend) lane closure
 - Percent that occurred when lane closure queue lengths were longer than X miles during (daytime, nighttime, weekend) lane closure
- Individual vehicle delay (minutes per vehicle)
 - Average per hour of (daytime, nighttime, weekend) lane closure
 - Percent of lane closure hours when individual vehicle delay exceeded a certain amount of minutes per vehicle during (daytime, nighttime, weekend) lane closure
- Queues caused by lane closures (miles)
 - Average length per hour of (daytime, nighttime, weekend) lane closure
 - Percent of (daytime, nighttime, weekend) lane closure hours creating a queue
 - Percent of (daytime, nighttime, weekend) lane closure hours creating a queue longer than X miles.
- To measure these, use ITS devices set up in the work zone.
 - Archive any traffic data to be used for future work-zone performance measurements.
 - Use travel time-based systems to obtain delay times
 - Use queue detection system to obtain length of queue in work zone
 - Use CCTV and crash reports to monitor work zone crashes

C.6.6. Portable Work Zone Integration with 511NJ

Any portable remote control ITS devices or RTWZTS that will be in place for 6 months or more must be integrated into NJDOT's 511 system, 511NJ. For each type of device, the following steps should be clearly outlined in the project's special provisions to assure device integration. Questions pertaining to the need for integration can be directed to the 511NJ Coordinator at 609-530-2549.

The ITS Systems Device Integration form (see Appendix H.13) is to be filled in by the Resident Engineer (RE) or Project Manager to indicate any RTWZTS being used once the RE accepts the Work Zone ITS System.

- Portable Cameras (Temporary Structure-Mounted CCTV Camera Assembly (TSMCCA) or Portable Trailer Mounted CCTV Camera Assembly (PTMCCA))
 - Feed needs to be integrated into Genetec
 - The location of the camera should be submitted with the following information: State Route name and direction, closest milepost, county and municipality, and latitude/longitude coordinates. The route name should conform to the heading as shown on each straight line diagram page (e.g. NJ 18, US 1, I-80).
 - Include a GPS device on the cameras just in case the cameras are moved during construction and the location provided originally is not valid anymore.
- Portable VMS (PVMSRC)
 - Check with Traffic Operations if feed needs to be integrated into the Daktronics Vanguard software operating system.
 - The location of the PVMSRC should be submitted with the following information: State Route name and direction, closest milepost, county and municipality, and latitude/longitude coordinate. The route name should conform to the heading as shown on each straight line diagram page (e.g. NJ 18, US 1, I-80).
 - Each PVMSRC shall have a separate GPS location device and web based system.
- TTS
 - Data needs to be provided in an XML format.

- The location of the TTS should be submitted with the following information: State Route name and direction, closest milepost, county and municipality, and latitude/longitude coordinates. The route name should conform to the heading as shown on each straight line diagram page (e.g. NJ 18, US 1, I-80).
- The device ID and pairs (links) need to be submitted.
- The TTS devices need to be 1 mile apart or less for work zones. This will allow a more granular observation of the travel conditions. All distances should be coordinated with MSE.

C.7. Operations

The purpose of the “Operations” section is to define guidelines and procedures for impacts to Traffic Operations relative to ITS design and construction. It is to be used to assist design engineers in understanding and addressing these impacts. It also defines the responsibilities and obligations between Traffic Operations and a Contractor or Resident Engineer during construction.

The tasks listed under this section are only those which require participation by Traffic Operations, and are not inclusive of all design phase activities.

C.7.1. Designer Responsibility

During Design, the designer shall work with Traffic Operations to assess the impacts that the proposed work will have on the Traffic Operations organization. The designer shall develop designs that meet the goals and capabilities of Traffic Operations, address interferences with other ITS installations as well as other infrastructure, and shall ensure that the network infrastructure and computer equipment at the Operations Centers can support the new design.

While Traffic Operations may be consulted during the design process, their involvement is limited, except for CTSS projects where additional coordination is required. Coordinate with Bureau of Traffic Engineering during the development of CTSS Timing Directives. For ITS projects, most of their contributions to the design come in the Concept Design stage, as described in section B.2.

C.7.2. Facility Assignment

The county in which an ITS device is located dictates the Traffic Operations facility from which the device will generally be controlled, as discussed in Section A.4.3 - Facilities. TSM may make exceptions to this guidance on a case-by-case basis.

C.7.3. Construction Phase Preparation





C.7.3.1. Methods and Procedures

Regardless of the type and extent of ITS work on the project, the designer shall include certain requirements in the specifications and special provisions of the contract. These requirements include:

- Contractor shall submit cabinet wiring schematics, system block diagrams and network diagrams
- On projects using a fiber optic network, contractor shall submit a splicing plan (fiber assignment diagram)
- Fiber Optic Technician certificates
- Working drawings of the complete system for each pay item must be submitted by the contractor to the ITS designer for review and approval
- The Contractor shall use the System Block Diagrams included in the set of construction plans as working drawings by inserting the required equipment table(s) and all necessary stamps. Structural

items, such as standards, should be submitted as separate working drawings with the respective reference to the overall ITS system of which they are part.

- Underground items for standard conduit, standard junction boxes, and wiring from Section 701 shall be submitted through the Material Questionnaire/DC-2891 process with approved EE #'s; For any material that does not have an EE # assigned, sufficient information must be submitted for the designer to verify that the materials meet the requirements of the material specifications and the project requirements.
- Approved materials from the ITS Qualified Product List (QPL) can be submitted through the Material Questionnaire/DC-2891 process with approved ITS #'s. Non-QPL items must be submitted in accordance with the 2012 Working Drawings Manual.
- Working drawing submissions for the operational items of the systems should reference any related underground and structural item approvals when submitting separately.

NJDOT REFERENCE:		Intelligent Transportation Systems Qualified Product List http://www.nj.gov/transportation/eng/elec/ITS/qualified.shtm
		2012 NJDOT Working Drawings Manual http://www.nj.gov/transportation/eng/documents/BDC/pdf/WorkingDrawingsManual2012.pdf
NJDOT REFERENCE:		Material Questionnaire/Form DC-2891 http://www.nj.gov/transportation/eng/forms/docs/construction/dc2891.xls
		Material Questionnaire/Form DC-2891 (Instructions) http://www.nj.gov/transportation/eng/forms/docs/construction/dc2891Inst.pdf

C.7.3.2. Integration with Existing Systems

The Final Design phase is the opportunity to develop project specific requirements for contractors, to define their relationships with Traffic Operations, and to ensure Traffic Operations is prepared to accommodate the contractor as needed. This phase should also plan for any anticipated loss of functionality.

During the design phase, designers should ensure that the methods and requirements for this coordination are clearly spelled out in the contract and that affected units are able to support any coordination or anticipated service interruptions. Such coordination may include the following:

- Coordination of physical and logical connections of new equipment at TOC-S, STMC, AMC, and/or Elmwood Park as required.
- Basic configuration of installed devices
- Contractor's response to loss of device functionality as reported by Traffic Operations. (While the contractor owns the device, he may service it at his own schedule, but should notify Traffic Operations of any planned downtime as a courtesy, as Traffic Ops is already using these devices)
- Procedures for requesting and obtaining permission for lane closures in accordance with Sections D.3.3 and E.1.1.13. (Advance planning for these closures should be with concurrence of the Work Zone Management division of Mobility Management.)

C.8. 511NJ




NJDOT's 511 system (511NJ) is a free phone and web service that consolidates traffic and transportation information into a one-stop resource for commuters and motorists in the State of New Jersey. 511NJ provides up-to-the-minute traffic conditions and it is available seven days a week, 365 days a year. The information offered from the service is collected through various resources, including ITS deployments across the State.

Any new permanent ITS device or Temporary (Work Zone ITS) device (with the exception of RWIS, WIMS, and VLS) that will be in place for six months or more must be integrated into 511NJ. Each type of device shall provide data in the format described in this section and clearly be specified in the project's special provisions.

Table C-21: 511NJ Data Format Requirements

Device	Format for integration
Temporary Structure-Mounted CCTV Camera Assembly (TSMCCA) Portable Trailer Mounted CCTV Camera Assembly (PTMCCA)	Feed needs to be integrated with Genetec
Portable VMS (PVMSRC only)	Feed needs to be compatible with the Daktronics Vanguard software operating system
Temporary Travel Time System (TTS)	XML Format
Permanent Camera Surveillance System (CSS)	Feed needs to be integrated with Genetec
Permanent Dynamic Message System (DMS)	Feed needs to be compatible with the Daktronics Vanguard software operating system
Permanent Travel Time System (TTS)	XML Format

Instructions on the completion of an ITS Systems Device Integration Form during construction should be clearly outlined in the project's special provisions.

TSM REFERENCE:		511NJ website http://www.511NJ.org
		511NJ Phone Overview http://www.511NJ.org/showpage.aspx?pageName=PhoneOverview
		511NJ Web Overview http://www.511NJ.org/showpage.aspx?pageName=WebOverview

Questions pertaining to the need for integration can be directed to the 511NJ Coordinator at 609-530-2549.

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D.1. Intelligent Transportation Systems (ITS)

This section will be a resource for the Resident Engineer responsible for contract administration of projects that install new ITS components/systems or modify existing ITS facilities. Note that any reference to a contractor requirement must be found in the Standard Specifications, Special Provisions or on the project plans in order for it to be enforced. Ensure to follow the construction related activities in the TSM Limited Scope Project Delivery Process found at the link below:

NJDOT REFERENCE:		TSM Limited Scope Project Delivery Process http://www.state.nj.us/transportation/eng/elec/ITS/tsmprocess.shtm
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D.1.1. Pre-Construction Meeting


A pre-construction meeting (for CPM projects, it will be a separate meeting dealing with the ITS portion of the project), will be scheduled by the RE after the Prime Contractor has chosen his Electrical Subcontractor/System Integrator. This meeting's goal is to ensure the Contractor's intentions are in line with the Department's expectations by establishing protocols and procedures for all phases of the work. (The Integrator is responsible for all aspects of ITS device installation/testing as well as managing the interface with the NJOIT. For this reason, the RE needs to verify with the ITS designer that the Integrator has the qualifications set forth in the Special Provisions.) Invitees and agenda for this meeting can be found in Section 3L of the Construction Procedures Handbook (CPH). Additional personnel may include;

- Project's ITS Inspector (whether DOT or consultant)
- MSE representative
- RE/PM
- System Integrator
- ITS Subcontractor
- ITS Designer
- Statewide ITS Maintenance (SIM) representative as applicable
- Traffic Operations representative as applicable
- Environmental Program Resources & Project Support representative (not applicable for CPM projects)
- TRANSCOM if TTS Type A equipment is being installed
- Bureau of Transportation Data and Safety if a WIMS or TVS is being installed
- Bureau of Maintenance Engineering if a RWIS is being installed
- Office of Emergency Management (OEM) if a Homeland Security device is being installed

The following additional agenda items should be discussed;



- Obtaining VPN/Network assignments
- GSN Access forms & protocols (see Section D.2)
- Third party involvement/requirements. Note that a license to cross is typically required for performing any work on NJTA property and the railroad companies require similar type permits.
- Proximity issues; railroad and utility overhead wires require different clearances
- COP protocols
- Material submittals; discuss if any items can be handled separately as opposed to being part of an "ITS package"
- On some projects, there are "construction" ITS facilities (real time) in addition to the permanent ITS facilities. A separate ITS preconstruction meeting should be held for the "construction" work, since different DOT and contractor personnel are involved.
- Testing
- Hub Access forms
- F.O. Markouts

- Corrective Inspection requirements
- Cyber-security
- ITS equipment check walk through (similar to what is done prior to a contractor assuming responsibility of a traffic signal.)
- Additional OIT personal will be invited as required

NJDOT REFERENCE:		Construction Procedure Handbook, Section III, Subsection L
		http://www.nj.gov/transportation/eng/construction/pdf/Sec3SubSecL.pdf

D.1.2. Working Drawings/Submittals

Regardless of the type and extent of ITS work on the project, as stated in the specifications, the contractor is required to submit the following: cabinet wiring schematics, system block diagrams and network diagrams. On projects using a fiber optic network, a splicing plan (fiber assignment diagram) will be needed. Required working drawings of the complete system for each pay item must be submitted to the ITS designer for review and recommendation for approval. The Contractor should use the System Block Diagrams included in the set of construction plans as working drawings by inserting the required equipment table(s) and all necessary stamps. Structural items, such as standards, should be submitted as separate working drawings with the respective reference to the overall ITS system of which they are part. See Sample Plans for details. Underground items for standard conduit, standard junction boxes, and wiring from Section 701 can be submitted through the Material Questionnaire/DC-2891 process with approved EE #'s; MSE will require a copy of these. For any material that does not have an EE # assigned, sufficient information must be submitted for the designer to verify that the materials meet the requirements of the material specifications and the project requirements. Approved materials from the ITS Qualified Product List (QPL) can be submitted through the Material Questionnaire/DC-2891 process with approved ITS #'s. Non-QPL items must be submitted in accordance with the Working Drawings Manual. Approval under a previous project does not mean automatic approval for subsequent projects. Working drawing submissions for the operational items of the systems should reference any related underground and structural item approvals when submitting separately. Material Questionnaire submittals per Section 106 will no longer be required for all ITS materials covered under approved working drawings. Upon approval/certification/concurrence of working drawings by the Department, it is critical that separate copies are distributed to the ITS Inspector, the Regional Electrical Engineer, SIM and the RE. Designers must process through the Engineering Documents Unit for further NJDOT review and approvals.

NJDOT REFERENCE:		ITS Sample Plans http://www.nj.gov/transportation/eng/elec/ITS/plans.shtm
		CTSS Sample Plans http://www.state.nj.us/transportation/eng/elec/ITS/ctss.shtm

Working drawings submissions are not to be used by the Contractor for submitting proposed revisions to the contract. RFI's are to be submitted through the RE's office, to the ITS designer with a copy to MSE. The designer will provide a response directly to the RE with a copy to MSE. Should MSE have an issue, they will advise the RE within 2 days of the receipt of the designer's response. RE should check with MSE for any design error issues in the response prior to sending it to the contractor. If required, revisions will be issued by Change of Plan or Change Order, and then working drawings must be submitted in conformance with those revisions, following the same procedure as in the preceding paragraph.


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Contractor/Integrator requests to gain access to the various ITS Hub locations and/or buildings must be made using ITS Access Request Form. Saturday or Sunday requests require special permission. The RE should be copied on all requests. It normally takes five business days to process such requests.



Prior to accessing an existing Fiber Optic System, the Contractor must coordinate disruptions to the system with the regional TOC during allowable downtime as noted in the Special Provisions. The Contractor must coordinate an equipment inspection checklist with TOC to validate condition of those items. In addition, the Contractor must coordinate the transfer of existing communication systems to minimize downtime. Typically, there are significant hourly penalties for the Contractor when the system is down due to his negligence. It is important to thoroughly document all such incidents to properly determine the Contractor's potential liability.

Relocating and/or modifying ITS devices during construction must be approved by the RE, Regional ITS Maintenance Management and Traffic Operations. Other than minor adjustments for field conditions that can be addressed through the as-builts, any other changes will require coordination through the designer to develop a COP that must also be approved through the Bureau of MSE.

TSM REFERENCE:		ITS Sample Plans http://www.nj.gov/transportation/eng/elec/ITS/plans.shtml
		ITS Qualified Product List http://www.nj.gov/transportation/eng/elec/ITS/qualified.shtml
		ITS Access Request Form http://www.nj.gov/transportation/eng/elec/ITS/access.shtml
		MSE Engineering Contacts http://www.nj.gov/transportation/eng/assistance/engcontacts.shtml

NJDOT REFERENCE:		Working Drawings Manual 2012 http://www.nj.gov/transportation/eng/documents/BDC/pdf/WorkingDrawingsManual2012.pdf
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NJDOT REFERENCE:		Traffic Engineering (TE) Database http://www.nj.gov/transportation/eng/elec/EEDB.shtml
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NJDOT REFERENCE:		Material Questionnaire/Form DC-2891 http://www.nj.gov/transportation/eng/forms/docs/construction/dc2891.xls
		Material Questionnaire/Form DC-2891 (Instructions) http://www.nj.gov/transportation/eng/forms/docs/construction/dc2891Inst.pdf

D.1.3. Construction Issues

While the project documents include all of the necessary direction for proper construction of ITS devices, the following is a list of critical issues worth repeating;



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- A tracer wire is required to locate underground fiber optic cable conduits. When single conduit is used for fiber optic cable, ensure that a tracer wire is installed in the conduit. Where there is more than one conduit in the same trench, install a tracer wire in one conduit. The tracer wire shall be terminated inside the cabinet where the conduit is installed. This includes those locations where RMC is used for fiber optic cable.
- A total slack of 60 feet (30 feet from each conduit entry) is required for the fiber optic cable at each Junction Box Type A, B and D for future splices.
- All fiber optic splices are only to be performed in ITS junction boxes or ITS cabinets.
- 14” of No. 57 coarse aggregate is to be placed in the bottom of ITS junction boxes.
- If in a sidewalk, the top of a junction box should be flush with sidewalk elevation.

To assist the ITS Inspector during the construction of various components, checklists are available for his/her use. Refer to “Delivery Inspection Checklists (Acceptance)” in the ITSIMM Manual in Appendix H.16 for the actual checklist.

The Integrator is responsible to acquire all IP address information. The request is to be made to the RE who in turn will send it directly to the Manager, OIT), with copies of the email request to MSE/SIM. The request will be made using the ITS System Diagram (NBD) provided in the project plans along with an Excel spreadsheet. A sample is available in Appendix H.14.

The Contractor should review the Fiber Optic Cable Conduit database to investigate whether there are any Fiber Optic Cable facilities. If there are, then field markouts of the underground fiber optic network are required prior to doing any work in the vicinity of those facilities. Markouts can be requested by the Contractor by utilizing the Fiber Optic Markout Request Form. The ITS infrastructure inventory also includes conduits that are labeled for future fiber use. Markout Requests for these conduits shall also be made to ensure these are not adversely impacted by the proposed work.

TSM REFERENCE:		<p>Fiber Optic Cable Conduit Database</p> <p>http://www.nj.gov/cgi-bin/transportation/database/viewdb.pl?action=view&database=ITS_CONDUIT_SEGMENTS&URL=/transportation/eng/elec/ITS/requests.shtm&fields=0,1,2,3,5,7,8,9&sort=10</p>
		<p>Fiber Optic Markout Request Form</p> <p>http://www.nj.gov/transportation/eng/elec/ITS/markout.shtm</p>

D.1.4. Contract Changes

Amending the Contract, whether it is a specification change, adjustment of item quantities or adding Extra Work, requires a Change Order to be executed. Four paper copies of the Change Order are to be originally signed by the Contractor, RE, ITS PM (RE’s supervisor) and the Manager for MSE. The Change Order cannot be approved in Site Manager until Accounting has appropriated funds. Certain issues will necessitate a Change of Plan (COP) to be initiated by the Designer, reviewed and approved by MSE, and incorporated into the Contract by Change Order. Refer to CPH Section IV, Subsection B for additional information regarding construction changes.

The Change order is to have the reason for the change order, if appropriate a sentence indicating FHWA approval with the approval date, the description of the changes in items and the “T” sheets depicting the changes in funding amounts.

All change orders should be brought to the attention of the Budget Center Manager (“BCM”) for recording and tracking, regardless of whether the sum of individual changes will affect the overall net cost of the work. If additional funds are required for the Change Order, the BCM will add a memo to the Change Order

package to inform Capital Programming of the amount and account that will be funding the change. Once the Manager has signed the change order, MSE will retain one paper version as well as a scanned electronic copy. An AD-37 (Referral form) will be attached to route Change Order package through Capital Programming and then Accounting.

D.1.5. ITS Testing

The Contractor shall use the ITS Testing Forms unless otherwise specified for performing the testing and acceptance of the ITS facilities. Complete and submit the ITS testing forms as specified.

TSM REFERENCE:		ITS Testing Forms http://www.nj.gov/transportation/eng/elec/ITS/testing.shtm
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1. Contractor and ITS Inspector sign off as testing is done for the Level A Testing. If there is any failure (e.g. corrective work items are required) then initial level testing is not successful. The ITS Inspector documents the deficiencies observed during testing. The Contractor submits a plan to correct the deficiencies. The Contractor coordinates with RE and ITS Inspector to correct and retest the items where the deficiencies were noted. Repeat this procedure until all the deficiencies are corrected. The ITS Inspector signs off the initial level testing forms once all the deficiencies are corrected. The ITS Inspector provides a copy of the completed forms to the RE for Project records and returns the originals to the Contractor.
2. For Network communication system testing, the Contractor and the ITS Inspector coordinate with Office of Information Technology (OIT) if required.
3. The Contractor submits original completed testing form to the RE. The RE signs off if next level of testing is not required. The RE provides a copy of completed testing forms to the Contractor and keeps the originals with the Project records. If next level of testing is required then follow the directions noted below.
4. The Contractor and the ITS Inspector sign off as initial testing is done for the next level. If there is any failure (e.g. corrective work items are required), follow the procedure as outlined above under No. 1 to resolve the deficiencies. If operational testing (to observe the functionality) is not required, the Contractor submits the completed forms to the RE for sign off. The RE signs off and provides a copy of completed testing forms to the Contractor and keeps the originals with the Project records. If the operational testing is required then follow directions noted below, under No. 5 and No. 6 as applicable, to perform the operational testing.
5. **When Mobility Management (MM)/ITS Maintenance Sign off is required:** The Contractor requests the RE to coordinate with Statewide ITS Maintenance and Traffic Operations for performing operational testing. The RE forwards the completed testing forms to Statewide ITS Maintenance for operational testing. If there is any failure during operational testing (e.g. corrective work items are required) then Statewide ITS Maintenance documents the deficiencies observed during operational testing and submits the form to the RE. The RE forwards the list of deficiencies to the Contractor. The Contractor submits a plan to correct the deficiencies. The Contractor coordinates with RE, Statewide ITS Maintenance and ITS Inspector to correct the items where the deficiencies were noted. Once all deficiencies are corrected, the Contractor coordinates with RE and Statewide ITS Maintenance to perform the operational test again. Upon completion of successful operational testing period, Statewide ITS Maintenance completes the form and returns it to RE. The RE signs off if next level of testing is not required. The RE provides a copy of completed testing forms to the Contractor and keeps the originals with the Project records. If next level of testing is required then follow the directions as noted under No. 3.

6. **When Mobility Management (MM)/ITS Maintenance sign off is NOT required:** The Contractor requests the RE to coordinate with other responsible ITS SME's if required (Bureau of Transportation Data Development for TVS & WIMS; and Bureau of Maintenance Engineering & Support – Electrical Section for RWIS) for performing operational testing. The responsible ITS SME's must advise the RE if they wish to participate in any of the testing or deficiency corrections. The RE forwards the completed forms to ITS Inspector and directs the inspector to perform the operational test. ITS Inspector performs the operational testing. If there is any failure during operational testing (e.g. corrective work items are required), then the ITS Inspector, documents the deficiencies observed during operational testing and submits to the RE. The RE forwards the list of deficiencies to the Contractor. The Contractor submits a plan to correct the deficiencies. The Contractor coordinates with RE and ITS Inspector to correct the items where the deficiencies were noted. Once all deficiencies are corrected, the Contractor coordinates with the RE and the ITS Inspector to perform the operational test again. Upon completion of successful operational testing period, the ITS Inspector completes the form and returns the completed forms to the RE. The RE signs off if next level of testing is not required. The RE provides a copy of completed testing forms to the Contractor and keeps the originals with the Project records. If next level of testing is required then follow the directions as noted under No 3.
7. Contractor proposes to initiate Project Testing when all corrections and final levels of testing are complete. The Contractor submits copies of all previously completed testing forms for the project to the RE. The RE forwards the completed forms to Statewide ITS Maintenance or the other responsible ITS SME's as required with a request to initiate the observation test period. Statewide ITS Maintenance and the other responsible ITS SME's advise the RE if the Project Testing is complete or if corrections are required.
8. Corrected work testing will follow the same procedure as noted above, until all issues are resolved.
9. At the time of Substantial Completion, the Contractor submits two copies of all completed testing forms for ITS systems to the RE. The RE forwards one scanned, electronic copy of all completed testing forms to Statewide ITS Maintenance and other responsible ITS SME's for their records and keeps the original with the Project records. Also provide an electronic copy.
10. See the MS-ITS Testing Protocol in Appendix H.15 for the personnel and equipment required for the various levels of testing for CSS and DMS devices.
11. Table D-1 below identifies the personnel who are required to sign off when completing the testing forms for the ITS systems:

Table D-1: ITS Testing Forms Sign-off List

ITS Testing Forms Sign Off List								
Sr. No.	Testing Form Description	Level	Signoff Required					
			Contractor	ITS Inspector	MM	AAM	TSM	RE
704.03.01 - General System (GS)								
1	Communication Cable		√	√				√
704.03.02 - Camera Surveillance System (CSS)								

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2	Camera Surveillance System	Level A	√	√				
3	Camera Surveillance System	Level B	√	√	√			
4	Camera Surveillance System	Level C	√	√	√			√
704.03.03 - Fiber Optic Cable								
5	Fiber Optic Cable	Level 1	√	√				
6	Fiber Optic Cable	Level 2	√	√				√
7	Ethernet Communication System		√	√				√
704.03.04 - Controlled Traffic Signal System (CTSS)								
8	Controlled Traffic Signal System (CTSS)	Level A	√	√				
9	Controlled Traffic Signal System (CTSS)	Level C	√	√		√		√
704.03.05 - Travel Time System (TTS)								
10	Travel Time System (TTS)	Level A	√	√				
11	Travel Time System (TTS)	Level B	√	√			√	
12	Travel Time System (TTS)	Level C	√	√			√	√
704.03.06 - Road Weather Information System (RWIS)								

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13	Road Weather Information System (RWIS)	Level A	√	√				
14	Road Weather Information System (RWIS)	Level B	√	√				
15	Road Weather Information System (RWIS)	Level C	√	√				√
704.03.07 - Dynamic Message System (DMS)								
16	Dynamic Message System (DMS)	Level A	√	√				
17	Dynamic Message System (DMS)	Level B	√	√	√			
18	Dynamic Message System (DMS)	Level C	√	√	√			√
704.03.08 - Weigh in Motion System (WIMS)								
19	Weigh in Motion System (WIMS)	Level A	√	√				
20	Weigh in Motion System (WIMS)	Level C	√	√				√
704.03.09 - Traffic Volume System								
21	Traffic Volume System (TVS)	Level A	√	√				
22	Traffic Volume System (TVS)	Level C	√	√				√

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Upon successful completion of Level C testing for CSS and DMS, the RE should submit the "ITS SYSTEMS DEVICE INTEGRATION FORM" to the 511NJ Coordinator. This form can be found in Appendix H.13.

For CTSS/Adaptive projects complete the CTSS/Adaptive testing forms in Appendix H.28 of this manual.

1. Documentation/Certification: The contractor will provide documentation and certification for the testing of the devices carried out in the lab prior to installation and deployment in the field such as, but not limited to, 168 hour test for controller units, testing for image detector units, testing for system detector units and reference documentation as requested in the Verification Plan in the Special Provisions. For Network communication system testing, the Contractor and the ITS Inspector coordinate with Office of Information Technology (OIT) if required.
2. Deployment Testing: The deployment testing period of 14 business days shall be completed prior to the initiation of System Integration Testing. Deployment testing shall include accuracy testing of the field installed detection units (image and system detection) as per Plans, Standard Specifications, and Special Provisions, including the testing of the integration of the detection units with the controller for the designed intersection operation. Device failures are from the devices or components of the devices in the field. This type of failure requires that the failure be corrected within 24 hours of notification. The testing clock will be stopped when the Contractor is notified of the failure. After the repairs are completed, then the clock will resume at the start of the next business day. Contractor is required to submit the EL-11C form. If the device failure occurs after the 11th business day of the 14 business day testing period, the clock will be stopped when the Contractor is notified. Then the clock will be restarted on the next business day, after the repairs are completed. In addition, five additional business days will be added to the testing period due to the failure occurring after the 11th day. The Contractor is required to submit the EL-11C form. Operational failures will be defined as failure of the operation of the intersection as designed and indicated in the Systems Requirement document and the Verification Plan. This type of failure requires that the issue be corrected within four (4) hours of notification. The clock will be stopped upon notification to the Contractor and restarted on the next business day, after the repairs are completed. If the testing accumulates five (5) operational failures, then the Contractor will be required to submit a Corrective Action Plan for review and approval by NJDOT. After the repairs are completed, then the clock will be restarted on the next business day. If there is an operational failure number six, then the 14 business day clock will be reset to day zero, after the repairs have been completed.
3. Subsystem Testing: Subsystem testing requires testing of the remote operation of systems installed and integrated on NJDOT's IT network for the corridor, the testing period is 20 business days. Each subsystem will be tested independent of the other. The Image Detection System, Radar Detection System, and Traffic Control System will be tested for remote access, functionality, monitoring and reporting requirements as specified in the System Requirements and Verification Plan documents, and Special Provisions. The tests will be verified over a period of 20 business days, wherein the operators will monitor and test multiple functionalities of each of the subsystems, including alarms and alerts, if applicable. Failure will be defined as the inability of a subsystem to perform the designated function from a remote location, as indicated in the System Requirements, the Verification Plan, and the Special Provisions for the project. If one (1) or more devices fail at a specific time, then this will count as one (1) failure within that individual subsystem. If there is a failure which requires the system to be offline for less than 12 hours, then this will result in no penalties to the Contractor and the testing clock will not be stopped. If the repairs take greater than 12 hours but less than five (5) business days, then the clock will resume on the next business day after the repairs have been completed. If the failure takes greater than five (5) business days, then

the 20 business day testing clock will be reset to day zero. If a specific subsystem accumulates 20 or more failures, then the Contractor shall submit a Corrective Action Plan which shall be reviewed and approved by NJDOT. After the repairs have been completed, then the 20 business day testing period will be reset at day zero.

4. System Integration Testing: Each subsystem needs to integrate with Adaptive for full system functionality. The testing period will be 20 days. The testing for integration of the subsystems as per System Requirement and Verification Plans, part of Special Provisions, shall be carried out prior to acceptance of the system. The inputs of the subsystem to the Adaptive System, and the accuracy of the resultant outputs shall be verified. The operational failures are defined as errors of the input from a subsystem, or an erroneous resulting output from the Adaptive System. If the repair for any failure(s) takes between two (2) and 12 hours, then the testing clock will be stopped upon notification to the Contractor and will resume once the repair is completed. There will be one (1) business day added to the testing period due to this failure. If the corrective action for any failures takes more than 12 hours, then the testing clock will be stopped upon notification to the Contractor and will resume once the repairs are completed. There will be three (3) business days added to the testing period. If the failures accumulate to six (6) or more, then the Contractor shall submit a Corrective Action Plan for review and approval by NJDOT. The tasks or repairs will be at the Contractor's expense, and the testing clock will be reset to day zero, after the repairs have been completed.
5. System Acceptance Testing: Refer to Section D.5.1 Substantial Completion/Acceptance/Close out. The testing of the system, in accordance with the Validation Plan, part of Special Provisions and the successful completion of the System Integration testing shall be the initiation of System Acceptance. Additional documentation from the contractor will be required prior to Acceptance, as indicated in the As-Built Information forms, warranty, maintenance agreements, and continuing contractual obligations that need to be transferred over from the Contractor to NJDOT.

The payment schedule for the contractor is as follows:

Work Completed	Payment
Installing the Item	60% of Total Contract Price
Successful completion of Level A testing/Deployment Testing	10% of Total Contract Price
Successful completion of Level B testing/Subsystem Testing	10% of Total Contract Price
Successful completion of Level C testing/System Integration Testing	10% of Total Contract Price
Successful completion of Project testing/Validation	10% of Total Contract Price

D.2. Network

D.2.1. Construction Support Services

Once NJDOT has selected a preferred proponent contractor to build the system, the construction administration or construction support services phase of the project will begin. The designer may be required from time to time as described by their approved scope of services to assist the contractor in the successful implementation and turnover of the system into operations.

Should the assistance to the contractor entail field visits, all of the required safety precautions shall be observed with full Personal Protective Equipment (PPE) and safety protocols.

The contractor is to fill out the IP Request Form and submit to NJDOT IT (refer to [Appendix H.7](#)) as early in the phase as possible to allow for enough processing time.

D.2.2. Network Security during Construction

The designer shall assist the contractor to ensure that during construction, once network elements are activated that a security management plan is in place so that the network elements and ITS devices are not susceptible to being controlled by un-authorized parties. Refer to Section D.2.6.

D.2.3. Testing and Acceptance

The construction documents prepared by the designer shall include the project testing and Acceptance processes and procedures. The designer shall be available to witness testing and assist NJDOT bring the system into operation. OIT is to be notified of the testing process specific to each project.

Testing will generally be organized under the standard categories of:

- Factory Acceptance Tests
- Proof of Performance Testing - for which the Communications Networks shall include at a minimum the following proof of:
 - Link availability
 - Adequate bandwidth
 - Maximum latency which meets the needs of the most critical application being carried by that network
 - Providing to the MSE Project Manger a final System Block Diagram
 - Provide to the MSE Project manager final IP addressing, VLAN and network logical configuration details
 - Completed and accepted communications systems testing forms.
- System Integration Testing
- Operational Readiness Testing
- Burn-In

The testing regime shall be as described in section D.1.4 and shall be approved by the NJDOT project team.

D.2.4. Turn-over to Operations

Turnover to Traffic Operations shall only occur once the Operational Readiness Testing (ORT) has been completed and accepted and once the burn-in period has ended. The system must remain fully operational and available throughout the burn-in period. Should there be a critical operational failure during the burn-in period, the burn in period clock shall be reset and the burn-in period restarted until the successful completion of the burn-in. Burn-in is typically conducted over a two-week duration however, it will be specified in the final PS&E. The final PS&E will specify the definitions of a critical failure in the context of that specific project.

Once the system has been accepted by NJDOT and the project closed-out, this will mark the beginning of the contractor's warranty period. The Contractor shall always be responsible to provide as-built system drawings and all required operations and maintenance manuals and spares prior to project close-out. The designer and contractor shall turn-over all data circuit and ISP records to ensure service provider networks are turned on to NJ DOT ITS Maintenance and Operations staff. The Contractor must ensure that the ISP must transition services to NJDOT without downtime seamlessly.

The construction documents prepared by the designer shall include the project testing and Acceptance processes and procedures. The designer shall be available to witness testing and assist NJDOT bring the system into operation.

Testing will generally be organized under the standard categories of:

- Factory Acceptance Tests
- Proof of Performance Testing - for which the Communications Networks shall include at a minimum the following proof of:
 - Link availability
 - Adequate bandwidth
 - Maximum latency which meets the needs of the most critical application being carried by that network.
- System Integration Testing
- Operational Readiness Testing
- Burn-In

D.2.4.1. Physical System Architectural Review

For Non-Programmatic projects, reaching the system testing phase indicates that the system is ready for the Physical System Architectural Review (PSAR). Attended by the NJDOT business sponsor, technical subject matter experts from NJDOT, Business and Technical Project Managers and the Architecture Review team that includes representatives from Network, Security, Data Services, Infrastructure, Architecture, GIS, and Business Continuity; the PSAR is the checkpoint to confirm that the Architecture, Engineering, and Construction layers have been successfully planned and all areas are in agreement with regard to the physical design prior to the system being turned over to operations.

D.2.4.2. Implementation Review

For Non-Programmatic projects, no less than two weeks before the initiative is moved into production status, an Implementation Review (IR) shall be submitted by NJDOT to OIT.

The IR is an online review that confirms and certifies that all necessary development and implementation requirements have been satisfied and all outstanding action items from previous reviews have been successfully resolved and the system is ready to be deployed to production. This review occurs no less than two weeks before the scheduled production date. Review participants are the NJDOT business sponsor, technical subject matter experts from NJDOT, Business and Technical Project Managers and the Architecture Review team that includes representatives from Network, Security, Data Services, Infrastructure, Architecture, GIS, and Business Continuity.

D.2.5. Integration of Devices into Operations Software

When new ITS devices are integrated, decommissioned, or modified, the systems used by Traffic Operations will need to be updated to account for the change. Statewide ITS Maintenance is responsible (along with the Contractor, if so tasked) for making these updates.

The specific changes are outlined in the sections corresponding to the particular ITS device being altered, and may include a subset of the following:

- Building connections between vendor software and other systems
- Incorporating new cameras into an existing touring sequence, or defining a new touring sequence
- Upgrading operator software to accommodate newer features (for instance, color DMS)
- Program device passwords into operators software

All DMS and TTS are to be integrated in to the current operating systems at STMC, TOC-S, and the AMC. TTS shall also be integrated, by the contractor, with TRANSCOM, with coordination done during Final Design Stage.

All CSS statewide are to be integrated into existing camera operating systems.


Maintenance upgrades or replacements could be reflected in a number of ways, depending on the actual scenario. An in-kind replacement of a faulty device may require only a device's Serial Number to be updated. An upgrade of a faulty, out-of-production device may introduce new functionality which is best handled by following a device Additions/Removals process.

D.2.6. ITS Device Security Management

Some security measures are required while others are recommended. Consult the DOT IT Security Unit for project specific requirements.

D.2.6.1. Critical Security Controls

Use the Critical Security Controls (CSC) as a guideline and for best practice whenever applicable to mitigate risk exposure. The following controls should be given special emphasis when designing for ITS control systems, in particularly for non-programmatic devices and system upgrades:

EXTERNAL REFERENCE:		<p>Critical Security Controls (CSC)</p> <p>https://www.sans.org/critical-security-controls</p>
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D.2.6.1.1. CSC 3-1

Establish and ensure the use of standard secure configurations of your operating systems. Standardized images should represent hardened versions of the underlying operating system and the applications installed on the system. Hardening typically includes: removal of unnecessary accounts (including service accounts), disabling or removal of unnecessary services, configuring non-executable stacks and heaps, applying patches, closing open and unused network ports, implementing intrusion detection systems and/or intrusion prevention systems, and use of host-based firewalls. These images should be validated and refreshed on a regular basis to update their security configuration in light of recent vulnerabilities and attack vectors.

D.2.6.1.2. CSC 3-3

Limit administrative privileges to very few users who have both the knowledge necessary to administer the operating system and a business need to modify the configuration of the underlying operating system. This will help prevent installation of unauthorized software and other abuses of administrator privileges.

D.2.6.1.3. CSC 3-4

Follow strict configuration management, building a secure image that is used to build all new systems that are deployed in the enterprise. Any existing system that becomes compromised should be re-imaged with the secure build. Regular updates or exceptions to this image should be integrated into the organization's change management processes. Images should be created for workstations, servers, and other system types used by the organization.

D.2.6.1.4. CSC 3-6

Negotiate contracts to buy systems configured securely out of the box using standardized images, which should be devised to avoid extraneous software that would increase their attack surface and susceptibility to vulnerabilities.

D.2.6.1.5. CSC 3-7

Do all remote administration of servers, workstation, network devices, and similar equipment over secure channels. Protocols such as telnet (port 22), VNC, RDP, or others that do not actively support strong encryption should only be used if they are performed over a secondary encryption channel, such as SSL or IPSEC.

D.2.6.1.6. CSC 6-1

For all acquired application software, check that the version you are using is still supported by the vendor. If not, update to the most current version and install all relevant patches and vendor security recommendations.

D.2.6.1.7. CSC 11-1

Ensure that only ports, protocols, and services with validated business needs are running on each system.

- The prudent approach to take when implementing port security on any device is to block all ports and only enable/open each service/port required for the device to function correctly.
- Modifying default ports for services operating should be performed when applicable to mask the service operating but should always be documented for reference.
- All enabled/open services and ports should be documented and stored in a secure location for reference throughout the lifecycle of the device.

In Addition: Device services and associated default ports which should not be allowed to operate on DOT / vendor equipment, unless additional OIT or DOT IT Security Unit's approved security measures are in place:

- TCP Port 20 and 21 – File Transfer Protocol (FTP)
 - Secure FTP, which runs by default on port 22, is a solution that is allowed in lieu of FTP. The Office of Information Technology (OIT) offers a Secure FTP solution for person to person use. Please inquire with DOT IT Security Unit for more information.
- TCP Port 23 – Telnet
 - Used to remotely connect and configure a device. Highly insecure due to the communication being sent and received in clear text (not encrypted) and easily read by anyone monitoring the communications between devices.
 - TCP Port 22 - Secure Shell (SSH) should be used in lieu of Telnet
- TCP Port 69 – Trivial File Transfer Protocol (TFTP)
- TCP Port 80 or 8080 (HTTP) should be depreciated in lieu of TCP port 443 (HTTPS)
 - TCP Port 443 (HTTPS) should be used in lieu of HTTP whenever possible and the latest version of the web server application is strongly recommended. The use of industry standard security protocols should be used for configuration and hardening the web server and proper implementation of X.509 certificates practices should be followed, with the specific use of Transport Security Layer (TLS) any version as a primary means to secure the server communication and SSL version 3.0 whenever TLS is not available. SSL versions 2.0 and 1.0 are not acceptable and deemed thoroughly vulnerable and insecure. (As of Sept 16, 2015)
 - Current Industry Standards should be used in every aspect of configuration and maintenance for HTTPS and supported secure communications with the web server. The following link is to be used as a reference but should not be utilized as the de facto standard for deployment of the above mentioned systems: <https://www.ssllabs.com/projects/best-practices/index.html>

- TCP Port 161 (SNMP) should be disabled when not on the Garden State Network and protected by firewalls.

D.2.6.1.8. CSC 11-2

Apply host-based firewalls or port filtering tools on end systems, with a default-deny rule that drops all traffic except those services and ports that are explicitly allowed.

D.2.6.1.9. CSC 12-3

Configure all administrative passwords to be complex and contain letters, numbers, and special characters intermixed, and with no dictionary words present in the password. Pass phrases containing multiple dictionary words, along with special characters, are acceptable if they are of a reasonable length.

D.2.6.1.10. CSC 12-4

Before deploying any new devices in a networked environment, change all default passwords for applications, operating systems, routers, firewalls, wireless access points, and other systems to have values consistent with administration-level accounts.

D.2.6.1.11. CSC 13-1 (Partial)

Deny communications with (or limit data flow to) known malicious IP addresses (black lists), or limit access only to trusted sites (whitelists).

- External devices that do not reside in the Garden State Network (GSN) should be configured with a whitelist IP range that will be provided by the DOT IT Security Unit.

D.2.6.1.12. CSC 13-7 (If applicable)

Require all remote login access (including VPN, dial-up, and other forms of access that allow login to internal systems) to use two-factor authentication.

D.2.6.1.13. CSC 16-16

Configure all systems to use encrypted channels for the transmission of passwords over a network.

D.2.6.1.14. CSC 17-7

Move data between networks using secure, authenticated, and encrypted mechanisms.

- FTP - TCP Port 21-22 is not a service and port that provides any security.
- Secure FTP is a service that can be used in lieu of FTP.

The securing of an infrastructure and all related devices cannot be comprehensively covered by SANS Critical Security Controls, with a special emphasis with the above precautions and best practices. Questions or inquiries pertaining to the Critical Security Controls or other related security measures can be emailed to DOT's IT Security Unit at DOT-IT.Security@dot.nj.gov.

D.2.6.2. ITS Devices Hosting Webpages

If a device hosts webpages, modify all device landing/splash pages to not display any device information/company logo. The landing/splash page should display a disclaimer statement for legal purposes deterring malicious/unauthorized use or otherwise face possible prosecution.

D.3. Operations

D.3.1. Role of Traffic Operations during Construction

In active construction zones, Traffic Operations must monitor conditions and activate devices in order to best allow safe and free flow of traffic. In this regard, Traffic Operations has certain obligations to support ongoing construction process, which include:

- Assist MSE with the integration of new ITS devices into existing head-end systems to ensure proper functionality.
- Use the tools at its disposal to monitor and safely direct traffic through or around construction areas.
- On a case-by-case and based on contract terms, use and control devices that have been installed but not yet turned over to the Department for the purpose of gathering or disseminating traffic-related information.
- Monitor the overall functionality of ITS devices once they are placed on the Network, will maintain a “burn-in period” log, and will coordinate malfunctions with the contract Resident Engineer.
- Operate the Real-Time Work Zone Traffic Systems as defined in Section C.6.

D.3.2. Interim Use of New Devices

During the construction phase, Traffic Operations has the ability to use newly-installed devices to monitor traffic conditions and display messages to the public. However, if these devices have not yet been formally accepted by NJDOT, the contractor also has the right to operate them for approved testing-purposes. In the event of a conflict, Traffic Operations will need to coordinate operation of these devices with the Resident Engineer.

Traffic Operations shall use these devices, and/or nearby devices, in such a manner to support the construction. This may include a different touring sequence of cameras or display of caution or advisory messages on a DMS.

If Traffic Operations requires a message to be changed on a PVMS or a portable camera to be moved, the RE should be contacted.

D.3.3. Lane Closure Requests

Anticipated lane closures during construction will be coordinated in advance with Mobility Management-Work Zone Management to identify allowable times for lane-closures due to contractor activity.

When Traffic Operations receives a Lane Closure Request (LCR), they will first check to see if the request has already been approved by Work Zone Management. If so, the request will be processed. If it has not, Traffic Operations will need to evaluate the request and either approve or deny the request, notifying Work Zone Management of the determination, before advancing to the next step.

Once an LCR is approved, Traffic Operations will enter it into OpenReach. When the lane closure is in effect, DMSs or PVMSs, if available, will be used to communicate this information to motorists. 511NJ may also be used (refer to Sections D.4 and E.3 of this manual covering 511NJ).

Traffic Operations will coordinate the actual times of the lane closures with the Resident Engineer so that information is communicated effectively, as they may differ from the request. In addition, Traffic Operations may spot-check some of the lane closures, in particular looking for:

- Lane closures that may be within view of a CSS
- Lane closures with a DMS upstream
- Lane closures that may cause severe congestion or delays

If the lane closure is not within view of a camera but there is a DMS leading to the closure, the operator should call the Resident Engineer (primary contact on the Lane Closure Request) to confirm that work is ongoing. The operator should also check other traffic detection and INRIX data to gauge the traffic flow through the area.

D.3.4. Integration of New Devices

During construction, the contractor may need to request, via the Resident Engineer, the required downtime as allowable and specified in the special provisions on existing systems in order to integrate new work. The outage is scheduled and implemented with collaboration from Traffic Operations, MSE, Mobility Management, and the contractor. Ultimately, Traffic Operations will determine the allowable maintenance window, will schedule the downtime, and will notify all affected.

D.3.5. Assistance toward Final Device Acceptance

After new ITS devices are installed and prior to formal acceptance, the device must be active for a specified period of time (“burn-in”) in which it operates continuously without errors. Traffic Operations is responsible for maintaining this Error Log, which is a prerequisite to final acceptance.

Traffic Operations will be called upon to assist Statewide ITS Maintenance units during the integration and final acceptance testing of new devices.

D.4. 511NJ

Any new permanent or Temporary Work Zone ITS device(s) (with the exception of RWIS, WIMS, and VSLs) that will be in place for six months or more must be integrated into 511NJ. Information about each new ITS device must be documented on the ITS Systems Device Integration Form. This form can be found in Appendix H.13.

If the proposed ITS devices are permanent, the project manager or Resident Engineer (RE) must complete the ITS Systems Device Integration Form after the devices have successfully passed Level C testing. This form should be submitted to the 511NJ Coordinator.

If proposed devices are temporary and being used for portable work zones, the form should be sent in after the RE accepts the Work Zone ITS System and the system is in operation.

D.5. Post Construction Inspection

There may be reasons why the Department can't accept an ITS device/system after the successful completion of Level C testing and a satisfactory burn-in period. For instance, during a particular stage of construction, a camera may have been installed, tested and brought on line. However, since other work in the area is incomplete and the maintenance forces cannot get access to the location, then the Department might decide not to accept the camera until a later date. The contractor is typically responsible to maintain operability of all systems until acceptance, including regular system checks when in operation for longer than six months. This requirement is similar to traffic signal inspections that the DOT requires every 2 months from the time they are activated until acceptance. Similar to the resource available for construction inspection, go to the “Preventive Maintenance” and “Troubleshooting” sections in the ITSIMM reference manual in Appendix H.16 for guidelines that the contractor should follow.





D.5.1. Preparation for Substantial Completion/Acceptance/Close out

Prior to a project being considered for Substantial Completion, the following is required: (NOTE: Nothing stated here is meant to supersede any direction found in Section VII of the CPH)

- Satisfactory completion of Level C testing for the various non-CTSS devices.

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- For CTSS/Adaptive projects, the testing of the system, in accordance with the Verification and Validation Plans of the Systems Engineering Analysis and incorporated as Attachments to the , Special Provisions and the successful completion of the Deployment Testing, Subsystem testing, and System Integration Testing as per the Department’s testing procedure and forms shall initiate System Acceptance. (Refer to CTSS Adaptive Testing Forms in Appendix H.28 for CTSS projects)
- Submission of red-lined as-built drawings (typically prepared by the ITS Inspector),
- As-Built Inventory Report, completed by the contractor and submitted to MSE and the respective Statewide ITS Maintenance office for each of the devices installed.
- The contractor must provide at least a 2 Year Manufacturer Warranty (2 years from the date of acceptance or substantial completion, whichever is later) for each ITS device/component purchased and installed on the project. Examples: Ethernet switch, router, encoder, modem, DMS sign, Camera etc. The warranty requirement for the CTSS devices such as Image Detectors, System Detectors, Controllers, external Adaptive Devices, etc., should be provided as laid out in the Special Provisions for the specific project.
- When a new or existing fiber optic cable is utilized, submit splice machine, OTDR and power meter readings. Upon review and approval by the ITS designer, submit one electronic copy of all required final documentation listed in the specs to Bureau of MSE and one copy to the respective Statewide ITS Maintenance office.

TSM REFERENCE:	 As-built Inventory Report http://www.nj.gov/transportation/eng/elec/ITS/asbuilt.shtm
TSM REFERENCE:	 Project Completion and Acceptance – Construction Procedures Handbook http://www.nj.gov/transportation/eng/construction/pdf/Sec7SubSecA.pdf
TSM REFERENCE:	 Project Close-out Workbook – Construction Procedures Handbook http://www.nj.gov/transportation/eng/construction/pdf/Sec7SubSecB.pdf
TSM REFERENCE:	 DC-155 – Project Close-out Workbook http://www.nj.gov/transportation/eng/forms/zip/dc155.zip

D.5.1.1. MSE Devices

In addition to Substantial Completion preparation requirements, the following is needed prior to close out the ITS portion of the project. It is also recommended to hold a post construction meeting (ITS post construction meeting for CPM projects), with similar attendees as that of the preconstruction meeting, to discuss these issues.

- Satisfactory completion of all levels of required testing for each device.
- Transfer of power and communication services, without disruption to the ITS systems, are permitted once Level C testing has been completed and the device has been accepted by MM. Billing with account numbers and the appropriate transfer forms must accompany the request by the contractor through the RE's office to MSE.
- As-Built drawings must include I.P. / Port / Gateway and Subnet Mask assignment information for all ITS devices. A copy of the As-Built must be sent to MSE and to the respective TOC office at the completion of the project. (The Integrator is responsible for this action. It would be a good idea to have him/her submit a sample as-built for review by the Department.)
- Corrective Action work is completed subsequent to inspection by the respective Statewide ITS Maintenance office. Common deficiencies that are noted during these inspections are listed below.
 - Improper or lack of equipment labeling in junction boxes and cabinets
 - Continuous trace wire not installed

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- RMC not grounded
- Conduits not sealed
- Fiber incorrectly hung on hangars
- Fiber not tagged correctly in junction boxes and cabinets
- Trace wire missing
- IP information not transmitted to MM/IT
- Configuration information for IT devices needs to be saved to a disk and turned over to MM/IT
- Manuals not placed in cabinets
- Warranties not turned over
- As-Builts/Block Diagrams not submitted.
- JB lids not bolted down
- Pull string/tape not installed in all conduits
- If provided for in the specifications, the RE should coordinate ITS equipment training with the contractor and the respective Statewide ITS Maintenance office.
- The RE should coordinate the transfer of all applicable ITS device manuals to the Regional TOC.

D.5.1.2. Non-MSE Devices

Note: The above instructions are specific to Transportation Systems Management ITS facilities, and contain general information applicable to other ITS facilities managed by other units within the Department. When those facilities are included in a project, the applicable units need to be contacted. Below is helpful information for a few of those facilities;

- **WIMS and TVS:** Bureau of Transportation Data and Safety (BTDS). As noted previously, they should be invited to the ITS Preconstruction meeting. The manufacturer must be present during installation and BTDS requires 72 hour notification in advance of proposed installation. For Department acceptance, two weeks of data, in parallel to Level C testing, is analyzed. Providing that the two week data is in line with expectations and the as-built layout is physically inside the cabinet, the unit will get accepted. A warranty, as explained in the Special Provisions, will be required.
- **RWIS:** Bureau of Maintenance Engineering (BMS). All aspects of the construction inspection, testing and acceptance are handled by the vendor's technician. Still, BMS should be invited to the ITS Preconstruction meeting.
- **Homeland Security Cameras:** Office of Emergency Management: 609-530-2717. They deal directly with MSE and have no procedure regarding their equipment.

Coordination may also be required with other agencies sharing our fiber network. Some of the agencies are: OIT, NJTA, and SJTA. Any information regarding these relationships, specifically that which has the potential to impact the construction schedule, has to be communicated as early as possible to the RE by MSE.

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E.1. Intelligent Transportation Systems (ITS)

E.1.1. Role of Statewide ITS Maintenance

During the Operations and Maintenance phase of the ITS lifecycle, the maintenance of ITS assets is the responsibility of the Statewide ITS Maintenance unit.

E.1.1.1. Detection of malfunctioning device

Device malfunctions are tracked via Work Orders in the ITS Readiness Database. On a daily basis, Traffic Operations tests all ITS devices statewide via a process described in Section E.1.2.1, culminating in Work Orders being generated for those which are non-functional. Statewide ITS Maintenance may also generate Work Orders for other malfunctions that are encountered outside of Traffic Operations' daily ITS checks.

Upon receipt of a Work Order, Statewide ITS Maintenance will:

- Check to see if the malfunction duplicates an existing open Work Order with a repair "in progress" (for example, awaiting delivery of a component) or if it is the result of another known problem (such as a fiber break or commercial power failure).
- Check to see if the malfunctioning device is a new installation that is still under the responsibility of a contractor (flagged as "Construction" in the ITS database. If so, Statewide ITS Maintenance notifies the Resident Engineer (RE) of the problem, and the RE instructs the contractor to make the necessary repair.
- Check to see if the malfunctioning device is covered by a manufacturer's or contractor's warranty. If so, the necessary entity is contacted to initiate repair proceedings.
- Visit the device location to diagnose the problem. If the resolution is a "quick fix" (such as resetting a tripped circuit breaker), the repair is performed immediately, is documented, and the work order is closed.
- If the repair will take additional time, effort, manpower, or materials, arrangements are made to proceed with the repair at a later time.

Statewide ITS Maintenance's role begins with the receipt of Work Orders issued by Traffic Operations and ends with the closure of Work Orders by Statewide ITS Maintenance. Statewide ITS Maintenance may also create and issue Work Orders to themselves as the need arises.

E.1.1.2. Response time

Mobility Management attempts to perform a field visit to all non-functional devices within 48 hours of the reported outage, but preferably within 24 hours. If failure of a particular component of the device is reported but the device remains operational due to built-in redundancy, the site should be visited when time permits, but the 48-hour constraint does not apply.

E.1.1.3. Emergency outage

A major equipment failure impacting NJDOT's ITS equipment is considered an Emergency outage and must be addressed immediately.

Refer to Operations Bulletin 2.002 for examples of an Emergency outage and the appropriate response to such outages.

E.1.1.4. Maintenance of Deployed assets, no longer used

Over time, devices will reach the end of their operational as well as their functional life. As older devices become phased-out of operation (i.e. they no longer meet the functional needs of MSE), maintenance on these devices is discontinued.

The devices are not physically removed unless they physically pose a particular hazard or if they present a continuous, ongoing demand on power or communications resources. In the latter case, they may be simply disconnected but allowed to remain in place.

Actual removal of obsolete devices may be performed as part of an ITS Maintenance Contract or another contract in the vicinity, if warranted. The removed devices and parts are brought to a specified MMN or MMS warehouse facility, where Statewide ITS Maintenance personnel identify components to be salvaged for use during maintenance of ITS devices elsewhere in the State. Any components that Statewide ITS Maintenance chooses not to retain become the property of the contractor and are removed from NJDOT property.

E.1.1.5. Maintenance of Deployed assets, no longer manufactured


Some devices continue to be used even after new parts are no longer available. Statewide ITS Maintenance shall make their best attempt to repair these items, as needed, which may include re-use of salvaged parts from other installations. Statewide ITS Maintenance also should keep a record of the effort required to continue maintenance of the system, as it may lead to justification for a full system replacement.

E.1.1.6. Preventive maintenance

The goal of NJDOT is to perform preventive maintenance on all ITS infrastructure in accordance with the manufacturer’s recommendations. Although reactive maintenance to malfunctioning devices is always the priority, an effort should be made to proactively keep devices in good working order so that malfunctions do not occur with great frequency.

NJDOT funded a study by Rutgers University to develop a manual to guide the installation, acceptance, and maintenance of ITS devices. Although the Intelligent Transportation Systems Inspection and Maintenance Manual (ITSIMM) has not been formally adopted by NJDOT, the manual includes recommended Preventive Maintenance measures. ITSIMM can be found in Appendix H.16 of this manual.

In addition to maintenance on existing infrastructure, a replacement cycle should be developed that will provide for the replacement of hardware, software, firmware, and network infrastructure to minimize failures that could occur due to physical deterioration or obsolescence following the end of the equipment’s useful, functional life. No such cycle exists at this time; however a recommended cycle is provided within the NJDOT ITS Investment Strategy, 10 Year Program, FY07-16.

TSM REFERENCE:		NJDOT ITS Investment Strategy, 10 Year Program, FY07-16 http://www.nj.gov/transportation/eng/elec/ITS/pdf/10yearplan.pdf
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E.1.1.7. Repair procedures

NJDOT funded a study by Rutgers University to develop a manual to guide the installation, acceptance, and maintenance of ITS devices. Although the Intelligent Transportation Systems Inspection and Maintenance Manual (ITSIMM) has not been formally adopted by NJDOT, it is a valuable resource in providing checklists, suggestions, and methods towards the troubleshooting and maintenance of ITS devices.

ITSIMM can be found in Appendix H.16 of this manual.

E.1.1.8. Incident responses

If an ITS device is knocked down and presents a hazard to the public, Statewide ITS Maintenance may be notified either by Traffic Operations or by Central Dispatch Unit (CDU). In addition, and depending on the severity and nature of the incident, CDU may also contact the Incident Management Response Team (IMRT) to secure the area and restore safe conditions.

When Statewide ITS Maintenance is called, they must cooperate with other units in removal of hazards and to restore operation to the damaged ITS device. If no other units are on-site, it is MM's responsibility to restore safe conditions.

Since this type of incident may have caused damage that requires replacement of a device or structure with a substantial lead-time, Statewide ITS Maintenance should make an effort to visit the site as soon as possible to determine what is needed to restore operation to the damaged device.

E.1.1.9. Chronic faults

This section addresses devices which experience a higher-than-expected rate of failures and repairs.

E.1.1.9.1. Individual installations

The "burn-in" period following Level C testing is used to identify devices that fail to perform reliably. However, all devices with chronic faults may not be detected during this period.

Following installation of equipment and prior to Level C testing, Statewide ITS Maintenance should maintain a log of failures that are detected and repaired by the contractor. If repairs are excessive, Statewide ITS Maintenance shall notify the Resident Engineer that the device will not be accepted and should be replaced.

During the warranty period following the burn-in period, MM should be aware of the number of in-warranty repair calls that are made on a particular device. If this becomes excessive, Statewide ITS Maintenance should request from the manufacturer or integrator that the device be replaced.

Following the warranty period, Statewide ITS Maintenance should continue to be aware of devices that continually malfunction and should attempt to identify a root-cause, or consider the device for replacement.

E.1.1.9.2. Similar devices at multiple installations

When chronic failures of identical or similar products occur at multiple locations, these should be brought to the attention of ITS Engineering promptly. Such patterns may indicate poor design or poor assembly by the device manufacturer, and may affect the use of such devices in future contracts.

E.1.1.10. Replacement of parts

At times, parts may malfunction to the point that they are beyond repair and need replacement. However, due to the evolution of products as well as MSE's preference for certain products over others, the replacement products will not necessarily be "in-kind"; rather the replacement may be a newer model, a different manufacturer's product, one with a better performance history, or one that is immediately available.

For replacement due to maintenance issues, Statewide ITS Maintenance is not required to use items that are included in the ITS Qualified Product List (QPL). Replacement of components as part of a planned, contracted program is limited to items listed in the QPL.

For additional information about the QPL, refer to sections C.7.3.1 and D.1.2.

E.1.1.11. Maintenance of Traffic Operations facilities

Maintenance of the video wall at STMC is handled by the New Jersey Turnpike Authority. Equipment at STMC that is exclusively used by NJDOT, as well as all equipment at TOC-S is maintained by the Office of Information Technology (OIT).

E.1.1.12. Purchasing

Statewide ITS Maintenance has a limited annual funds allocation for purchasing supplies for ITS maintenance.

In order to purchase equipment, one must obtain three quotes from varying vendors prior to making a purchase. If the item being purchased is covered under a Treasury Contract, the price has already been negotiated and therefore there is no requirement to obtain additional quotes.

If the equipment is eligible for federal funding, the quotes (or Treasury Contract cost, if applicable) must be submitted, along with justification, to the FHWA New Jersey Division Office for preliminary approval. Only if the preliminary submission is accepted may the formal process begin for obtaining federal authorization. If FHWA will not cover the costs and Statewide ITS Maintenance still wishes to obtain the equipment, then State funding must be pursued.

The quote will need to either be verbal or written, depending on the item’s cost and the current NJDOT policy. Procurement is done through the Automated Procurement Requisition Workflow System (APRWS) process. Because quotes generally are valid for only 30 to 60 days, the effort to obtain approvals for purchases should be completed within an appropriate timeframe.


For State-funded purchases, if the item is covered under a Treasury Contract, then Statewide ITS Maintenance may proceed with ordering the item. If not, three quotes from different vendors must be obtained prior to making a purchase. Purchases made outside of a Treasury Contract are subject to a dollar-amount ceiling which applies per vendor, per year.

A Treasury Contract would be used if the value of equipment desired exceeds Statewide ITS Maintenance’s allocation and is within NJDOT’s budget. This contract would be awarded via a typical advertise-bid process.

Purchases are processed using the Automated Procurement Requisition Workflow System (APRWS).

E.1.1.13. Lane Closure Requests

If a lane closure or shoulder closure is needed in order to perform the work, Statewide ITS Maintenance must submit form TO-101, Lane Closure Request (LCR) to Traffic Operations ahead of the planned activity. Additionally, the actual lane-closure should be coordinated by telephone, in real-time, with Traffic Operations. This will facilitate putting the necessary prerequisites into place, which including notification of road work to motorists, and also provides Traffic Operations with an explanation of any resultant traffic impacts that may occur. In emergency situations where submission of an LCR is not practical, Statewide ITS Maintenance should maintain direct telephone contact with Traffic Operations.

<p>TSM REFERENCE:</p>		<p>Form TO101 – Daily Lane and Closure Request http://www.nj.gov/transportation/eng/forms/docs/statewide/to101.rtf</p>
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The responsibilities of Traffic Operations with regard to Lane Closure Requests are detailed in Section E.1.2.2.

E.1.1.14. Deployment of portable devices

Deployment of portable devices (PVMS, PVMSRC, and PTMCCA) by Statewide ITS Maintenance is performed solely under direction from Traffic Operations. The reasons for deployment of portable devices may be in response to damaged permanent devices, unplanned or planned incidents, work zone management, or other activities.



E.1.1.15. Safety

While working on or adjacent to roadways, maintenance personnel must comply with PEOSHA and NJDOT regulations to ensure they perform their work safely. The NJDOT Safety Manual, available on the NJDOT Intranet, describes these requirements and procedures.

Additionally, the Work Zone Safety Set-up Guide contains instructions on controlling traffic through work zones, which must be set up and coordinated with Traffic Operations prior to beginning work.

As of the writing of this manual, the 2011 Work Zone Safety Set-up Guide is the current and effective version. As this version is not hosted on the NJDOT website, the Department cannot ensure the content provided at the reference hyperlink is correct. Readers should ensure that the correct and most recent version of the Guide is used. If the link to the 2011 Guide is found to be non-functioning, please notify MSE as per Section A.2.2.3.

Although not the prevailing version, a link to the 2005 Work Zone Safety Set-up guide is provided for convenience.

<p>NJDOT REFERENCE:</p>		<p>NJDOT 2005 Work Zone Safety Set-up Guide http://www.nj.gov/transportation/publicat/pdf/WorkZoneSafetySetupGuide.pdf</p>
<p>EXTERNAL REFERENCE:</p>		<p>NJDOT 2011 Work Zone Safety Set-up Guide http://cait.rutgers.edu/system/files/u11/WZ_Guide_2011_revised.pdf</p>

E.1.1.16. Use of third-party Contractors

Certain maintenance tasks may be performed by third parties by use of ITS Maintenance Contracts.

Traditional ITS Maintenance Contracts are used to supplement Statewide ITS Maintenance's efforts on specific tasks that are finite in scope and quantity and are generally not time-sensitive.

Beginning in 2016, Statewide ITS Maintenance will phase-in use of Job Order Contracts. Job Order Contracts allow the Department to outsource specific types of maintenance tasks, selected from a "menu" that contains previously-determined work at previously-agreed upon rates.

For both traditional ITS Maintenance Contracts and Job Order Contracts, the contractors will be responsible for providing their own safety and support if and when required. This includes maintenance and protection of traffic as well as protection for workers. The Department will not deploy its own resources to assist in a contractor's maintenance activities.

For details on the administration of ITS Maintenance Contracts and Job Order Contracts, refer to Section G.4.

E.1.2. Role of Traffic Operations

Traffic Operations plays an integral role in the management of ITS assets. This section serves to define these obligations and reactions to various scenarios. Note that this document is limited to that which involves ITS, and does not constitute a full Concept of Operations for the organization.

E.1.2.1. ITS Device Functionality Checks

Every morning, on a daily basis, Traffic Operations will conduct a series of functionality checks on every ITS device statewide. This includes (but is not limited to), posting and verifying test-messages on DMSs and verifying the visibility (and pan-tilt-zoom functionality, if so equipped) of CSS images.

Malfunctioning equipment is marked as such in the ITS Readiness Checklist. The checklist is then routed through a series of reviews and approvals, culminating in the generation of a Work Order for each malfunction. Statewide ITS Maintenance then responds to and acts upon each malfunction.

The Readiness Database and Work Order Process is documented in a draft version of an Operations Bulletin titled “Daily ITS Readiness Checks”, which can be obtained from MSE.



If Traffic Operations detects a device malfunction outside of the morning Daily Readiness Checks, they can generate and issue a Work Order directly to Statewide ITS Maintenance.

E.1.2.2. Assisting Maintenance

It is essential to ensure cooperation occurs between Traffic Operations and Statewide ITS Maintenance. When maintenance is being performed on an ITS device on-site, assistance by Traffic Operations is required to verify remote connectivity and operability of these devices. For instance, during the repair of a camera, Statewide ITS Maintenance will rely on Traffic Operations to report if a camera image is visible at STMC or TOC-S before a repair can be considered complete and a Work Order can be closed.

In addition, if a lane closure or shoulder closure is needed in order to perform the work, Traffic Operations will need to be advised via a previously-submitted Lane Closure Request, but also by telephone in real-time. This will facilitate putting the necessary prerequisites into place, which including notification of road work to motorists, and also provides Traffic Operations with an explanation of any resultant traffic impacts that may occur.

For CTSS systems, the Arterial Management staff coordinates with Electrical Maintenance. AAM staff will implement remote timing changes with Electrical Maintenance staff in the field and/or Arterial Management Center. AAM staff coordinates with the applicable Electrical Maintenance supervisor. Adjustments to CTSS/Adaptive software settings such as changes to degree of saturation, etc. can be completed by AAM staff within the limits of the CTSS/Adaptive Timing Directive.

TSM REFERENCE:		Form TO100 – Weekly Closure Request http://www.nj.gov/transportation/eng/forms/docs/statewide/to100.rtf
		Form TO101 – Daily Lane and Closure Request http://www.nj.gov/transportation/eng/forms/docs/statewide/to101.rtf

The role of Statewide ITS Maintenance regarding Lane Closures is described in Section E.1.1.13.

E.1.2.3. Operation of ITS Devices

Operations bears the ultimate responsibility for operating the ITS devices in an appropriate manner. These operations may be according to a prescribed schedule (posting safety messages on DMSs, monitoring traffic near a sporting event) or reactionary (in response to a traffic incident or roadway condition).

Additional details on the operations of ITS devices are covered in the following Operations Bulletins:

- OB 1.002 - NJDOT's Video Camera Operations Policy
- OB 1.004 - AMBER and Silver Alert Procedure
- OB 5.002 - Fog Advisories on Dynamic Message Signs
- OB 5.003 - Transit Delays Advisory on Dynamic Message Signs
- OB 5.006 - PATH Train Delays on Dynamic Message Signs

E.1.2.4. Interagency Coordination

Coordination between NJDOT, the New Jersey Turnpike Authority, and the State Police occurs quite easily due to their co-location at STMC. Coordination with other agencies (such as, but not limited to, the South Jersey Transportation Authority, adjacent state DOTs, authorities, and commissions) is often done by telephone, particularly when making a request to utilize assets for a particular purpose such as posting a message on a DMS. Additionally, TRANSCOM is used as an information conduit through New Jersey, New York, Pennsylvania, and Connecticut and may be used to provide notifications.

More information on TRANSCOM is available in Section B.2.2.

A training course for operators at the Traffic Operations Centers was produced by VHB, Inc. The documentation from this course is included in Appendix H.17.

E.1.3. ITS Device Password Management

Most vendor-equipment arrives from the factory with a default login/password method of controlling access to the device. Before deploying equipment into the field, the contractor must remove the default login/password. MSE shall provide the contractor with specific log-in credentials to be used in the device, which will permit connectivity with the Traffic Operations centers and will lock-out unauthorized users. In order to keep out unauthorized users, the device's default passwords shall not be retained. Once the contract is closed and the device is turned over to NJDOT, Statewide ITS Maintenance should change the login credentials again.

Throughout the Operations state of the device, the Statewide ITS Maintenance Unit will be responsible for maintaining the passwords on all devices deployed in the field. When a password is changed, they shall coordinate with the MSE Engineers who will reflect the change in the head-end systems at the Traffic Operations centers. Since the passwords are programmed into the head-end, Operators do not have a need to know them.

E.2. Network

E.2.1. IT/OIT Coordination

As more and more devices become IP-based, communications with these devices relies on the network operated and maintained by the New Jersey Office of Information Technology (OIT) or the DOT's own Information Technology (IT) divisions. Refer to the Networking Sections C.5 and D.3 for more information.

Historically, the delineation between IT/OIT and Statewide ITS Maintenance was dependent on the type of data stream. Statewide ITS Maintenance would maintain all serial interfaces and devices while IT/OIT would

maintain the IP infrastructure. Equipment from the Terminal Servers through, and including, the end devices would fall under Statewide ITS Maintenance responsibility.

However, as newer devices utilize IP directly to the end device, the physical delineation has become less obvious. Currently, IT/OIT still maintains sole responsibility for the assignment of all IP addresses and of the core network, but Statewide ITS Maintenance maintains field-equipment that use serial communications. Devices such as Fiber Optic modems, hubs, and non-Cisco equipment are maintained by SIM.

Breaks in Fiber Optic Cable are repaired by SIM. However, since critical data is carried over these cables and re-routing may be in place, these repairs are always performed under close coordination with IT/OIT. Because of the increased interdependence of Statewide ITS Maintenance with IT/OIT, the coordination and defined procedures between these two entities needs further development. The objectives in formalizing this relationship include:

- Clear documentation of a delineation of responsibility of equipment
- Development of mutual service-level agreements (time-to-repair)
- A procedure and contact-list for real-time troubleshooting and resolution of problems
- Method to catalog all systems running on a fiber optic cable, in order to prioritize repairs
- Establishment of a Trouble-ticket/Work-order system to keep track of outstanding repairs
- Documentation of a "Call-out sheet", identifying who to call in various scenarios

Coordination between Statewide ITS Maintenance and OIT is done via the CA Service Desk. If Statewide ITS Maintenance cannot resolve a problem on its own, they should reach out to this Service Desk.

For CTSS projects The Designer provides OIT notification of projects details commensurate to the level of design detail for the following milestones of the Design Process:

- Notice to Proceed – This high-level notification shall include the number of traffic signals and the corridor location and project limits.
- Final Design Submission – This notification shall include any updated or revised information since the first notification.
- Plans, Specifications, and Estimate Submission – This notification shall include server information, a network diagram, the template (Plan Sheet) for IP address assignment, and the number of devices

Notifications are transmitted to the OIT Manager via email. Notifications are drafted by the designer and sent to OIT by the MSE Project Manager.

E.2.2. CTSS Server and Security Requirements

The Designer follows standard NJDOT protocol for CTSS Server and Security Requirements. Ensure that the default IP addresses and passwords set from the manufacturer are changed for all electronic devices where applicable and the Contractor forwards that information to the RE for each device. This includes but is not limited to ITS devices, IP switches, routers, modems and wireless equipment.

E.2.3. CTSS Template for System Architecture Review (SAR)

For CTSS projects, at the Notice to Proceed provide the System Architecture Review team general project information. The SAR is the checkpoint to confirm that the Architecture, Engineering, and Construction layers have been successfully planned and all areas are in agreement with regard to the physical design prior to the system being turned over to operations. At FDS when the number of servers is known (including existing, proposed, virtual and physical) the designer provides that information to the System Architecture Review team. For CTSS projects that utilize a Distributive System or a system with proprietary "appliances",

all devices should be listed. 30 days after the Pre-Construction Meeting the contractor submits the SAR notification and their VPN access request. Servers need to be installed prior to gaining VPN access. OIT should be copied on these notifications.

E.3. 511NJ

511NJ is a free, real time phone and web service that consolidates traffic and transportation information into a one-stop resource for commuters and motorists in New Jersey as well as the surrounding region. The real time information contained in the 511NJ Suite of Services is captured by traffic operation centers and entered into a database called OpenReach.

OpenReach is a Java based database application developed by TRANSCOM. It is used by NJDOT as well as other member agencies to enter and collect incident, congestion, active and planned construction as well as active and planned special event data.

511NJ also provides up-to-the-minute traffic conditions on all State highways, toll roads and New York, Pennsylvania, and Delaware crossings and is available 24 hours a day, seven days a week, 365 days a year.

Travelers can find information such as:

- Traffic conditions
- Traffic Speeds
- Live traffic camera images
- Twitter feed for many of NJ's major roadways
- Mega Construction Projects
- Real time parking information for Port Authority of NY/NJ
- Highway construction updates
- Winter road conditions
- Weather conditions and alerts
- NJ TRANSIT Promotions
- Cross promotion of Highway Traffic Safety Messages
- Links to other travel resources

E.3.1. Website

The www.511NJ.org website was designed to complement the 511NJ telephone service. It provides an easy, user friendly way for commuters to see where incidents, accidents, congestion and events like weather and construction are happening before they leave their office or home. 511NJ.org employs interactive widgets, as well as the more traditional tabs across the top of the page, to interact with and access the region's transportation information.

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Figure E-1: 511NJ Website

The web page is organized into tiles of transportation related information. The height of these tiles is variable based on the information contained within. The width of the tiles is fixed and dependent on the column the tile is placed in. Figure F-3 illustrates the fixed widths of each column.



Figure E-2: Column Widths

(Buffer zones between and bordering tiles are spaced at 5 pix each)

E.3.1.1. Mega Projects

The mega project tile is typically in the top left corner of the page but is configurable. Mega Projects are classified as projects that have a substantial traffic impact, a regional impact, and/or require Work Zone ITS, MSE or Traffic Operations management should be consulted to decide if a project warrants a “Mega Project” designation.

Mega Projects need to be defined by an area of impact. When adding a new Mega project on the manager page, the operator should input coordinates for latitude and longitude at each corner of a box that encompasses the project limits. The “Origin Lat” and “Origin Long” would be the southwest corner of the box and the “Destination Lat” and “Destination Long” would be the northeast corner of the map. Incident data (construction, accidents, congestion, special events, and weather related conditions) from the drawn box will come in XML format to the mega project page. The mega project tile provides links to the corresponding project on 511NJ.org as well as other web pages with additional information.

E.3.1.2. Severity Alerts

Severity alerts are on the top center of the web page and are highlighted red to denote the urgency and importance of the messages contained within the box. The alerts include serious traffic conditions, AMBER alerts, Silver alerts, and statewide emergencies.

The alerts are manually entered into the 511NJ website by the operator. Messages from 511NJ partner agencies are also posted for major events. Below are a few guidelines on creating and posting messages to the severity alerts section.

- Messages should be concise, informative, and clear.
- Messages for a specific situation should be consistent along the roadway corridor and adjacent corridors and may require coordination among different agencies
- A hyperlink can be added to a message if more information on the alert is available on another site.
- A hyperlink can be added to another agencies website if message/alert is from another agency.
- Each alert is assigned a priority number. A designation of “1” is the highest and consequently any alert assigned that number will display on the top of the page. If there are multiple high priority messages, the message that was updated most recently will show up first.
- Older messages can be saved in the database but not used if re-activation may be required at a later time.
- There is no preference on capitalization for the alert.
- Proper grammar and spelling should be utilized.
- Construction messages should be as per traffic management plans.
- AMBER and Silver alerts are obtained from the New Jersey State Police and therefore the operator should not deviate from what is received.

Samples of common alerts are below (these samples are fictitious and for sample purposes only):

- **AMBER ALERT:** THE NEW JERSEY STATE POLICE IS ACTIVATING THE AMBER ABDUCTION CHILD ALERT PLAN. THE NJ STATE POLICE IS INVESTIGATING A CONFIRMED CHILD ABDUCTION WHICH OCCURRED ON 24 NOVEMBER 2015 AT 2118 HRS. IN THE CITY OF TRENTON, MERCER COUNTY, NJ. THE CHILD, JENNIFER JOHNSON, IS A 4 YEAR OLD GIRL WITH BLACK HAIR AND BROWN EYES. SHE IS APPROXIMATELY 40" TALL AND WEIGHS APPROXIMATELY 40 POUNDS. SHE WAS LAST SEEN WEARING A RED MICKEY MOUSE SHIRT WITH BLACK PANTS. THE SUSPECT, JOHN K. SMITH IS A WHITE MALE, APPROXIMATELY 26 YEARS OLD, WITH BROWN HAIR. HE IS APPROXIMATELY 5'8" TALL AND WEIGHS APPROXIMATELY 193 POUNDS. HE WAS WEARING A BLACK JACKET AND KHAKI PANTS. THE SUSPECT WAS LAST SEEN OPERATING A 2009 SILVER DODGE CHARGER WITH NY LICENSE PLATE ZYX987. THE VEHICLE/SUSPECT MAY BE HEADING TO JERSEY CITY. IF YOU HAVE SEEN THE VEHICLE OR CHILD PLEASE CALL 911.

- **SILVER ALERT:** A DISORIENTED PERSON IS MISSING AND THE NEW JERSEY STATE POLICE NEED YOUR HELP: 81 YEAR OLD WHITE MALE, HEIGHT 5'4", WEIGHT 127 LBS, WITH BROWN EYES AND WHITE HAIR. HE IS WEARING BLUE JEANS AND A BLACK SWEATSHIRT. HE SUFFERS FROM DEMENTIA. HE WAS LAST SEEN AT 1234 APPLE DRIVE, TRENTON, MERCER COUNTY, NJ. DIRECTION OF TRAVEL IS UNKNOWN. POSSIBLE DESTINATION IS UNKNOWN. HE IS OPERATING A 2005 GOLD PONTIAC GRAND PRIX WITH NJ REGISTRATION PLATE ABC 123. PLEASE CALL 911 IF YOU SEE HIM. YOUR COOPERATION MAY HELP SAVE A LIFE. THANK YOU.
- Attention motorists: There's an Accident on I-78 westbound Exit 3 – NJ 173/US 22 in Pohatcong Twp. All lanes closed and detoured, due to accident in Pennsylvania. Expect major delays. Please use alternate route.
- NJ Transit Alert
Due to extreme weather conditions, NJ Transit Bus, Rail and Light Rail are cross honoring today.

E.3.1.3. Current Incidents Widget

The Current Incidents widget provides visitors to the main page with a quick glance at what is affecting the region's roadway network. Users can click on the text of the incident and the 511NJ Map widget automatically orients itself to that incident.

The information that makes up the alert comes from the Open Reach database. It also contains data for New York and Connecticut.

The list is sortable by state and county.

E.3.1.4. Camera Widgets

The Camera Widget directs visitors from the main page to a page that provides a graphical list of the region's traffic cameras.

Users can select a particular camera by clicking on the map icon or by selecting the camera from the camera tour list.

Camera tours are managed by the 511 Coordinator and the vendor with appropriate privileges. Camera tours are populated by a bounding box and selected highways and adjacent roadways are included in the tour.

E.3.1.5. Map Widget

The 511NJ Interactive Map Widget allows users to pan and zoom around the region's roadway network, offering a quick glance of the current conditions. Among the features of the map are:










- The Zoom tool located at the bottom of the widget allows users to zoom in and out.
- The various map layers (incidents, congestion, construction, detours, satellite view, traffic cameras, special-events, weather-related event and full-map view) identified by icons located on the upper right portion of the widget may be toggled on and off.
- Panning the map by pressing the right mouse key and moving the map.

The full page view is also accessible front the gear icon on the Map Widget as well as the Traffic Menu Tab. This full-page view provides users with a map legend to better understand the meaning of the color coding for current roadway conditions as well as the icons inserted on the map.

Table E-1: Congestion Level by Color

Congestion Level	% of Speed Limit	Speeds based on a speed limit of 55 MPH	Speeds based on a speed limit of 65 MPH	Default Color
Stop and Go	0-31	0-17 MPH	0-20 MPH	Red
Heavy Traffic	32-62	18-34 MPH	21-40 MPH	Orange
Moderate Traffic	63-92	35-50 MPH	41-50 MPH	Yellow
Free Flow	93-100(+)	51-55 MPH	61-65 MPH	Green
No Data	N/A	N/A	N/A	Grey

Table E-2: Icons

Icon	Legend
	Incident
	Camera
	Congestion
	Construction
	Detour
	Weather
	Special Event
	Scheduled Construction
	Scheduled Events

The interactive map icons are populated based on 135 different incident types in Open Reach. The operator selects a type and the system automatically assigns an icon. Agencies that reported the incident are included in the description of the incident.

E.3.1.6. Popular Travel Routes Widget

Web visitors can also get real time travel times along major highways that include the New Jersey Turnpike, Garden State Parkway, Atlantic City Expressway, I-80, I-78, I-287, I-295 as well as the I-76/NJ42 freeway.

The highways are broken down into segments that coincide with commuting patterns as well as major decision points. Popular travel routes are separated into bridges and tunnels, interstates, and toll roads.

Information is provided by direction, distance between intersections, as well as the travel time for each link. When a travel time goes 25% over the time that is required to travel the road under ideal conditions, the time shows in red. Any changes to this threshold would have to be done by the vendor (and TRANSCOM).

E.3.1.7. Tiles/Widgets

There are multiple tiles/widgets on the web page that are provided and maintained by other agencies, as outlined below:

- The parking widget is from the Port Authority of NY & NJ. It updates every 3-5 minutes, indicates parking lot capacity, and allows users to reserve parking spots.
- The NJ Transit tile is obtained from the NJ Transit marketing department and currently links to the main NJ Transit website.
- The Transit Trip Planner is powered by Google. It allows users to plan a trip between two points via multiple modes of transportation.
- The safety tile is for the NJ Division of Highway Traffic Safety. It contains the latest safety message, campaign, or promotion.
- The Accu-Weather tile is a widget from the Accu-Weather website.

There is no current widget policy. Other widgets can be added, if requested.

E.3.2. 511NJ Phone System

Dialing 511 in New Jersey or the toll free number (866)-511-NJDT (6538) allows motorists to find all the same information as the web page regarding area road conditions via an IVR (Interactive Voice Response) System.

The 511 IVR is available via landline and wireless phones. The incident data input into the OpenReach Database by the operators automatically populates the phone system.

The IVR also offers callers options such as Traffic Conditions, Shore Traffic (during Summers only), or call transfers to , NJ TRANSIT, EZ Pass, 511 New York, or 511 Pennsylvania. Callers can respond verbally or by using the telephone's keypad.

E.3.2.1. Shortcuts

The following shortcuts can be used at the Main Menu:

- **Traffic Conditions**
This section provides current information about incidents statewide. To select a route, you can simply say "78" instead of "Interstate 78," or to be more specific, say "I-78" or "I-78 East." As with the rest of the 511NJ system, you can interrupt the operator at any time. While 511NJ is giving you information about an incident, you can say "next" to skip to the next incident.
- **New Jersey TRANSIT**
This option transfers callers to New Jersey TRANSIT's Customer Service Center.
- **E-ZPass**
This option transfers callers to New Jersey's E-ZPass™ Customer Service Center, which has information on the E-ZPass™ Electronic Toll Collection program.
- **511 New York and 511 Pennsylvania**
This option transfers callers to the neighboring state's 511 systems. If you are interested in getting traffic condition information about roadways in New York or Pennsylvania, simply ask 511NJ for this feature and you will be transferred to the appropriate state system.
- **Leave a Comment**

This option allows callers to record a message for **511NJ.org** partner agencies on how the service performed and/or suited your needs. Calls are monitored and reviewed but it should be noted that callers should NOT anticipate a returned call or acknowledgment of their message.

- **Help**
If you need help, just say "**Help**" or "**What are my choices?**" at any time to go to hear your options for the current menu. To return to a previous menu, say "**Go Back.**" To start over, say "**Main Menu.**"

The following are general shortcuts in the system.

- **Main Menu**
This command is recognizable anywhere in the system and will take you directly back to the **Main Menu**. It is necessary if you want to check **Traffic Conditions** but are in the **Help Menu**.
- **Repeat**
If for some reason you forget or are unable to hear part of the listed prompts, you can always say "**Repeat**".
- **Next Incident**
In **Traffic Conditions**, say "**next incident**" if you want to skip an incident during incident playback.
- **Go Back**
To return to a previous menu, say "**Go Back**"

E.3.2.2. Floodgates

Floodgates are specially recorded audio messages containing important information that is necessary to all users of the phone system.

The purpose of a floodgate is to provide the ability to create customized recordings about special conditions that may exist that cannot be created in Open Reach and placed at various locations in the call tree.

Typically floodgate messages will follow the opening greeting of the 511NJsystem (AMBER and Silver Alerts) but they can be placed anywhere in the phone system when only applicable to a certain area like a city, road, or point of interest to the driving population.

Floodgate messages must be created and posted as outlined below after a request for a floodgate message is received or a requirement for one is spelled out in either a Traffic Mitigation Plan or by management.

E.3.2.2.1. Create a Floodgate Message

- Download the Freeware application called Audacity on to a computer with a microphone.
- Access the Audacity recording program on the "Floodgate Manager" laptop or workstation.
- Ensure that the project rate on the bottom left is set to 8000 Hz or the recording will not upload to the phone system.
- Ensure that the input selected is "1 (Mono) Input". This can be selected from the farthest right dropdown list at the top of the Audacity home window. Once ready, click the red record button to begin message. A timeline will appear on the screen to indicate changes in pitch and duration of message. Once complete, the message can be modified to remove long stretches of no audio (flat line). The flat lines can be highlighted, as illustrated in the figure below, and deleted. All floodgate messages should be less than 30 seconds, if possible.

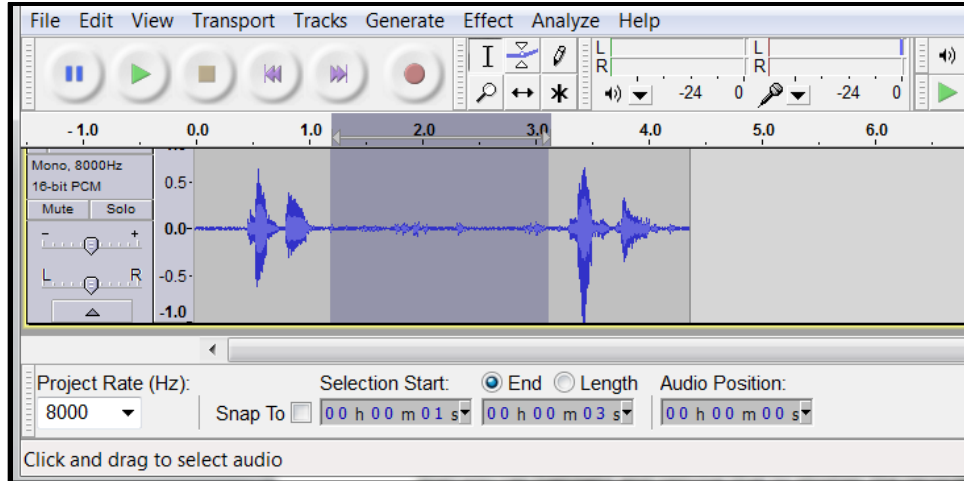


Figure E-3: Record Floodgate Message

- Once you are satisfied with the recording, the audio file can be saved with the date and description of the file by opening up the “export file” box. File names should exclude special characters (& * % ^ #) or the phone system will not accept the floodgate. The type of file should be “Other uncompressed files”. Under options, ensure that the encoding is “U-LAW”. After “Save” is clicked, a window will appear titled “Edit Metadata”. Click “OK” and your audio file will be saved.

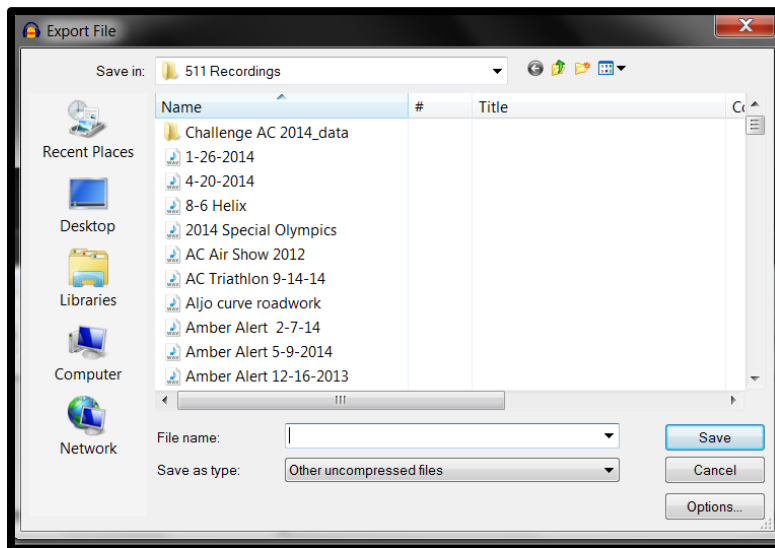


Figure E-4: Export Floodgate Message

E.3.2.2.2. Upload floodgate message

- Login to “My511NJServices” as an admin on the 511NJ website at www.511NJ.org with the credentials provided by the 511NJ Project Manager.
- After logging in, a new button will appear to the right of “My511NJServices”. Click on “Admin” and go to manage floodgates:

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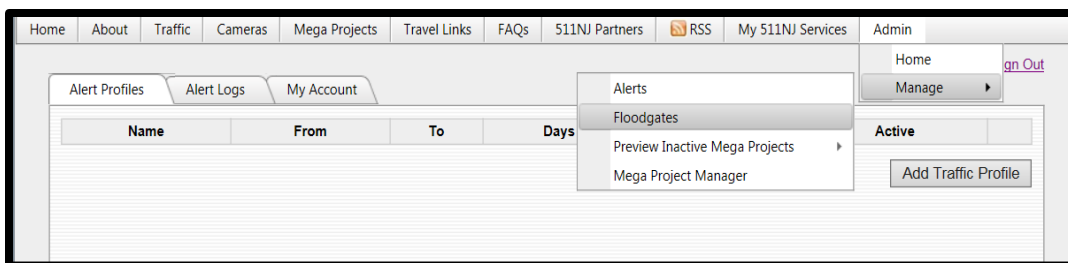


Figure E-5: Update Floodgate Message (1)

- To upload an audio file, click on “Manage Audio Files” and upload desired file that was recorded from Audacity

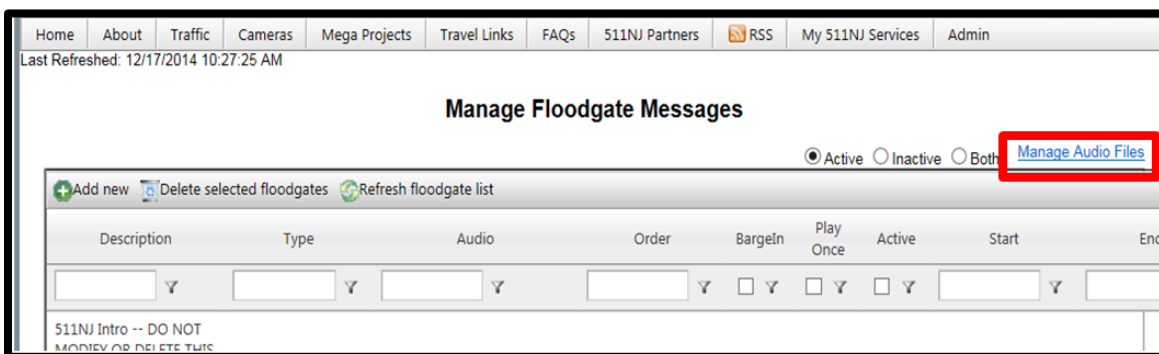


Figure E-6: Update Floodgate Message (2)

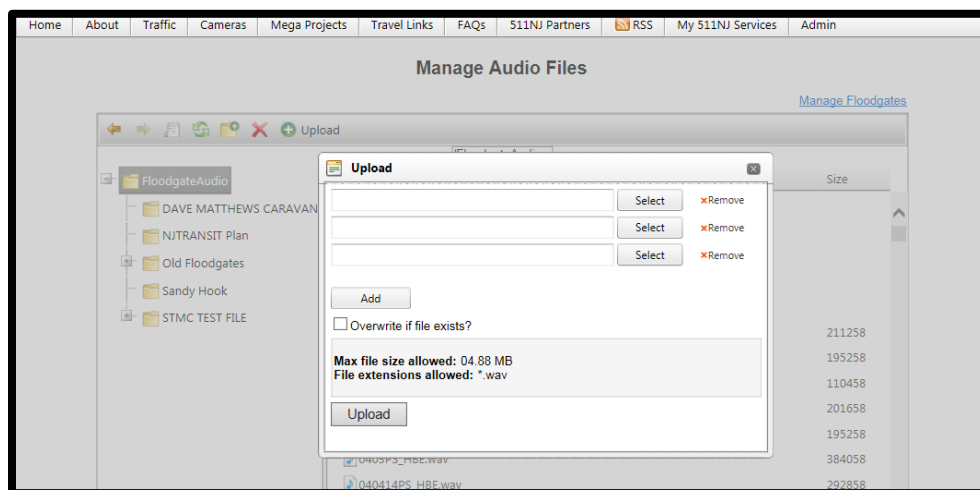


Figure E-7: Update Floodgate Message (3)

E.3.2.2.3. Post floodgate message

- To post a floodgate message, click on “Add new” under “Manage Floodgate Messages”.

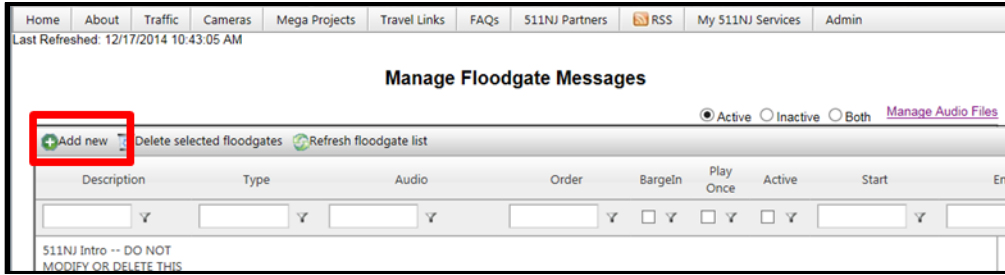


Figure E-8: Post Floodgate Message (1)

- A window will appear in which the details of the floodgate can be assigned.

Figure E-9: Post Floodgate Message (2)

- **Description:** Title of floodgate with date
- **Type:** The type of floodgate refers to the location in the system that the message will be placed. The options are EZ-Pass, NJ Transit, NY511, PA511, General, POI, and Traffic. Typically, the General and POI are used by NJDOT personnel:
 - General type messages play after the opening greeting of the 511NJ system and can be heard by all callers. Statewide emergencies, AMBER alerts, and Silver alerts are examples of common General type floodgate messages.
 - POI (Points of Interest) type messages are for specific areas or roadways of the State. Only callers requesting information on the specific roadway, facility, municipality, and/or landmark will hear the POI floodgate message. For example a caller requesting information on I-295 will not hear a POI floodgate message placed under Bergen County as I-295 is not close to that County.
 - When a POI type is selected, a list of roadways, facilities, municipalities, and landmarks in the State will appear for the operator to choose the parameters from.

The screenshot shows a web-based form for creating a Post Floodgate Message. The form is titled "Post Floodgate Message (3)". It includes the following fields and options:

- Description:** A text input field.
- Type:** A dropdown menu set to "POI".
- POI:** A list box containing several locations, each with a checkbox. The list is highlighted with a red rectangular box. The locations are:
 - Aberdeen Twp
 - Absecon City
 - Adventure Aquarium
 - Albany Street Bridge
 - Alexander Hamilton Bridge
 - Alexander Hamilton Service Area
 - Alexandria Twp
 - Allamuchy Twp
- Play Order:** A dropdown menu set to "1".
- Barge In:** A checked checkbox.
- Play Once:** A checked checkbox.
- Audio File:** A dropdown menu set to "--Select a file--".
- Active:** An unchecked checkbox.
- Start Date/Time:** A date and time picker.
- End Date/Time:** A date and time picker.
- Buttons:** "Cancel" and "Add" buttons at the bottom.

Figure E-10: Post Floodgate Message (3)

- **Play Order:** The hierarchy of the floodgate messages (1 being the highest and 20 being the lowest).
 - **Barge In:** This option, if selected, allows the caller to interrupt the floodgate message without completely listening to it. AMBER alerts and Statewide Emergencies must be un-interruptible and an option for "barging in" should not be selected. All other messages can be either interruptible or un-interruptible.
 - **Play Once:** This option, if selected, ensures that the floodgate message is only played once during a single 511 call and the caller does not have to listen to the message multiple times as they are navigating the system. Once the caller hangs up and calls back, the message will play again.
 - **Audio File:** Select applicable audio file for floodgate message.
 - **Active:** This should be selected for all messages that are to be active on the phone system, either at the moment or at a later date specified by the start and end time. When not in use, this box should be unselected to render message inactive. Any messages that are not needed in the future can be deleted.
 - **Start and End Date/Time:** Duration of floodgate message can be specified when specific date and time boundaries are applicable to message, such as construction activities. This is not a required field and can be kept blank if it does not apply. If date and time are not specified, the message will play in the phone system until the "active" box is unselected.
- Once parameters of the floodgate message are defined, click "Add". There is no confirmation prompt that will notify one of a successful post. Verify that message has been posted to the system by calling "511".

E.3.3. Integration

Any new permanent ITS device or Temporary (Work Zone ITS) device that will be in place for 6 months or more must be integrated into NJDOT's 511 system, 511NJ. Each type of device should provide data in the format described in this section and clearly be specified in the project's special provisions.

Table E-3: 511NJ Device Integration Formats

Device	Format for integration
Temporary Structure-Mounted CCTV Camera Assembly (TSMCCA) Portable Trailer Mounted CCTV Camera Assembly (PTMCCA)	<ul style="list-style-type: none"> • Feed needs to be integrated with Genetec • The feed provided will be used as a day to day operational tool at the TOC. When needed/requested, the feed can be integrated in to the video distribution system called “WINK” which will be linked to the 511NJ website. WINK integration is performed by NJDOT staff.
Portable VMS (PVMSRC only)	<ul style="list-style-type: none"> • Feed needs to be compatible with the Daktronics Vanguard software operating system. • Vanguard will provide a XML feed which will be used to feed the 511NJ website.
Temporary Travel Time System	<ul style="list-style-type: none"> • XML Format • The XML format will go to TRANSCOM for inclusion into the data fusion engine.
Permanent Camera Surveillance System (CSS)	<ul style="list-style-type: none"> • Feed needs to be integrated with Genetec • The feed provided will be used as a day to day operational tool at the TOC. • The feed will be integrated in to the video distribution system (“WINK”) which will be linked to the 511NJ website. WINK integration is performed by NJDOT staff.
Permanent Dynamic Message System (DMS)	<ul style="list-style-type: none"> • Feed needs to be compatible with the Daktronics Vanguard software operating system. • Vanguard provides a XML feed which will be used to feed the 511NJ website.
Permanent Travel Time System	<ul style="list-style-type: none"> • XML Format • The XML format will go to TRANSCOM for inclusion into the data fusion engine.

Any new permanent ITS device or Temporary (Work Zone ITS) device that will be in place for 6 months or more must be integrated into 511NJ. Information on each field component of new ITS devices must be documented on the ITS Systems Device Integration Form. This form can be found in Appendix H.13.

If the proposed ITS devices are permanent, ensure that the project manager or Resident Engineer (RE) completes the ITS Systems Device Integration Form after the devices have successfully passed Level C testing. This form should be submitted to the 511NJ Coordinator at 609-530-2549.

If proposed devices are temporary and being used for portable work zones, ensure the form is sent in after the RE accepts the Work Zone ITS System and the system is in operation.

Any and all changes to portable and/or permanent ITS device locations, operational condition, or IP Address should be relayed to the 511NJ Coordinator at a minimum, five days ahead of the change.

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F.1. Introduction

The New Jersey Department of Transportation (NJDOT), Mobility and Systems Engineering (MSE) has identified traffic signal optimization projects as high-priority projects for traffic corridors throughout New Jersey. These projects are focused on achieving the maximum benefits of coordination and progression within a corridor through the implementation of optimization techniques all while working within the operational constraints of the intersections. This section applies to signal optimization projects for controlled and un-controlled corridors (i.e., not controlled at a Traffic Operations Center (TOC)). Signal optimization projects are independent of other projects (e.g., ITS and CTSS projects), but CTSS projects could include optimization and the designer through the direction of the NJDOT Project Manager would be required to perform some of the tasks described under this section. For projects involving CTSS/TSO refer to H.27 CTSS Project Guidelines.

Depending upon the Project Delivery Process (TSM vs CPM) that involves TSO, the designers and PM will selectively adopt guidelines to customize their process. For limited scope projects, all the activities that are listed under the PE phase are either addressed under the CD or FD phase. The TSM Limited Scope Project Delivery Process Activities 4510, 4545 and 4595 covers all the sub activities that are described in this section and required for Traffic Signal Optimization with the exception of those activities that may have been specifically covered under the CD phase.

<p>MANUAL REFERENCE:</p>		<p>CTSS Project Guidelines Appendices\CTSSProjectGuidelines.pdf</p>
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F.1.1. Definition

The term “signal optimization” refers to the process by which signal timing tools and techniques are applied to coordinate a traffic signal corridor in an effort to enhance the operation of one or more directional movements. As used in this section, the term “corridor” refers to a logical grouping of signalized intersections or zones that operate together, including, but not limited to, pedestrian signals, pre-emption only signals, school flashers, and pedestrian hybrid beacons (i.e., Hawk).

F.1.2. Audience

This section is intended primarily for Consultants and MSE staff engineers working on projects as defined under Section F.1.1 Definition, where there is an identified need to perform signal optimization.

F.1.3. Purpose

The purpose of this section is to define the process by which traffic signal optimization projects as described under Section F.1.1 Definition are carried out from project initiation to final acceptance and closeout. This section also includes guidelines for conducting data collection, signal timing, and simulation for signal optimization projects. This section is not intended to cover every aspect of signal timing criteria as there are an extensive number of references that cover that topic in great detail, namely the *Highway Capacity Manual* (HCM), *Manual on Uniform Traffic Control Devices (MUTCD)*, *FHWA Signal Timing Manual*, and *FHWA Signalized Intersections: Informational Guide* just to name a few. The Consultant is encouraged to review those manuals for greater details. Any deviations from what is contained within the procedures and guidelines described herein should be consulted and approved by the MSE Project Manager.

The signal optimization process discussed herein is intended to serve as a guide and it is not intended to be restrictive in nature. It is understood that not all signal optimization projects are identical and that each project will have unique requirements that should be discussed and agreed upon by the entire project team. Both Consultants and MSE staff engineers are encouraged to apply engineering judgment where necessary and with proper justification as engineering judgment must ultimately supersede the guidelines herein should the conditions of the specific project warrant it.


F.1.4. Organization of Section

This section is organized into six (6) major subsections. Section F.2 documents the Signal Optimization Guidelines which defines the tasks involved in a signal optimization project from project initiation to project acceptance and close-out. Section F.3 documents the requirements and guidelines for performing Data Collection for Signal Optimization Projects and identifies required deliverables that are part of that Task. Sections F.4 through F.6 cover general guidelines for performing data analysis, model development, optimization, and micro-simulation. Section F.7 provides guidelines on the development of optimized timing directives, implementation of timing directives, benefit analysis, and development of the final report. The manual references may be updated from time-to-time and the Consultant is encouraged to check this manual for updates.

F.2. Signal Optimization Guidelines

In an effort to deliver Signal Optimization Projects in a structured and efficient manner, MSE proposes the following Signal Optimization Guideline to be followed while using the TSM Limited Scope Project Delivery Process. These guidelines are intended to guide MSE staff engineers and Consultants through the scoping, design and implementation stages of a typical Signal Optimization Project managed by MSE or a Capital Program Project involving the design and construction of a CTSS Project. The Signal Optimization Project Delivery Process Flowchart illustrates the process for delivering Signal Optimization Projects.

Depending upon the Project Delivery Process (TSM vs CPM), the designers and PM will use these guidelines to customize the process. For limited scope projects, all the activities that are listed under the PE phase are either addressed under the CD or FD phase. The TSM Limited Scope Project Delivery Process Activities 4510, 4545 and 4595 covers all the sub activities that are described in this section and required for Traffic Signal Optimization with the exception of those activities that may have been specifically covered under the CD phase.

MANUAL REFERENCE:		Signal Optimization Guidelines Flowchart Appendices\MSE601.pdf
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F.2.1. Delivery Process Task Descriptions

The following task descriptions describe in greater detail the process tasks illustrated in the Signal Optimization Project Delivery Process Flowchart discussed under Section F.2. This process defines the roles and responsibilities of MSE Staff, Consultants, and Regional Electrical Operations staff involved in a Signal Optimization Project. As discussed under F.1.3 - Purpose, the process discussed herein is intended to serve as a guide as not all projects are the same. The task descriptions discussed herein are divided by Scope Development, Design, and Implementation.

F.2.1.1. Scope Development

Signal Optimization Projects procured through MSE go through a scoping process that determines whether a corridor under investigation is a candidate for signal optimization, signal hardware and/or software upgrades, or recommended as a CTSS (Responsive or Adaptive) Project for future consideration. Similarly, a corridor under investigation may be rejected as a candidate for signal optimization due to conflicts with other ongoing projects, inability to be improved by signal optimization or other control method, and other related factors. ITS or CPM projects that involve CTSS corridors will not need to go through the Scoping Process outlined herein. The tasks herein are characterized as Scope Development tasks and are described in greater detail.

Task Name	Review Corridor Selection Inputs and Operational Needs
Responsible	MSE Staff Engineers
Related Guidance/Documents	N/A

All Signal Optimization projects are initiated from one of three distinct sources: Asset Management System Ratings, Capital Program Projects, or Complaints Database. MSE staff engineers are tasked with the review of select input information from the applicable sources as follows:

- Asset Management System Ratings – Review of system ratings by MSE staff includes, but is not limited to, the following categories: Congestion, Safety, and Bottleneck Rankings. In addition, intersection Measures of Effectiveness (MOE’s) such as v/c ratios, delays, Level of Service (LOS), queues, emissions, accidents, and travel times are also reviewed.
- Capital Program Projects – MSE staff will review intersection/corridor design information for existing CTSS projects being upgraded or new CTSS Projects that involve either Responsive or Adaptive

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signal control. Also, information for Non-CTSS projects that require signal optimization would also be reviewed, such as a corridor impacted by the construction of a new development or the need to optimize a corridor that could potentially handle additional volume due to a long term construction related detour.

- Complaints Database – MSE staff will review information for intersection/corridor complaints that are related to signal timings.

Operational needs are identified based on input information and an assessment of potential benefits due to signal optimization. If the assessment yields that operations along the corridor cannot be improved with signal optimization, the corridor is not selected and the process is closed.

Task Name	Identify Stakeholders and Initiate Internal Coordination
Responsible	MSE Staff Engineers
Related Guidance/Documents	Planning Request Letter

Stakeholders are identified based on the location of the intersections within the corridor. Stakeholders other than NJDOT include, but are not limited to, the following:

- Contractors/Developers
- Municipality
- County
- Other External Agencies (e.g. FHWA, NJTA, PANYNJ, NJMC, OIT, etc.)
- State of New Jersey DOT Information Technology

Once the stakeholders are identified, MSE staff sends out a Planning Request Letter to other NJDOT Departments / Divisions (Roadway Maintenance Engineering and Operations, Access, Traffic Engineering, Regional Electrical Operations, Bureau of Transportation Data and Safety, and Capital Program Management). MSE staff should also use Capital Program Management’s Project Reporting System (PRS), and Highway Access Permits System (HAPS) as resources for identifying current or upcoming projects within NJDOT. MSE staff engineers will periodically coordinate with identified PM’s of conflicting projects for schedule updates. A corridor field visit should be conducted during this time.

MANUAL REFERENCE:		Planning Request Letter Appendices\MSE603.pdf
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Task Name	Conflict and Data Gathering Analysis
Responsible	MSE Staff Engineers
Related Guidance/Documents	Coordination / Conflict Spreadsheet, Traffic Signal Survey Spreadsheet

After submitting the Planning Request Letter to internal stakeholders, MSE staff develops a Coordination and Conflict Spreadsheet to document and easily identify project conflicts. The spreadsheet contains information about the corridor being investigated and includes but is not limited to the following corridor specific information:

- Job number
- Route Number
- Milepost Begin and End
- County
- Municipality
- Signalized Intersections Affected

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The spreadsheet also contains information about the conflicting project and includes but is not limited to the following information:



- Responsible Party/Department
- Conflicting Project Description
- Project Start and End Date
- Current Progress of Project
- Project Manager
- Comments
- Source of Information
- Project Name
- Information Needed

The information contained in this spreadsheet serves to identify conflicts with other ongoing projects but will also assist MSE staff Engineers during the Tier Assignment Task and in making a decision about whether or not the corridor being investigated will be recommended for signal optimization.

The second part of this task involves the Data Gathering Analysis which includes a documentation of existing conditions and available resources. This task establishes the initial point of coordination between MSE staff and the Regional Electrical Operations Offices (North, Central, South). Throughout the Signal Optimization Process, MSE and Regional Electrical Operations will be required to coordinate at several different milestones in the process following this task. These subsequent points of coordination are described under the task description “Coordination with Regional Electrical Operations” under Scope Development.

During the Data Gathering Analysis task MSE will request confirmation from the Regional Electrical Operations Office (North, Central, or South) the hardware and software information which includes the controller type, make and model, most current timing plan, detection devices, interconnect, software version, potential changes to phasing, and communication networks available both public (State, regional, and local) and private, for each intersection within the corridor under consideration. This information will be documented in a Traffic Signal Survey spreadsheet and will be valuable throughout the Signal Optimization Process as coordination with Electrical Operations will continue through Design and Implementation. Any changes to the existing hardware/equipment or software will need to be documented and considered during the development and implementation of Optimized Timing Directives.

Part of this request and initial coordination with the Regional Electrical Operations Office is to determine whether there is a need to install GPS clocks (where feasible and if available) at intersections within the corridor that do not currently have them and are not integrated into a CTSS or may be integrated into a CTSS, but the communications are either not working or intermittent communications exist to the point where it is deemed unreliable for signal coordination purposes. In the latter case, if the intermittent communications problem cannot be fixed prior to the start of the Existing Conditions data collection, the MSE staff engineers must decide whether GPS units should be installed or whether dependence on the controller’s time clocks should be the course taken. At intersections where the CTSS is online and GPS clocks will be installed, the intersection must be taken offline in the CTSS by disconnecting the communications cable since the controller can only accept one time clock.

MANUAL REFERENCE:		MSE Coordination and Conflict Spreadsheet Appendices\MSE625.pdf
MANUAL REFERENCE:		Traffic Signal Survey Spreadsheet Appendices\MSE626.pdf

Task Name	Tier Assignment
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Responsible	MSE Staff Engineers
Related Guidance/Documents	N/A

After the Conflict and Data Gathering Analysis process, MSE staff engineers identify the level of treatment that a corridor requires. Taking into consideration any corridor needs and conflicts, the MSE staff assigns a Tier Label between T1 through T6 to a corridor based on the guidance provided in Classification of Arterial System Technology – New Jersey (COAST-NJ). The six (6) Tiers are described as follows:

- T1 – Adaptive Signal Control Technology
- T2 – Responsive System, inbound and outbound timing plans
- T3 – Optimized with corridors that have communications, upgrading and optimizing time of day plans.
- T4 – TOD plans with local communication.
- T5 – Optimized with existing infrastructure.
- T6 – Isolated intersection

After MSE staff assigns a Tier to a corridor, the MSE staff will determine whether a corridor will be considered for Signal Optimization or not. If the corridor is not selected, it will be logged into a corridor database for future consideration. If Tier 1, 2, or 3 are assigned to a corridor, the project is recommended as a new ITS/CTSS project. Refer to Sections A through E of this manual for the procedures required to be followed by Consultants when working on CTSS projects. If the corridor is assigned Tiers 4 through 6, the project will continue with the Signal Optimization Process and coordination with conflicting projects will continue throughout the life of the project. If an intersection is assigned T6, the intersection may be improved through hardware or timings upgrades but the intersection will not be part of any coordinated system.

Task Name	Coordination with Regional Electrical Operations
Responsible	MSE Staff / Regional Electrical Operations
Related Guidance/Documents	N/A

Coordination between MSE and Regional Electrical Operations has been identified as being a critical aspect of the Signal Optimization Process. Throughout this process, coordination with Regional Electrical Operations is to occur during all stages of a project: Scope Development, Design, and Implementation.

Scope Development

During this stage, coordination is to occur during the Conflict and Data Gathering Analysis Task, which establishes the first point of coordination in the Signal Optimization Process as described earlier in this section under that task. Also, coordination is to occur after the Tier Assignment Task. After the assignment of a Tier to a corridor under investigation, and if the corridor is selected for signal optimization MSE staff will request from the Regional Electrical Operations staff to provide updates on the information received during the initial coordination, if any, on existing intersection hardware, software, communications, verification of installation of GPS clocks, and repair of broken or non-working loops/image detectors for all intersections within the corridor selected. MSE staff will also request that Regional Electrical Operations staff provide a schedule or time frame for implementing timing directives on the selected corridor. This schedule will be used by MSE staff to update the Master Project Schedule and will be integrated into the Consultant’s time frame once a Consultant is selected and a scope of work is developed.

As part of this request, MSE staff will provide electronically the following information to Regional Electrical Operations so that they can make an assessment of the work to be completed and provide an appropriate schedule/time frame to MSE:

- Hardware / software updates needed/anticipated including purchasing and procurement of hardware for the selected corridor.
- Number of intersections for which signal timing directives are to be implemented.

- Equipment upgrades needed/anticipated.

Design

During this stage, coordination is to occur after approval of the Calibrated Existing Conditions Model and after the approval of the Optimized Model.

After completion of the above mentioned milestones MSE staff will request from Regional Electrical Operations staff to provide updates, if any, on existing intersection hardware, software, and communications for all intersections within the corridor selected that had been previously submitted under Scope Development. In addition, MSE staff will also request that Regional Electrical Operations provide an updated schedule for implementing timing directives on the selected corridor.

As part of these requests, MSE staff will provide electronically updated information to Regional Electrical Operations on the following project details so that they can make an assessment of the work to be completed and provide an updated schedule to MSE:

- Hardware / software updates needed/anticipated including purchasing and procurement of hardware for the selected corridor.
- Number of intersections for which signal timing directives are to be implemented.
- Equipment upgrades needed/anticipated.
- Number of Timing plans to check whether the controllers are capable of handling them.

Implementation

During this stage, coordination is to occur before the Work Order is issued and will serve as the final point of coordination prior to implementing the optimized timing plans. During and after Implementation, coordination will continue to address any changes, if any, to the timing plans or any other equipment or software integration issues.

Prior to the issuance of the Work Order, MSE staff will request from Regional Electrical Operations staff to provide updates, if any, on existing intersection hardware, software, and communications for all intersections within the corridor selected that had been previously submitted under Scope Development and Design. In addition, MSE staff will also request that Regional Electrical Operations provide an updated schedule for implementing timing directives on the selected corridor.

As part of these requests, MSE staff will provide electronically updated information to Regional Electrical Operations on the following project details so that they can make an assessment of the work to be completed for the selected corridor and provide an updated schedule to MSE:

- Hardware / software updates needed/anticipated including purchasing and procurement of hardware for the selected corridor.
- Number of intersections for which signal timing directives are to be implemented.
- Equipment upgrades needed/anticipated.
- Anticipated schedule for delivering optimized timing directives to Regional Electrical Operations (work order issuance)
- Optimized timing directives

Task Name	Consultant Selection and Scope Development
Responsible	MSE Staff / Consultant
Related Guidance/Documents	NA

MSE submits an RFP and engages in the Consultant selection process. After selection of a Consultant, MSE develops the scope for the project and identifies the project limits. Under certain circumstances, the Consultant will assist in the development of the scope and identification of the project limits.

F.2.1.2. Design

The design phase of the Signal Optimization Process is typically handled by a Consultant working in close coordination with MSE staff engineers. Tasks include but are not limited to data collection, development of the existing and optimized traffic models, and the development of timing plans.

Task Name	Project Kick-off
Responsible	MSE Staff / Consultant
Related Guidance/Documents	N/A




After the development of the scope and the Consultant selection, the Project Kick-off is initiated. During the Project kick-off, the scope, project schedule and deliverables are discussed and agreed upon between MSE and the Consultant. Also, the Consultant will be given the Task Order Package consisting of the following:

- Corridor Summary Sheet
- Existing Timing Directives
- Electrical Plans (As-Built)
- Traffic Signal Plans (As-Built)
- Data Gathering Analysis Information
- Volumetric Data (if available)
- Straight Line Diagram
- Sample Planning Request Letter
- Sample Authorization Letter

Task Name	Perform Data Collection
Responsible	Consultant
Related Guidance/Documents	Data Collection Program, Authorization Letter, Data Collection Report

The Consultant will perform Data Collection for the project as discussed under Section F.3 Data Collection. This process includes the development and approval of a Data Collection Program (DCP) prior to initiating any type of data collection. The DCP will outline the Data to be collected, the process by which that data is to be collected and the location of the data collection points. The DCP is submitted to the NJDOT MSE for review and approval prior to the start of the data collection. Upon approval, the MSE Project Manager will provide the Consultant with a signed copy of the Authorization Letter, a letter authorizing the Consultant to initiate data collection on behalf of NJDOT. In addition, the schedule will be shared with the Bureau of Maintenance and Equipment Operations Permits to notify them of when and where the data collection activities will be performed. After the data is collected, reduced, and analyzed the Consultant will prepare a Data Collection Report (DCR) summarizing all data collection.

As part of this task activity, the Consultant will collect Traffic Counts, Speed and Travel Time Data, Roadway and Signal Equipment Inventory, Physical Characteristics, Field Observations including, but not limited to, queues, use of the yellow by drivers as an extension of green including sneakers, and other roadway and signal characteristics as discussed under Section F.3.3 Physical Inventories (PI). Other data may be collected or requested at any time during the Data Collection process as agreed to by MSE and the Consultant. The sample DCP and DCR are discussed in greater detail under Section F.3.10 Data Collection Deliverables and Processing.

MANUAL REFERENCE:	 Data Collection Program (DCP) Appendices\DataCollectionProgram.pdf
MANUAL REFERENCE:	 Sample Authorization Letter Appendices\MSE602.pdf
MANUAL REFERENCE:	 Data Collection Report (DCR) Appendices\DataCollectionReport.pdf

Task Name	Perform Data Analysis and Develop Existing Conditions Model
Responsible	Consultant
Related Guidance/Documents	N/A

After approval of the DCR, the Consultant will perform data analysis and develop the Base Model. The Base Model should only include geometric data and is to be submitted to MSE for approval. The Base Model should include the following:

- Street/Route Names
- Lane widths
- Lane configurations
- Link speeds
- Grades

Once approved, the Consultant will develop the Existing Conditions Model to replicate existing conditions during the system peak periods to be analyzed. The Existing Conditions Model includes but is not limited to the current geometric configuration approved as part of the Base Model, existing signal timing parameters (including existing clearance intervals, minimum times, etc.), link speeds, ideal saturation flow rate, No Turn On Red (NTOR), Peak Hour Factor (PHF), heavy vehicles percentage, volume to capacity (v/c) ratio, and vehicular and pedestrian volumes.

Task Name	Calibration and Validation of Existing Conditions Model
Responsible	Consultant
Related Guidance/Documents	N/A

Following the development of the Existing Conditions Model, the Consultant must calibrate and validate the model to actual field conditions and submit to MSE a calibration document, explaining the changes that were made during the calibration, and the calibrated model for approval before further analysis is conducted. After submittal, MSE and the Consultant are to hold a calibration meeting at the Consultant's office to discuss the calibration document. In addition to performing adjustments to the model parameters to better reflect nuances experienced in the field, this process serves as an opportunity to validate the accuracy of the model inputs.

Model outputs should be compared against any available and comparable field data to determine the validity of the model results. Such data includes but is not limited to the following:

- Traffic volume served versus demand
- Travel times
- Delays
- Queues
- Lane utilization

Refer to Section F.4.6 Calibration and Validation for further details.

During MSE’s review of the Calibrated Existing Conditions Model and the calibration document, the model MOEs are analyzed and a determination is made whether to terminate the Signal Optimization Process or to continue with the process. If upon review of the MOE’s, it is determined that the selected corridor is operating optimally or that operations cannot be improved by signal optimization, the process is terminated and the results are documented in a Final Report.

Task Name	Develop No-Build and Optimized Model
Responsible	Consultant
Related Guidance/Documents	N/A



After the calibration meeting and approval of the Existing Conditions Model and the calibration document, the Consultant develops the No-Build Model. The No-Build Model includes updates to clearance calculations, pedestrian intervals, and link speeds according to NJDOT and MUTCD/HCM/ITE Traffic Engineering Handbook standards. Also, the Consultant applies annual growth rates from various sources, following discussions with the PM and technical lead on the project to capture the growth in traffic, even when no new development is being planned along the corridor. Finally, cycle lengths and signal groupings are reviewed and modified if necessary. The No-Build model will be used to compare to the Optimized Model. After submittal and approval of the No-Build Model the Consultant will develop the Optimized Model.

After submittal of the Optimized Model, if the model is not approved, further tweaking of the model will be required and re-submission will be necessary until approved. When it is approved, the Consultant will initiate the development of Timing Directives in Microsoft Word or Excel format.

Task Name	Develop Optimized Timing Directives
Responsible	Consultant
Related Guidance/Documents	Timing Directive Review – Quality Assurance Form, Incident Management Timings Guidelines

The Consultant will prepare timing directives, Timing Directive Review – Quality Assurance Forms, and EL-09 Forms and submit to MSE for approval. As part of this task the Consultant will prepare the necessary timing directives including Incident Management (IM) Plans, where required for all traffic signal optimization projects within the TOC corridors as agreed to with MSE. IM plans should be developed according to the Incident Management Timings Guidelines (IMTG) document.

Upon Approval of the optimized timing directives, MSE will initiate preparation of the Work Orders. If the timing directives are not approved, MSE will provide comments to the Consultant who is to revise the timing directives and re-submit to MSE for approval.

MANUAL REFERENCE:	 Timing Directive Review – Quality Assurance Form Appendices\MSE600.pdf
MANUAL REFERENCE:	 Incident Management Timings Guidelines Appendices\MSE617.pdf

F.2.1.3. Implementation

The Implementation phase of the Signal Optimization Process is handled by Regional Electrical Operations. The Consultant will perform the after study and prepare the Final Report working in close coordination with MSE staff engineers once the optimized timings are implemented. Tasks under this stage include Issuance of Work Order, Program Testing, Implementation, After Study, Development of Final Report and Closeout.

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Task Name	Issue Work Order
Responsible	MSE Staff
Related Guidance/Documents	Work Order Package Procedures, Timing Directive Work Order Package Checklist, EL-9 Form, Timing Directive Review – Quality Assurance Form






After approval of the optimized timing directives, MSE prepares a Work Order Package. The Work Order Package is prepared according to the MSE Work Order Package Procedures and consists of two (2) sets: Distribution Set and In-House Set. The Distribution set is provided to Regional Electrical Operations and the In-House Set is for MSE records. Both the Distribution Set and the In-House Set are packaged together and submitted to the signal optimization supervisor for approval. The following documents are included as part of the Work Order Package:

In-House Set - In-house package consists of the following:

- Existing Traffic Signal/Electrical Plan (red-lined)
- Existing Timing Directive
- Proposed Timing Directive
- EL-9 Form (Consultant to contact MSE for latest forms to be used)
- Timing Directive Review – Quality Assurance Form
- Timing Directive Work Order Package Checklist (In-house set)

Distribution Set – to the regions consists of the following:

- EL-09 Form – six (6) copies (3 white, 1 blue, 1 green, and 1 pink) (seven (7) if 1 yellow copy is required)(Consultant to contact MSE for latest forms to be used)
- Proposed Timing Directives – six (6) copies (seven (7) if EL-09 Form yellow copy is included)
- Timing Directive Work Order Package Checklist (Distribution set)

MANUAL REFERENCE:	 Timing Directive Work Order Package Procedures Appendices\MSE618.pdf
MANUAL REFERENCE:	 Timing Directive Work Order Package Checklist Distribution Set Appendices\MSE619.pdf
MANUAL REFERENCE:	 Timing Directive Work Order Package Checklist for the In-House Set Appendices\MSE620.pdf
MANUAL REFERENCE:	 EL-9 Form Contact MSE for the latest EL-9 Forms
MANUAL REFERENCE:	 Timing Directive Review – Quality Assurance Form Appendices\MSE600.pdf

Task Name	Program Testing
Responsible	Regional Electrical Operations
Related Guidance/Documents	N/A

After receipt of the Work Order Package, Regional Electrical Operations staff reviews the timing directives for errors prior to programming the controllers. After their review, they will program the timing directives on a test intersection in their shop to ensure that the controller can execute the proposed directives (bench test) without any malfunctions.

Depending on the number of different controllers used on a particular corridor, and the various equipment upgrades necessary, if there are no issues, Regional Electrical Operations staff will proceed with implementing the timing directives for all intersections within the corridor.

If issues are encountered with respect to the timing directives, they are returned to MSE. MSE staff will review the rejected directives and if minor changes are required they will revise the directives and re-issue a new Work Order. If the rejected directives require substantial changes, they are returned to the Consultant for revision and the Consultant would need to re-submit the revised directives to MSE for approval and if accepted, MSE would issue a new Work Order Package.

Task Name	Implementation
Responsible	Regional Electrical Operations
Related Guidance/Documents	N/A

Regional Electrical Operations staff programs the optimized timing directives on all intersections within the project corridor. If changes or impacts to communications or fiber are necessary, Regional Electrical Operations staff would coordinate with the appropriate TOC, through the MSE Project Manager.

Once the optimized timing directives are programmed into the controllers for all intersections within the corridor, Regional Electrical Operations staff will notify MSE.

Task Name	Verification of Implemented Timing Directives and After Study
Responsible	Consultant
Related Guidance/Documents	N/A

After MSE receives notification from the Regional Electrical Operations staff that the optimized timing directives have been programmed, MSE will notify the Consultant to initiate the Verification of Implemented Timing Directives, typically after a two (2) week period unless directed otherwise. The verification of timing directives will include verification of cycle lengths, splits, offsets and vehicular and pedestrian clearance intervals at every intersection within the project corridor and for every time of day that the timing directive was prepared for. Once the implemented timings are verified as per the final timing directive the Consultant will initiate the After Study.

As part of the After Study, the Consultant conducts a data collection program that includes traffic counts, and travel time runs. Depending on the results of the After Study, tweaking of the timing directives may be required and would need to be re-programmed by Regional Electrical Operations. Once the results of the After Study are deemed acceptable by MSE, the Consultant initiates the development of the Performance Summary and the Final Report.

Task Name	Develop Performance Summary and Final Report
Responsible	Consultant
Related Guidance/Documents	Final Report Template

After approval of the After Study, the Consultant develops the Performance Summary and Final Report. The Performance Summary should include all MOEs in a tabular format within the Final Report for ease of review. The summary of MOEs prepared for the optimization analysis should include a comparison between no-build and optimized conditions results.

The Consultant will prepare the Final Report as described under Section F.7.5 Final Report and submit to MSE for Approval. Once approved, MSE is to provide a copy of the Final Report to Regional Electrical Operations. The Final Report is to include the following major headings:

- Project Purpose
- Background


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- Before Conditions Data Collection
- Existing Conditions Analysis
- Optimization
- Implementation
- After Conditions Data Collection
- Anticipated Benefit Analysis or Reasoning Why Benefit Wasn't Achieved
- Future Recommendations

MANUAL REFERENCE:		Final Report Template Appendices\FinalReportTemplate.pdf
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Task Name	Acceptance and Closeout
Responsible	MSE Staff
Related Guidance/Documents	NA

After acceptance of the Final Report, The Consultant will provide MSE with all project documentation including all deliverables into one submittal package. MSE will close the project and provide documentation into a completed corridor database for future review.

MANUAL REFERENCE:		Project Closeout Template Contact MSE for required documentation
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F.3. Data Collection

As described under Section F.2.1 Delivery Process Task Descriptions, any project that involves traffic signal optimization should start with a relevant data collection phase.

This section provides general guidelines for conducting traffic data collection for signal optimization projects. These general guidelines are provided to develop consistency and uniformity in data collection as well as to ensure the accuracy and quality of the counts for use in the subsequent analyses and must always be followed by all Consultants working on signal optimization projects for MSE. In addition, the guidelines under this section provide guidance on the development of the Data Collection Program (DCP) and the Data Collection Report (DCR) which are MSE required deliverables to be developed by Consultants as part of the Data Collection phase. The DCP is to be prepared prior to beginning any data collection and must be approved by the Project Manager. The DCR is prepared at the end of the data collection phase to document all the findings from the data collected.

In certain instances, the Project Manager may allow exceptions to these guidelines to align with the needs of the project or to meet other goals or requirements. Any deviation from these guidelines must be discussed and concurrence reached with the Project Manager before proceeding further. Directions and suggestions should be sought at the project kickoff meeting from the Project Manager by the Consultant.

F.3.1. Use of Existing or Previous Data

F.3.1.1. Previous and Existing Data Request

The Consultant will formally request from the Project Manager any previous or existing data that may already exist within the NJDOT that may be relevant and pertinent to the current project. Generally, the Project Manager will provide this information at the Project Kick-off meeting; however, the Consultant must formally request the information prior to developing the DCP for the project. All previous and existing data available within NJDOT and relevant to the project will be provided by NJDOT at no charge. In cases where the Consultant has the existing data, but was collected for a client other than NJDOT, the Consultant must provide assurance to NJDOT about the quality and reliability of the data as well as consent in writing from their client permitting the release of the data. Based upon the circumstances, the Project Manager may directly contact the Consultant's client, other agencies or private clients for data release for NJDOT's use.

Further, NJDOT's Bureau of Transportation Data and Safety (BTDS) maintains a traffic monitoring program consisting of continuous and short-term elements in accordance with the FHWA's Traffic Monitoring Guide (TMG) and the American Association of State Highway and Transportation Officials (AASHTO) Guidelines for Traffic Data Programs. The traffic counting program is designed to utilize, at a minimum, 48-hour short-term counts to produce estimates of Annual Average Daily Traffic (AADT).

The traffic count data that is processed by the BTDS is provided to customers outside of NJDOT upon being requested. These customers include engineering Consultants, educational research facilities, transportation planners, and other government agencies to name a few.

Current traffic counts are available through the NJDOT website:

NJDOT REFERENCE:		New Jersey Department of Transportation http://www.nj.gov/transportation/refdata/roadway/traffic.shtm
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F.3.1.2. Guidelines for Use of Previous and Existing Data

In the case of previous and existing traffic data, the following guidelines will be followed:

F.3.1.2.1. Data which is More Than 3 Years Old

Traffic data which is 3 years old or greater is generally not acceptable for use in Traffic Studies and Environmental Impact Statements. The quantification of traffic impacts on roadway networks generally requires the most recent and updated data. For signal optimization projects, exceptions can be made if there has been little change to the land use/activity level/ traffic patterns since the data was collected. The validity of the data will need to be verified with 30 minute spot counts performed during the AM, MD, PM, or weekend time periods as discussed with the MSE Project Manager. Volume data available for a previous year may need to be adjusted to reflect the existing conditions study. The Project Manager may provide appropriate growth factors to the Consultant to adjust the counts or may require control counts at selected locations to determine appropriate adjustment factors. If the Consultant is to calculate the growth factor, these should be calculated based on data obtained from a Metropolitan Planning Organization (MPO). The decision will be based upon pertinent factors specific to the project location and requirements of the study.

F.3.1.2.2. Data which is Less Than 3 Years Old

Traffic data which is less than 3 years old is generally acceptable in traffic studies. An exception to this rule is when major changes in land use/activity level/traffic patterns are reported within the project area since the data was collected. While a general acceptance is granted for the use of traffic data less than 3 years old, its use will be decided upon on a case-by-case basis and must be discussed at the project initiation. The decision will be made by the Project Manager with information provided by the Consultant.

F.3.2. Collection of New Data

Whenever the project requires the collection of new data, the following requirements must be considered:

- Collection of traffic volumes must only be planned during roadway and traffic conditions which reflect typical and average setting for the roadway network. Construction detours and planned diversion or lane restriction are examples of conditions which would affect the quality of the counts. All the information for active construction projects on or impacting State Routes is available with the NJDOT, and should be checked before determining the count days.
- In instances where the Consultant is aware of activities on the roadway that may impact the data collection efforts, the Consultant must notify the Project Manager immediately.
- The season in which data is being collected must be in accordance with the nature of the corridor. If the corridor is a summer/recreational corridor all data must be collected during the summer months. In addition, any data collection performed after implementation of timing directives must occur in the same season as the before conditions data. The same can be stated for non-summer/recreational corridors.

The time periods and duration when traffic counts should not be conducted, unless otherwise requested by the MSE Project Manager are as follows:

- Weekend before Thanksgiving through mid-January
- Last week of June through mid-September (coinciding with the school summer vacation)
- Typical vacationing periods. This period can also be an exception when looking for vacation/recreational timings (such as shore routes or ski resorts)
- Mondays or Fridays
- Holidays, including the day before and after. Engineering judgments should be applied to determine which holidays significantly impact traffic patterns. Below are some common holidays:

Martin Luther King Jr. Day

Labor Day

Presidents Day

Election Day

Good Friday	Veteran's Day
Easter Sunday	Thanksgiving
Memorial Day	Christmas
Independence Day	New Year's Eve/Day

- When bad weather significantly alters the existing traffic patterns. Exceptions can be made if reasonable adjustments to the count data can be made. For all traffic data collection field surveys involving pedestrian counts, inclement weather will impact the accuracy of the counts.
- During special events such as street fairs, street closures, or other local events. The Consultant should investigate if such events that would alter traffic patterns are to take place for the intersections under study.

F.3.2.1. Traffic Counts and Peaking Characteristics

Peak period, off-peak and daily traffic counts are all necessary in order to fully understand the traffic characteristics of an intersection or a corridor. The following guidelines present how traffic counts are to be collected when working on Signal Optimization Projects. The guidelines include determination of the peak hour, considerations for weekday and weekend counts, Turning Movement Counts (TMC), Vehicle Classification Counts (VCC), and Automatic Traffic Recorder (ATR) counts.

The Consultant must ensure that the collection of various types of data such as TMC and ATR counts are conducted concurrently. MSE acknowledges the possibility that specific project-related constraints may impact this policy. However, every effort must be made to adhere to this policy. Deviation from this policy must be discussed and concurrence reached with the Project Manager prior to the execution of the counts.

F.3.2.1.1. Determination of the Peak Hour

Generally, the Project Manager will provide general guidelines for peak periods from previous experience, if available. If required and approved by the Project Manager, installation of the ATRs may be required prior to the manual counts to determine the periods of peak activity for the entire corridor. The Project Manager may then decide to limit the manual TMC during these specific hours only. However, this is a long and tedious process for a long corridor involving several signals and may require post-processing ATR data collected prior to conducting the manual TMC.

F.3.2.1.2. Traffic Counts for the Weekday Periods

The following guidelines should be considered with regards to traffic counts during the weekday periods:

- Generally, all traffic counts should be taken over at least two mid-week days and then averaged for analysis. This requirement specifically applies to data collected for TMC, VCC, and Speed and Travel Time runs.
- For TMC on weekdays, only one day of counts with seven days of ATR at ALL approaches of the intersection may be substituted. In such case, the ATR must be installed at ALL approaches of the intersection continuously for days which reflect typical traffic patterns (excluding all holidays and weekends) including the day of the manual count to confirm the total approach volumes on other days. The Consultant is to obtain direction from the Project Manager prior to conducting the counts. Based on the comparison of the approach volumes, the Project Manager may instruct the Consultant to conduct additional counts at the same location.
- For a roadway carrying typical commuter traffic: The traffic count should start at 6:00 am for typical weekday conditions. The Project Manager may decide to modify this based on several factors such as the time of year, if visibility is compromised due to daylight savings, or other conditions that would impact the accuracy of the count or the safety of the data collector. The typical count periods are AM, MD, PM, and Weekend (Saturday). Refer to subsection F.3.2.1.4 for details.

- For a roadway carrying predominantly non-commuter traffic (i.e., shore and recreational routes): the specific route and the destination it serves, the count may not start as early as 6:00 am. Alternatively, the Project Manager may also suggest additional counts for peak periods. The typical count periods are MD, PM, Saturdays, and Sundays. Under special cases the AM peak period may be considered. Refer to subsection F.3.2.1.4 for details.

F.3.2.1.3. Traffic Counts for the Weekend Periods

The following guidelines should be considered with regards to traffic counts during weekend periods:

- Generally, traffic patterns for Saturday and Sunday may be significantly different on each day based on the specific route and the destination. Often times, the Saturday traffic pattern also follows an early morning peak (between 7:00 am to 10:00 am). Sunday traffic typically does not exhibit noticeable volume activity before 10:00 am and continues to build up into the late evening periods often as late as 10:00 pm. The Project Team must discuss the weekend counting period early in the project and make recommendations.
- It should be assumed that TMC and other data for the weekend will be conducted for one time period. If more than one time period is required, this should be discussed and approved by the Project Manager.
- Traffic counts for weekends should be conducted for more than a single day for averaging purposes.
- If the peak hour is not easily discernible, then the manual count period should extend over all hours that could potentially comprise the peak hour for the study area. An exception to this is if one weekend of manual counts is conducted separately for Saturday and Sunday along with nine consecutive days of ATR data including the two weekends.
- Under special circumstances the Project Manager may request two days of counts on the weekend.
- For roadways carrying predominantly shore and recreational traffic, the Consultant should discuss counting periods with the Project Manager.

F.3.2.1.4. Manual / Automatic Turning Movement Counts (TMC)

The following guidelines should be considered with regards to TMC's:

- When specified, manual traffic counts should last at least three hours, and are to be recorded in fifteen (15) minute intervals, overlapping the projected peak hour with a 30 minute buffer before and after the peak hour. In cases where the peak period extends beyond a clearly demarcated hour, the buffer should be an hour before and after the proposed peak hour. The hours will be as defined below or as approved by the Project Manager.
- As a rule of thumb, the manual TMC shall be conducted for two representative weekdays (Tuesday, Wednesday or Thursday) for at least the peak periods listed below. These are the minimum periods for which the TMC are required. Exceptions to these requirements are already discussed in the preceding subsection.
 - Weekday AM peak period 6:00 am - 10:00 am
 - Weekday MD peak period 11:30 am - 2:30 pm
 - Weekday PM peak period 3:30 pm - 7:30 pm
 - Weekend (Saturday) peak period 12:00 noon - 3:00 pm
- The TMC may comprise of the following minimum vehicle classes for each movement at every approach of the intersections specified in the count program.
 - Passenger Cars (2 axles - 4 tires including 4-tire vans and pickup trucks)
 - Medium/Heavy Trucks (3 or more axles)

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Weekday MD peak period	11:30 am - 2:30 pm
Weekday PM peak period	3:30 pm - 7:30 pm
Weekend (Saturday) peak period	12:00 noon - 3:00 pm

- The VCC may comprise of the following classes for each of the movements at every approach of the intersections specified in the count program:
 - Passenger Cars - (2 axles – 4 tires including 4-tire vans and pickup trucks)
 - Medium/Heavy Trucks - (3 or more axles)
 - Buses/RVs

In special cases additional classes may be required and would need to be discussed with the Project Manager.

- The VCC for the signal optimization projects may be conducted in two different ways as described below based on the requirements of the project and the direction of the Project Manager. Both are acceptable methods, but the Consultant will receive clear direction from the Project Manager on which of the two methods will be followed.
 - In the first method, VCC are conducted for each movement per approach for a minimum of one and a half hours in 15-minute intervals within the peak period. This method requires a significant amount of resources, and based upon the number of classes required segregating the classes for each movement may not be possible. However, in some cases this may be the preferred method for more accurate and precise results. The NJDOT understands, however, that it will require a significant amount of manpower resources.
 - In the second method, VCC are conducted at the mid-block location in both directions preferably at the same time for 2-way streets. The TDCC must ensure there are no major sources or sinks of traffic at the mid-block where the VCC are conducted and must provide written confirmation. The total through traffic separated into various classes will be specified by the Project Manager. For 2-way streets, the mid-block count may be conducted at the same locations opposite to each other. This is more accurate to conduct using minimum resources since no turns are involved. The heavy vehicles proportions are later distributed based on the turn proportions taking into consideration any turn restrictions that may apply for any class of vehicles. The Consultants must discuss this early on in the project before the initiation of the actual count program.
- The raw data forms must be clearly labeled for each approach and paired correctly, especially if more than one person was performing volume counts at various approaches of the same intersection. It is assumed that the Consultant will meet with the awarded TDCC, if one is being used to conduct traffic counts, to establish manpower requirements for some of the critical or complex intersections with full classification count.
- Contact MSE for a Sample Classification Count format.

F.3.2.1.6. Automatic Traffic Recorder (ATR)

The following guidelines must be followed with regards to ATR counts:

- All ATRs should be installed at the specified locations at least 24 hours prior to conducting Turning Movement Counts (TMC) within the study area. As ATR data are generally required for supplementing and verifying the TMC, it is therefore necessary to ensure that all ATRs are operating accurately before, during, and after the TMC.

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- ATR counts taken during constrained or congested traffic conditions or on wide roadways carrying more than 2 lanes may give inaccurate and misleading results and should be field verified and/or calibrated.
- All ATRs must be installed, maintained, and replaced when necessary in a timely fashion to provide 24 hours of continuous volume information in each direction for a period of seven consecutive days or as specified by the Project Manager. The ATR data must also include volume information for a complete typical weekend comprising of a Saturday and Sunday. The TDCC must ensure the weekday data are reliable and accurate and comprise of complete 24 hour volume information for a typical consecutive mid-weekday (Tuesday, Wednesday and Thursday).
- All ATRs must be installed using at least two air switches (two rubber hoses) at each location for redundancy and as a backup for volume recording. Each ATR must be assigned a unique location number and should be documented in the count location map, maintenance log, and should also be included in the file name when submitting raw files to MSE. The guidelines shown on Table F-1 should be used when assigning an alphanumeric location number to ATR equipment unless otherwise directed by the MSE Project Manager.
- On local streets, ATRs should be installed along a curb side where parking is strictly prohibited at all times (e.g., at fire hydrants). The TDCC must ensure the two hoses are spread at least one car length apart from each other, as this will allow at least one of the rubber hoses to be functional in case a vehicle is parked on the other and completely pinches the hose.
- The TDCC must conduct a “Short Count” for calibration at every location where an ATR is installed after installing the ATR. The objective of this count is to adjust the ATR volume based on the number of axles counted in traffic flow at that location. The calibration count data sheets must also be submitted for each ATR and include the day of the count, time of the count and the number of axles counted manually along with the number of axles counted by the ATR for the same time period. The format for this count will be provided by MSE to the awarded TDCC.
- A typical ATR calibration count will comprise of two 15-minute periods during each of the two daily peak periods. The calibration count will be conducted during peak periods on Tuesday, Wednesday or Thursday. The calibration counts MUST be synchronized with the ATR clock.
- Each ATR is to be inspected before each weekday peak period (6:00 am -10:00 am and 3:00 pm – 7:00 pm). The morning period coincides with the time period before which the street sweepers might be deployed and may damage the rubber hose. The ATR must also be inspected before 12:00 noon on Saturdays and Sundays. Maintenance logs must be maintained and provided to MSE at the conclusion of the counts. A sample Maintenance Log is provided at the end of this subsection.
- The ATR should be removed from each location only after the period specified in the contract is completed. If the ATR is removed before the completion of the required duration, the Consultant and/or the Department has the right to reject the entire count for that location and the TDCC will be required to recount immediately at no charge to NJDOT. This requirement must be iterated to the TDCC at the initiation of the project.
- MSE will request from the Consultant a list of locations along the corridor where the raw ATR data counts must be provided the day after the counts are completed. The rest of the raw ATR data is to be submitted by the end of the week.
- The TDCC must perform their Quality Assurance/Quality Control (QA/QC) protocols before releasing the data within the aforementioned time frame.
- The ATR data must be submitted both in electronic and hardcopy format. In the electronic format, Excel spread sheet should be used and aggregated in 15-minute intervals. Electronic files will be provided for each location in the raw (number of axles, without the axle correction factor) and processed format (number of vehicles along with the axle correction factor for that location). All

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ATR data must include station numbers and GPS coordinates as per the DCP to identify count locations.

- After the submission of the ATR data, the Consultant will review the data and ascertain the validity and accuracy of the count at that location. If the data is determined to be invalid for any reason, the TDCC will be notified of the outcome of the review and will be required to revise the count at that location at no charge to the NJDOT.

Table F-1: ATR Location Number Guidelines

ATR Location Numbering Guidelines				
Description	Field Position	Field Length	Accepted Values	Comments
Roadway	1	1	M, C, O	M = Mainline, C = Cross Street, O = Other. The "other" option could be used for Driveways, Ramps, or other special location.
Intersection Number	2,3	2	00,...99	For any corridor for which counts are being conducted, begin with the intersection at the north end for a North/South corridor and at the west end intersection for a West/East corridor. Number the intersections sequentially and include this number as a 2 digit number.
Direction of Traffic	4,5	2	NB, SB, EB, WB, NE, SE, NW, SW, NS, WE	NE = Northeast, SE = Southeast, NW = Northwest, SW = Southwest, NS = North/South, WE = West/East. NS and WE are used when an ATR is installed to count both directions of travel.
Number of Lanes	6	1	1,...9	Number of lanes being counted. For locations where both directions of travel are being counted, include the total number of lanes.
Count Type	7	1	V, C, S, G, M	V = Volume, C = Classification, S = Speed, G = Gap, M = Multiple Types
Reserved	8	1	0	This field is reserved for future use or for special circumstances. Any value other than "0" means it is a special case.

ATR Location Numbering Guidelines				
Description	Field Position	Field Length	Accepted Values	Comments
EXAMPLE				<p style="text-align: center;">M01SB3V0</p> <p>The ATR Location Number is interpreted as follows: Mainline Roadway, First intersection, Southbound Traffic, 3 Lanes, Volume Count, No Special Case</p>

MANUAL REFERENCE:		Automatic Traffic Recorder Count Format Appendices\MSE605.pdf
MANUAL REFERENCE:		ATR Maintenance Log Form Appendices\MSE624.pdf

F.3.2.1.7. Pedestrian Counts

Pedestrian counts should be included as part of intersection turning movement counts. Pedestrian counts are of particular importance at locations where pedestrian volumes play a significant role in intersection operation. It is important to differentiate between the number of pedestrians and the number of actuations/calls or instances of pedestrians crossing together when collecting pedestrian data. Multiple pedestrians may cross under 1 (one) actuation or at the same time.

F.3.3. Physical Inventories (PI)

The Consultant shall provide the following information in hardcopy or electronic format (AutoCAD or Micro station) or simply a mark-up on sketch template for the Street Geometry and Physical Inventory of the intersection if there is no plan for the intersection.

The following information is required to be submitted:

- A. Street Geometry and Physical Inventory:
 - a. Lane widths, markings, and symbols
 - b. Number of travel lanes including mark outs for bike lanes and shoulders
 - c. Direction of each street in the study area and along major routes into the study area
 - d. Pedestrian and vehicular clearance distances measured in the field
 - e. Grades
 - i. Grade is indicated as either positive or negative. If the approach is uphill, this would be positive; if the approach is downhill, it would be negative.
 - f. All the above should be represented graphically
- B. The location of traffic control devices including, but not limited to:
 - a. Traffic signals
 - i. Controller location
 - ii. Junction Box locations
 - iii. Pole locations
 - iv. Pedestrian push buttons/distance to curb/height of pushbutton

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- v. Signal lenses type (e.g., Ball, Arrow, LED, etc.)
 - vi. Lighting
- b. Stop controlled intersections
- c. Yield controlled movements at intersections or Yield control intersections
- d. Turn prohibitions (e.g., Blank-out Signs, etc.)
- e. Warning and Regulatory signs
- C. For signalized intersections:
 - a. Signal cycle lengths (as recorded in the field)
 - b. Phasing (as per field conditions)
 - c. Timing directives (as obtained from the NJDOT)
 - d. Any lane restrictions (“ONLY” lanes, bus lanes or bicycle lanes)
 - e. Posted speed limits on side streets (look up to a quarter mile upstream of the stop bar if the posted speed limit sign is not located near the intersection)
 - f. Type and frequency of transit impacting the intersection
- D. On-street parking regulations, if any
- E. Parking maneuvers along approaches to the intersections in the study area.
- F. General pavement or alignment conditions along major roadways in the area that affect traffic flow, including, but not limited to:
 - a. Poor pavement conditions
 - b. Difficult vertical or horizontal geometrics
- G. Major traffic generators including, but not limited to, malls, schools, warehouses, etc.
- H. Railroad crossings and frequency of activity

The photo log will also be provided as part of this Physical Inventory submission for each intersection. The photographs will be provided in digital format with a legend or description to determine the location and direction of the pictures. The photographs must be clear to verify the information on the PI. The approach photo should be taken from a position where all approach and departure lanes and signal equipment are visible. If this cannot be done with one photo or there are unusual features, additional photos should be taken to capture pertinent data.

Intersection photographs should be taken in all approach directions (If there is a one way road or departing ramp, this should be included also) and labeled accordingly in the Approach Direction (Northbound, Southbound, Eastbound, Westbound, etc.). A photo log template is included at the end of this subsection.

The Consultant shall also provide the signal timing field observations in a format consistent with the template found at the end of this sub-section. If available, the Department will provide to the Consultant as-built traffic signal plans for each intersection which must be field verified. The Consultant will provide redlines on these plans reflecting the requirements stipulated in the latest version of the Federal Highway Administration’s (FHWA) Manual on Uniform Traffic Control Devices (MUTCD).

The following are sample documents part of the Physical Inventory



MANUAL REFERENCE:	 Physical Inventory Format Appendices\MSE608.pdf
MANUAL REFERENCE:	 Signal Timing Field Observation Format Appendices\MSE609.pdf
MANUAL REFERENCE:	 Photo Log Template Appendices\MSE612.pdf
MANUAL REFERENCE:	 Sample Red-Line As-Built Plan Appendices\MSE613.pdf

F.3.4. Speed and Travel Time Runs

Speed and travel time runs are necessary for calibrating the analysis model and may be required for air quality modeling at the discretion of the Project Manager. The following requirements must be followed while conducting speed and travel time runs.

- A. Speed and Travel Time runs must be collected concurrently with the traffic count program.
- B. At a minimum, the Information required is listed as follows:
 - a. Running time of traffic
 - b. Stopped delay at intersections
- C. Travel Time Information Collection
 - a. Techniques - Type of technique must be accepted by and discussed with the Project Manager before use
 - i. Floating Car (Information best collected using this technique as outlined in the Institute of Traffic Engineering (ITE) Manual)
 - ii. Average Car (drive at the average speed of traffic)
 - iii. Maximum Car (drive at the posted speed limit)
 - b. Devices
 - i. Electronic toll collection readers
 - ii. Global Positioning Satellite (GPS)
 - iii. Bluetooth
 - c. Software (including, but not limited to)
 - i. Tru Traffic
 - ii. PIPS Technology's Travel Time Measurement System
- D. Take decent field notes during the study, especially at each location. This will determine accurate travel speeds between points in the study area.
- E. At a minimum, six runs per link for each analysis hour/period (3 runs per direction). If feasible and at the discretion of the Project Manager, six (6) runs per direction should be conducted to provide adequate data.

Sample Speed and Delay Runs Format and Sample Travel Time Run Map Format

MANUAL REFERENCE:	 Sample Speed and Delay Run Format Appendices\MSE607.pdf
MANUAL REFERENCE:	 Sample Travel Time Run Map Format Appendices\MSE615.pdf

F.3.5. Field and Queue Observations

The following guidelines should be followed when recording queue and field observations:


- Queue length(s), including residual queues observed at intersections should be expressed in feet. The TDCC or Consultant shall provide to the Project Manager for approval, the method to be used (e.g., mark-up and measurement, supported estimates, or others) for collecting queues. The method for collecting residual queues should be documented and submitted to MSE for approval. Also, the document should be included as part of the DCP and the DCR.
- The queue observation files and field observation notes are to be submitted to the Project Manager in electronic form within ten (10) business days after the counts have been performed for the day.

F.3.6. Peak Hour Balance Flow Diagrams

Peak hours are found to the nearest 15-minute interval. All peak hours plotted on a map of the study area that includes all through and turning movement volumes at each location.

Maps can be balanced. Any major imbalances along the corridor are to be documented and explained.

Sample Volume Balancing Format

MANUAL REFERENCE:	 Sample Volume Balancing Format Appendices\MSE616.pdf
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F.3.7. Level of Accuracy

Checks should be made to see if the following occurred. The following information should be placed into a memo or a small report to be included in the DCR:


- ATR malfunction
- Unforeseen street closures/construction
- Any traffic altering scenarios such as, but not limited to, crashes
- Any detection failures

NJDOT reserves the right to review the quality of data collection and, if warranted, may require the Consultant to re-do the whole process or part thereof.

F.3.8. Insurance and Safety

The Consultant, sub-consultant, and the TDCC must ensure that any person, working directly or indirectly on their behalf for the NJDOT on these assignments including, but not limited to, the Consultant, sub-consultants, vendors or contractors, must carry in their possession a copy of the Authorization Letter provided to the Consultant at the Project Kick-off and follow all safety related requirements, procedures, guidelines and protocols issued by the NJDOT for performing any work in the NJDOT right of way including lane and shoulder closures

It will be the responsibility of the Consultant to become familiar and aware of these requirements.

MANUAL REFERENCE:		Sample Authorization Letter Appendices\MSE602.pdf
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F.3.9. Crash Data

Crash data, if available, should be collected for study intersections in order to identify any crash patterns that may be correctable through signal timing or equipment modifications. While most data will be available through NJDOT, the assistance of local agencies may be required in some cases. Crash data should be obtained for the last three (3) consecutive years of complete crash data.

It will be at the discretion of the Project Manager to determine whether a crash analysis is warranted and should be conducted.

F.3.10. Data Collection Deliverables and Processing

As described earlier, two deliverables are required as part of the Data Collection effort;

1. Data Collection Program (DCP)
2. Data Collection Report (DCR).

The Consultant is to prepare and submit for approval the DCP prior to commencing any data collection for the specific project. The DCR is to be prepared and submitted for approval at the end of the data collection effort and serves as the final document of that effort. This report and the collected data will be analyzed for optimizing the signal parameters and updating the system. The following sub-sections describe in greater detail the contents of the DCP and the DCR along with a sample document template for the Consultant to use in preparing a DCP and a DCR.

F.3.10.1. Data Collection Program (DCP)

The first deliverable expected from the Consultant prior to conducting any field work or collection of actual raw data for any Task Order will be the DCP wherein all the listed information required should be presented, preferably in tabular and graphical format – and submitted as a hard copy and electronic binder. The Consultant is responsible for obtaining written permission from MSE on the entire Data Collection Program (DCP) prior to the actual execution of the program. Data collected without the written permission of MSE may not be accepted and the Consultant shall be responsible for recollecting raw data and revising any subsequent calculations or analyses.

The Consultant is encouraged to discuss the details of the count program with the Project Manager prior to formalizing the details in the DCP. This will limit the number of iterations or revisions that may otherwise be required.

F.3.10.1.1. Information Required in the Data Collection Program (DCP)

The Data Collection Program will comprise of the following:

- Section I, “Data Details”. The details of each type of data being collected based on the requirements of the scope or the complexity and/or technical needs of the project. This section must address details about issues such as:
 - Type of data being collected including, but not limited to, Turning Movement Counts (TMC), Origin-Destination Surveys, Automatic Traffic Recorders (ATRs), Classification Counts, Pedestrian Counts, Parking Inventories, Geometric Inventories, Crash Data, Queue







- Observations, etc. A brief description justifying the need for each type of data being collected will be necessary.
- All data collection locations for the entire project for each type must be shown on an aerial map or roadway network map (see Sample ATR, TMC and Class Count Location Map and Zoomed-in Map samples at the end of this sub-section).
 - Brief description for the justification of selecting the locations for each type of data being collected.
 - The details outlining the actual schedule for the execution of the entire count program. Days and hours when the actual counts will be conducted at each location. This should be presented in a matrix format (see Sample Data Collection Schedule at the end of this sub-section) facilitating the reviewer to determine the details of the various types of data being collected at each location along with their duration and indicating overlapping periods of collection between various types of data.
 - The locations and the number of the control count stations that will be required for the entire count program. Control count or validation counts are required to ensure accuracy of the automatic counts. Collection of validation data at one or more control intersections (not more than 20% of intersections in the study area) on a second day is advised. The requirement of the control count stations must be discussed with the assigned Project Manager of the Bureau for concurrence.
- Section II, “Permits and Notification Required”. This section will list all parties/agencies that must be notified and informed prior to conducting the counts. The Consultant is responsible for identifying all such stakeholders for prior notification for all locations within the study area where data is required. The Consultant will coordinate closely with the Project Manager to draft letters of notification on the NJDOT’s letterhead which will be signed and sealed by the NJDOT (if required) before the deployment of crew for conducting traffic counts. Often times, the installation of data collection hardware such as ATRs requires working in active traffic lanes. Depending upon the controlling jurisdiction, right of way permits may be required for installing such hardware or working in the traffic lanes. (Refer to Section F.3.8 Insurance and Safety) The Consultant must submit the following to the Project Manager:
 - A complete list of all agencies and entities which must be notified or contacted to obtain written permission for conducting data collection. State or local police within the study area must always be considered as a concerned entity for notification.
 - A draft of the notification letter / permission letter to be forwarded to the concerned entity.
 - Copy of the application for conducting any work on the traffic lanes.
 - Section III, “Format of the Submission”. This section will list the format of the reports for various types of data for submission to MSE. Generally, if a report sample or template is not provided in the appendices of these guidelines, this information will be provided to the Consultant during the Project Kickoff meeting by the Project Manager or the Consultant will be required to submit such report in their own format.
 - Section IV, “Quality Control and Quality Assurance Plan”. The Consultant must also submit a detailed Quality Control and Quality Assurance (QA/QC) plan that will be followed by the Prime Consultant during the collection of the actual field data. This QA/QC plan will be in addition to the plan that the Traffic Data Collection Contractor (TDCC) may follow and submit for ensuring the accuracy of the counts. The plan will consist of the following:
 - The type of supervision / efforts being extended by the Consultant to ensure the accuracy of the counts during the data collections.

- The details and the locations of the control count stations for ensuring the accuracy of the ATRs along with the determination of the axle correction factors. The plan will list the duration of the control count for each peak period for each location. The Consultant may choose to discuss the details of the control counts locations during the initial discussion with the Project Manager prior to formalizing the program.
- The protocol and procedures to observe spillbacks and queues at critical intersections within the network. Critical intersections are defined as intersections with constrained capacity that regulates the flow of vehicles through the network. The bottlenecks at these intersections will severely skew the traffic counts at the downstream intersections as traffic cannot flow freely through these bottlenecks. Unless queues and spillbacks are observed and recorded by visual observation at these intersections, the analysis will be severely skewed. The Consultant will be required to record spillbacks at such intersections within the network.

An Authorization Letter from MSE for the traffic data collection efforts as well as all Planning Request Letters will be required documents to be submitted by the Consultant in the DCP. In addition, if residual queues are required to be collected, then an MSE approved memo should also be included in the DCP.

The formats for Turning Movement Counts, ATR Counts, Classification Counts, Speed & Travel Time Runs, and Physical Inventories are to be presented and submitted as shown in previous sub-sections, or as per discussion with the Project Manager.

Sample Data Collection Program (DCP), Sample ATR, TMC and Class Count Location Map, Sample Zoomed in Map, Sample Data Collection Schedule, Sample Authorization Letter, and Sample Planning Request Letter

MANUAL REFERENCE:	 Data Collection Program (DCP) Appendices\DataCollectionProgram.pdf
MANUAL REFERENCE:	 Sample ATR, TMC and Class Count Location Map Appendices\MSE610.pdf
MANUAL REFERENCE:	 Sample Zoomed-in Map Appendices\MSE614.pdf
MANUAL REFERENCE:	 Sample Data Collection Schedule Appendices\MSE611.pdf
MANUAL REFERENCE:	 Sample Authorization Letter Appendices\MSE602.pdf
MANUAL REFERENCE:	 Sample Planning Request Letter Appendices\MSE603.pdf

F.3.10.2. Data Collection Report (DCR)

The deliverable summarizing the efforts of field Data Collection as outlined in the preceding sections is expected from the Consultant. The Data Collection Report (DCR) wherein all the listed information required should be presented, preferably in tabular and graphical format with a written explanation of the work performed and data collected, and submitted in a hardcopy and electronic format. The DCR is subject to review and approval by MSE and the Consultant is responsible for the incorporation of comments presented by MSE. The DCR will include a “Body” and an “Appendix” section with proper references.

The Consultant is encouraged to discuss the details of the DCR with the Project Manager prior to formalizing the details in a final DCR. This will limit the number of iterations or revisions that may otherwise be required. The Consultant should be aware that the sample reports and templates reflect the basic requirements only. If the Consultant feels there is a need to include more information in order to illustrate a point or better present the data, the Consultant should feel free to include it in the Appendices section of the DCR.





F.3.10.2.1. Information Required in the Data Collection Report

The Data Collection Report (DCR) will comprise of the following:

- “Executive Summary” for the DCR highlighting, on a higher scale, the existing field conditions on the section of the corridor under study (this is contained in the “Body” of the DCR).
- Section I, “Background” will be described in the “Body” of the DCR. It should describe physical and geographical conditions peculiar to the particular corridor on which the data was collected. This section should include, at a minimum, the following information:
 - A description of the corridor with milepost limits, counties, municipalities, and number of signalized intersections.
 - A brief account of the cross-sectional build-up of the corridor with highlights on land use, road conditions, summary of road geometry, heavy vehicle frequency, mass transit impact (bus stops, nearby light rail, etc.), alternate routes, pedestrian traffic, bottlenecks, grades, and major highway intersections.
 - A map highlighting the corridor section.
- Section II, “Existing Conditions.” A paragraph summarizing the report’s subsections and type of data collected with reference to proper appendices where the data is located. The subsections should be as follows:
 - Turning Movements Counts (TMC’s)
 - In the “Body” of the DCR, summarize the data collected including peak hours, anomalies encountered that impact the data, breakdown of the type of categories counted, what observations and analyses were made from the data collected, queues observed for delay calculation, queue spill back and intersections affected, any changes in the dates, times, durations, or locations of the TMC from the original program, and any additional information that the Consultant feels is required.
 - In the Appendix of the DCR, include the raw TMC data, raw volume diagrams, balanced volume diagrams, pedestrian count data, signalized intersection counts, supplemental counts, and a justification of the volume imbalances, queue observations in tabular format, any NJDOT concurrence for changes in the DCP, new TMC locations on a map (if different from the DCP), and any additional information that the Consultant feels is required.
 - For appropriate formatting, refer to Sections F.3.2 Collection of New Data, F.3.6 Peak Hour Balance Flow Diagrams, and F.3.10.1 Data Collection Program (DCP).
 - Automatic Traffic Recorder (ATR) Counts
 - In the “Body” of the DCR, summarize the analysis of the data collected using the ATRs including direction of heavy traffic during each peak period, comparison of volumes between different peak periods, the fluctuation of volumes and what it says about the consistency (arrival rate) of the intersections, the relationship of the different volumes at each location and the inferences drawn about the corridor, and any additional information that the Consultant feels is required.
 - In the “Body” of the report, provide a graphical representation of the average weekday and average weekend ATR data represented on the same page for each

- ATR location (include directional and total ATR data on the same graph for each location with proper labels). See Example A at the end of this subsection.
- In the “Appendix” of the DCR, include the ATR installation log, ATR calibration count summary table, raw ATR data, ATR average hourly traffic volume graphs, new ATR locations on a map (if different from the DCP), and any additional information that the Consultant feels is required.
 - For appropriate formatting, refer to sections F.3.2 Collection of New Data and F.3.10.1 Data Collection Program (DCP).
- Peak Hour Selection
 - In the “Body” of the DCR, provide a tabular format of the calculated intersection peak hours and system peak hours and a brief explanation of how the system peak hour was calculated.
 - In the “Appendix” of the DCR, provide a table showing the calculation analysis of the system peak hour. Include all required calculations in Microsoft Excel. If during the analyses, ATR and TMC data are used, all references and tabulations should be included in the “Appendix.”
 - Speed and Travel Time Runs
 - In the “Body” of the DCR, provide a summary of the speed and travel time runs with color snapshots of the “Google Worm” (See Example B at the end of this subsection) showing the slow speeds and stops along the corridor with description of where the stops were frequently observed and probable cause of these interruptions in the flow (include explanation of stops due to pedestrian crossings); compare speed and travel times in different peak periods. Provide a key to explain the different colors as pertaining to the speeds along the corridor. Also, provide an explanation/description of the figures (“Google Worms”).
 - In the “Appendix” of the DCR, provide the raw Speed and Travel Time Data, Travel Time Run Graphs, and any additional information that the Consultant feels is required.
 - For formatting details, refer to Section F.3.4 Speed and Travel Time Runs.
 - Physical Inventory
 - In the “Body” of the DCR, provide a summary of the physical inventory collected on the corridor with reference to the proper appendices containing the physical inventory including transit information (frequency and bus numbers) turn restrictions (see Example C at the end of this subsection), heavy vehicle restrictions, parking restrictions, grades, posted speed limits, lane changes, analysis of the red lined plans and any significant changes in geometry, current signal timing observations, offset problems, and any additional information that the Consultant feels is required.
 - In the “Appendix” of the DCR, provide the red-lined plans, photo log, sketches, transit information, parking restriction information, grade calculations, heavy vehicle restriction information, field signal timing observations, residual queue estimates and memo, etc.
 - For format details, refer to Section F.3.3 Physical Inventories (PI).
- Section III, “Conclusions.” A summary of the analysis and explanation of the patterns presented in the report for data processed from ATRs, TMC, Speed & Travel Time Runs, and Queue Observations. Recommendation whether or not this particular corridor is suited for signal optimization. This section will provide an overall technical assessment of the existing conditions of the corridors.

Sample Data Collection Report (DCR) Template, Example A, Example B, and Example C

MANUAL REFERENCE:	 Data Collection Report (DCR) Appendices\DataCollectionReport.pdf
MANUAL REFERENCE:	 Example A - Graphical Representation of Average Weekday and Weekend ATR data. Appendices\ExampleADCR.pdf
MANUAL REFERENCE:	 Example B - Summary of Speed and Travel Time Runs with snapshots of the “Google Worm” Appendices\ExampleBDCR.pdf
MANUAL REFERENCE:	 Example C - Sample Turn Restrictions Table Appendices\MSE623.pdf

F.4. Data Analysis and Optimization of Existing Traffic Control Systems

F.4.1. Traffic Signal Modeling Software

Traffic data is analyzed by running simulation studies using macroscopic-simulation and/or microscopic-simulation software models, aka traffic models. Optimization models are characterized as macroscopic scale traffic models that are used to develop optimal signal timing directives for signalized intersections, corridors and roadway networks. Optimization models through the implementation of mathematical algorithms provide optimal cycle lengths, splits and offsets based on the quality of data input into the model software. The model software package selected needs to have some of the advantageous features such as easy data entry, complete and flexible optimization, graphical reports, Time-Space diagrams, and should be capable of analyzing oversaturated conditions, if necessary, all while adhering to the latest industry standards. Of particular interest in the selection of a software package(s) is the capability to measure the following three (3) parameters:

1. Uniform Delay
2. Incremental Delay
3. Residual Queue Delay

Software options that adhere to all three (3) parameters should be explored in order to accurately assess the performance of the signals within the specified corridor. Not all software tools accurately assess and model all three (3) parameters so this could be a major decision point in the optimization process. Some widely used macroscopic models include Synchro, Transyt 7-F, and PASSER to name a few.

Micro-simulation models, however, analyze the movement and traffic interactions on transportation facilities of individual vehicles over a period of time. Micro-simulation models employ mathematical techniques to predict system performance based on individual traffic events in space and time and reflect the random nature of traffic. These models are typically used for analyzing oversaturated conditions where queue build-up and discharge characteristics, delay, stop and go, and phase failures are important in the analysis. Micro-simulation models widely used by transportation professionals include TSIS-CORSIM, PTV VISSIM, Paramics and Simtraffic. Each software package has its various advantages, limitations, and functions all of which must be vetted before final selection and approval from MSE is provided.

Existing base model networks should be developed to replicate existing conditions during the AM, Midday, PM and/or Weekend periods, including the current geometric configuration, existing signal timing parameters (including existing clearance intervals, minimum green times, etc.), and traffic volumes as acquired through the DCP. The existing conditions model should be used as a starting point to create an optimized model. The following sections detail a common set of conventions to be used in developing the traffic models, as examples only. The Consultant shall review and get the approval of MSE for all of the data structures and file formats to be used in the development of the traffic models.

F.4.2. File Structure and Naming Convention

Model network files should adhere to the naming convention used by NJDOT unless otherwise discussed in advance with the NJDOT Project Manager.

The following abbreviations may be used in file naming:

Zone Number:

- Numeric designation (1, 2, 3...)
- "A" for all (the entire control section if no zone breakdown is used, or if multiple zones are included in the same file)

Condition:

- "EX" for existing condition
- "NB" for No-build
- "OPT" for optimized condition

Time of Day:

- "AM" for AM peak period
- "PM" for PM peak period
- "MD" for mid-day period
- "OP" for off-peak period
- "SAT or SUN" for weekend period
- "SP-IN" for an inbound special event timing plan
- "SP-OUT" for an outbound special event timing plan
- "IM" for an Incident Management plan

F.4.3. Basic Coding Parameters

As a general rule, coding parameters used by MSE shall be consistent. The following common procedures and values are suggested for use when coding the basic software model network:

F.4.3.1. Link Naming

Link names along a single corridor should be as consistent as possible so that the corridor will be recognized as a single arterial and be displayed properly in the time-space diagram.

Road names should match the NJDOT's common Standard Roadway Identifier (SRI) database. For major routes, it should start with the route number followed by the local name if there is one.

Dummy nodes should be named alphabetically without duplicates. The alphabetical sequence should also be consistent throughout all model network files between time periods.

F.4.3.2. Link Speed

As a suggested rule, the link speed coded in the model provides the basis for evaluating progressive movement between signalized intersections and should reflect field conditions. As such, the speed should always be set to the posted speed limit in the optimized model, which represents the desired progressive speed. Any deviation from using the posted speed limit for a specific roadway should be consulted and approved by the MSE Project Manager. In the event that the speed limit was not obtained from field observations or existing documentation, the legislative speed in discussion with MSE shall be used.

F.4.3.3. Ideal Saturation Flow Rate

A suggested default ideal saturation flow rate for a movement at an intersection would be 1,900 vehicles per hour. In the absence of field data the default value could be used unless otherwise advised by the MSE Project Manager.

F.4.3.4. Volume Input

Volumes should be input into the model as per the volumes recorded and approved through the DCR.

F.4.3.5. Peak Hour Factor

The Peak Hour Factor (PHF) is used to account for fluctuations in hourly volumes. Peak hour factors should be calculated by intersection approach, and should be input into the model for all movements on that approach. As per the HCM 2010, a single peak hour factor for an intersection can also be used to avoid the likelihood of creating demand volumes that are disproportionate to the actual volumes during the 15-minute analysis period. This however, should be discussed and approved by MSE prior to performing any such PHF calculations.

Exceptions may be made for locations where the turning movement peak hour factors should be calculated separately from the overall approach peak hour factor. This may occur at schools or factories where an approach may have steady overall volumes thru the peak hour, but the turning movement going to or from the traffic generator may have strong peaking characteristics. Exceptions may also be made for left turn movements or through movements causing starvation.

The following formula for calculating the PHF is based on the *HCM 2010 Volume 3: Interrupted Flow Manual*, Chapter 18 – Signalized Intersections.

$$PHF =$$

A PHF less than 0.85 will not be accepted for optimized models. For the existing model the PHF used should be based on the calculated value using the above formula.

F.4.3.6. Right and Left-Turn Lane Storage Distances

Right and left-turn lane storage lengths should be coded in the model as the greater distance from the stop bar to the end of the solid pavement marking for the lane, or the last left/right turn “ONLY” pavement marking, where applicable. Figure F-1 provides an example of the left turn lane storage length to measure and code in a traffic model.

Typically, taper lengths should not be measured. However, based on engineering judgment if a dedicated turn lane has a long taper length and vehicles are using the taper length as additional storage, then the portion of the taper being used as storage should be measured and coded as part of the storage distance for the existing conditions model only. If the turning vehicles extend past the end of the solid pavement marking for the lane or the last left/right turn “ONLY” pavement marking, whichever is greater, and consistently form a straight line using the area past the beginning of the turn lane as additional storage, then the portion of this area should be measured and coded as part of the storage distance for the existing conditions model only.

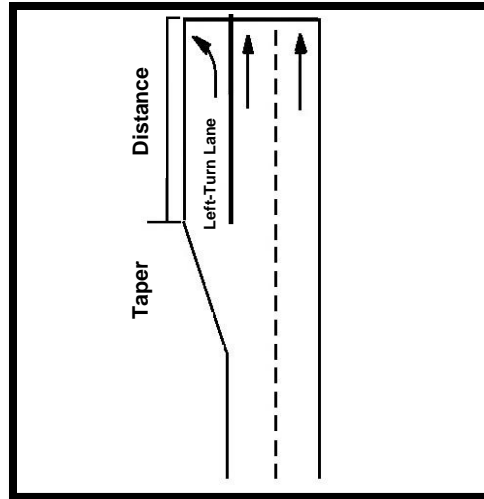


Figure F-1: Left Turn Lane Distances

F.4.3.7. Divided Highways

Where applicable, divided highways should be coded as parallel, one-way links, connected by crossing streets within the median space in order to appropriately replicate field operations.

If supported by the model software used, origin-destination information should be used wherever possible to properly proportion movements at the crossing locations.

F.4.3.8. Intersection Numbering

Intersection Node numbers are automatically generated by certain software programs. Where this is not the case, the intersection numbering should be developed by the Consultant in consultation with the Project Manager.

F.4.4. Standard Intersection Phasing Set-Up

The signal phasing used in the modeling software should follow the phasing as documented on the existing timing directive wherever possible. In cases where the timing directive phasing is unclear, NEMA standard phasing sequence may be used.

When coding intersection phasing, the offset must be referenced properly to the initial phase (or start-up phase) in the controller.

Offsets should always be set to match the existing timing directive. NJDOT typically references the offsets to the beginning of the yellow indication for the mainline through movement. Referencing offsets to the beginning of green or any other point in a phase should be discussed and approved by the Project Manager.

F.4.5. Signal Timing Parameters

F.4.5.1. Vehicular Clearance Interval Calculations

For Traffic Signal Optimization Projects, the method for calculating vehicular clearances (Yellow and All-Red) is based on the NJDOT methodology outlined in Chapter 12 of the NJDOT Design Manual. The process for calculating vehicular clearances is explained here for completeness and is as follows:

1. The total vehicular clearance interval is calculated using the following formula.

$$CP = t + +$$

- Where:
- CP = nondilemma change period (Yellow plus All-Red in seconds),
 - t = Perception-reaction time, use 1 second
 - a = Deceleration rate, use 10 ft/s²
 - L = length of vehicle, use 20 ft
 - V = approach speed, NJDOT uses the posted speed limit converted from mph to ft/s.
 - W = width of the intersection, measured from the back edge of the approach stop line to the farthest edge of the conflicting vehicle path or pedestrian crosswalk.

2. The NJDOT formula for calculating the yellow clearance is one second of yellow clearance for every 10 miles per hour of the approach speed limit (minimum of 3 seconds). The following formula is used for speeds above 30 mph:

$$Y =$$

- Where:
- Y = yellow change interval (seconds), rounded up to the nearest second
 - V = Approach posted speed limit (mph)


3. After establishing the yellow clearance interval, it is subtracted from the total vehicular clearance interval calculated in Step 1 to obtain the all-red clearance interval. Similar to the yellow clearance, the result is rounded up to nearest second.

Yellow and all red times should be calculated for thru and protected left/right-turn phases, if any, for all approaches.

The NJDOT has established the following minimum values for clearance intervals. The following minimum values are to be used in conjunction with engineering judgment and consultation with the Project Manager in the event that calculated values are lower:

Yellow clearance	3 seconds
Yellow arrow clearance	3 seconds
All-red clearance	2 seconds
All-red arrow clearance	2 seconds

The link below is for a *Sample Clearance Interval Calculation Template* to be used.

MANUAL REFERENCE:		Sample Clearance Interval Calculations Appendices\MSE622.pdf
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F.4.5.1.1. Pedestrian Timing

Pedestrian timing for use in Traffic Signal Optimization Projects is based on the methodologies outlined in the *MUTCD 2009*, Chapter 4E. The following sections describe in greater detail the requirements for the pedestrian Walk and Clearance intervals. Any deviation from the guidance provided should be discussed and approved by MSE.

Pedestrian Walk Intervals

As a general guideline for locations with pedestrian signals, the pedestrian walk interval should generally be 7.0 seconds or greater. Walk intervals less than 7.0 seconds will be considered if the pedestrian time requirements exceed the vehicular time requirements for that particular vehicular movement, or if low pedestrian demand exists, but the walk interval shall be no less than 4.0 seconds.

Pedestrian Clearance Interval

The pedestrian clearance interval is evaluated on two (2) conditions. The following formula is to be used for both conditions as explained below:

$$Pc =$$

Where: Pc = Pedestrian clearance interval (seconds), (rounded up to the nearest second)

Ws = Pedestrian walking speed, feet per seconds

Wd = crossing distance, feet

For Condition 1:

$Pc1$ = Flashing Don't Walk (FDW) (seconds) rounded up to the nearest second

Ws = use 3.5 feet per second

Wd = crossing distance is measured curb to curb.

For Condition 2:

$Pc2$ = Total takes the Walk and FDW time into consideration (seconds), rounded up to the nearest second

Ws = use 3.0 feet per second

Wd = crossing distance is measured from the pedestrian push button to the far side of the curb. If no pedestrian push button is present, measure this crossing distance as curb to curb plus 6 feet.

$Pc3$ = Walk time = $Pc2 - Pc1$ (seconds), where $Pc3 \geq 7.0$ seconds

The following considerations should be made with respect to the crossing distance:

- If a crosswalk exists, distance is measured along the crosswalk line closest to the stop bar from curb-to-curb. However, in the case where the pedestrian timing requirements exceed the time necessary to serve vehicular movements, the distance can be measured from the near curb to the extended edge of the farthest travel lane, or if agreed to by the Project Manager, from the near curb to half-the width distance of the farthest travel lane.
- If there is a crosswalk, separated by a median of a width not sufficient to be considered a refuge island/area, then use the entire curb-to-curb distance of the crosswalk in the calculations.
- If there is no crosswalk and/or no stop bar, measure the distance from curb-to-curb.
- If a crosswalk exists with a refuge island/area equipped with a pedestrian detector/push button in the middle of the crosswalk, measure the two (2) crosswalk distances found on the opposite sides of the refuge island/area and calculate the pedestrian clearance intervals for each crosswalk distance.

F.4.5.1.2. Minimum Green Intervals

Minimum green (i.e., minimum initial) intervals should be determined for each signal phase at the intersection for semi-actuated and fully-actuated intersections. Minimum green intervals should be applied as follows:

- 10.0 seconds should be used for all major street through movements, including:
 - Major arterial roadways
- 7.0 seconds may be used for the following:

- Minor cross-street movements (e.g., subdivision entrances, driveways, secondary roadways)
- All left-turn phasing with the exception of actuated permitted-protected left-turn phasing
- 5.0 seconds may be used for the following:
 - Actuated protected-permitted left turn phasing.
 - At locations with low turning volumes, the minimum green for left turn phases may be reduced to 5.0 seconds with approval of the MSE Project Manager.

For major or minor street crossings where there are no pedestrian push buttons (PPB), the minimum green interval should consist of the FDW as calculated above.

Minimum Split Calculations

The minimum split is the shortest amount of time allowed for a specific phase. The minimum split includes the minimum green interval plus the vehicular clearances (yellow interval and all red interval). Minimum splits for each phase must be calculated and entered into the software model in order to conduct the optimization. Alternatively, splits can be optimized using the simulation software settings. The minimum green split is calculated as follows:

$$\text{SPLITmin} = \text{Gmin} + \text{Y} + \text{AR}$$

Where:

- Gmin = Minimum Green Time (Minimum Initial)
- Y = Yellow Time
- AR = All Red Time

When there is a need to accommodate pedestrian demands at crossings that do not have pedestrian detectors, it is necessary to include pedestrian time intervals (Walk and clearance intervals) for pedestrian movements allowed during a particular vehicular phase within the calculation of the minimum split. The minimum pedestrian split equation used based on pedestrian time intervals would be as follows:

$$\text{SPLITmin} = \text{W} + \text{FDW} + \text{Y} + \text{AR}$$

Where:

- Gmin = Minimum Green Time (Minimum Initial)
- Y = Yellow Time
- AR = All Red Time
- W = Walk Time
- FDW = Flash Don't Walk Time

The above equation assumes that the W and FDW intervals are contained within the minimum green time. Typically, NJDOT includes the W and FDW intervals within the green interval, but as shown in Figure 2 (MUTCD 2009, Figure 4E-2) the FDW could also extend beyond the green interval. Under special circumstances where the calculated FDW interval is long enough that it would require for cycle lengths to be longer than desired, or that a particular phase would need to be lengthened thus resulting in poor operations for other approaches or the network, the FDW time could be extended into the yellow interval or a portion thereof. Under such conditions, the Consultant must consult and get approval from the MSE Project Manager.

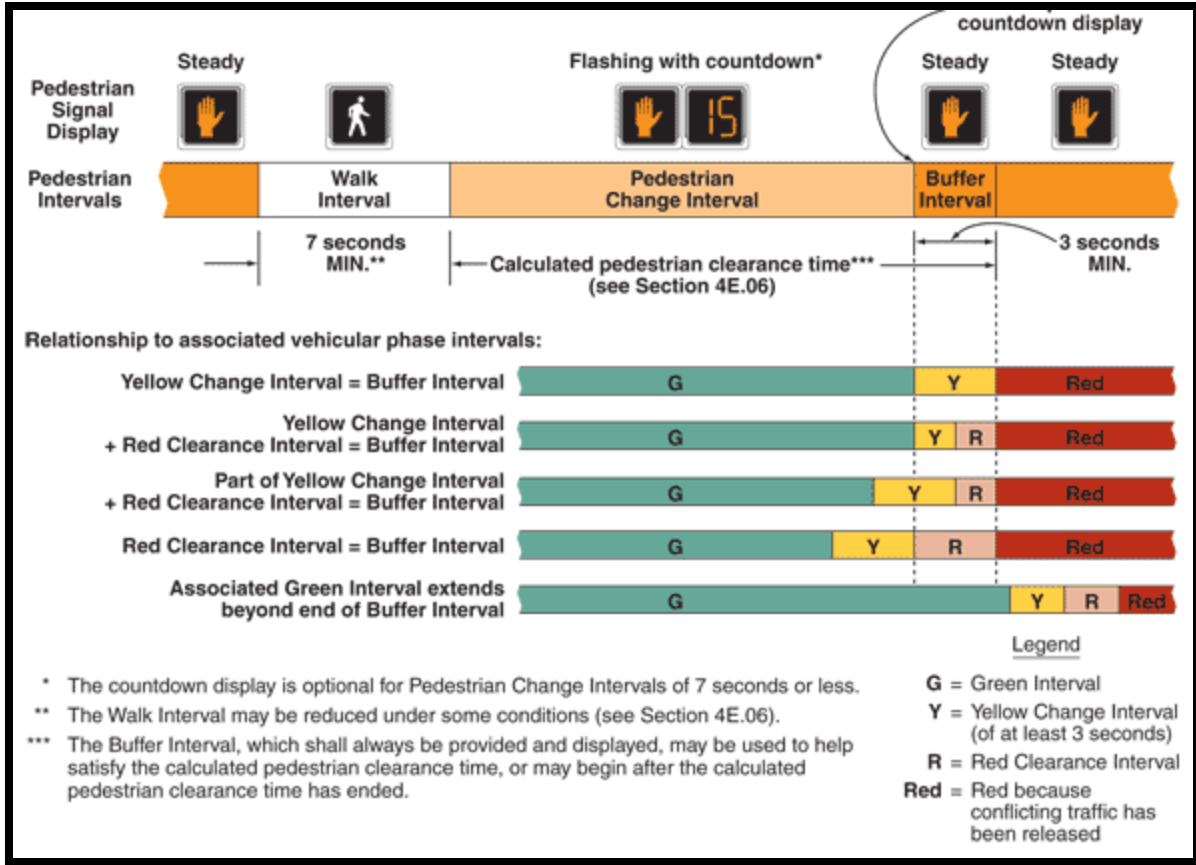


Figure F-2: Extension of FDW Scenarios
(Source: MUTCD 2009, Figure 4E-2)

The pedestrian minimum is calculated using one of two equations based on the extended pedestrian clearance type. The extended pedestrian clearance defines whether the Flashing Don't Walk will extend through the Yellow, or Yellow and All-Red, or neither. The two cases of extended pedestrian clearance and the corresponding equation for the minimum split are found in Table F-2. The equations found in Table F-2 are to be used under special circumstances only, as described earlier and the Consultant must obtain approval from the MSE Project Manager before using such equations.

Table F-2: Minimum Split Equations for Pedestrian Times

Description	Equation
Flashing Don't Walk extends through the Yellow and All-Red	$SPLIT_{min} = W + FDW$
Flashing Don't Walk extends through the Yellow and ends at the beginning of All-Red	$SPLIT_{min} = W + FDW + AR$

Where:

- Gmin = Minimum Green Time (Minimum Initial)
- Y = Yellow Time
- AR = All Red Time

W = Walk Time
FDW = Flash Don't Walk Time

Minimum Green/Walk intervals should always be based on the minimum interval times.

NOTE 1: For Signal Optimization Projects the optimized model will be coded assuming no pedestrian calls. Only in cases where pedestrian actuation happens every cycle would the modeling represent the pedestrian actuation in the optimized model.

It should be noted that the extension of the Flashing Don't Walk into the yellow and all red vehicular clearances can only occur if there is at a minimum a 3-second buffer between the end of the Flashing Don't Walk and the end of the All-red interval. For example, if the all red interval of a particular phase is 3 seconds long, the Flashing Don't Walk time cannot extend into the All-red interval because the all-red interval serves as the minimum 3-second buffer as shown in Figure F-2. If the all-red interval was 4-seconds long, then the Flashing Don't Walk time could extend 1-second into the all-red interval and the remaining 3 seconds of the all red interval would serve as the 3-second buffer.

F.4.5.1.3. Actuated Signal Settings

The following values should serve as the default settings in the case of actuated signals for the vehicle extension and minimum gap:

- Vehicle Extension = 2.0 seconds, refers to the unit time extension for each vehicle during the extensible portion of the green interval.
- Minimum Gap = 2.0 seconds, refers to a volume density parameter that specifies the minimum green extension when gap reduction is used.

For actuated locations, extra attention should be paid to make sure that phases are on the correct side of the ring barrier so that the signal will operate correctly when simulated in a traffic micro-simulation model (e.g., SimTraffic).

F.4.6. Calibration and Validation

The existing base software model must be calibrated and validated to actual field conditions before further analysis is conducted. In addition to performing adjustments to the model parameters to better reflect nuances experienced in the field, this process serves as an opportunity to validate the accuracy of the model inputs. This model serves as the benchmark for visualizing and designing any improvements for the future.

Model outputs should be compared against any available and comparable field data to determine the validity of the model results. On a typical project, this would be traffic volume served versus demand. A comparison of the actual Turning-Movement Counts (TMC) that were input into the model and the model results should be performed and reported. This report should be conducted to assure that the actual volume levels observed in the field are being replicated by the model. Other factors such as travel times, delays, queues, and lane utilization should also be considered when calibrating the existing model.

Special attention must be given to ensure that existing conditions are analyzed as accurately as possible and that the software being used has the capability to calculate those parameters being used for calibration. With respect to delays, the Consultant must ensure that the software used can account for the following three (3) parameters as calculated in the HCM:

1. Uniform Delay
2. Incremental Delay
3. Residual Queue Delay

If a particular software package does not account for all three (3) components of delay, additional software or other methods must be considered.

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NOTE: If the existing model includes driver behavior patterns of using Yellow or All-Red as an extension of green – it will be allowed under the Existing Conditions Model, but it will not be allowed for the Optimized Model(s). Other types of driver behavior that should not be replicated in the optimized model include, intersection blocking, and speeds other than the posted speed limit.

F.5. Optimization

F.5.1. Zone Assignment

In many cases, dividing a corridor into smaller coordinated zones with different cycle lengths may be necessary or desirable. Zone splitting could be beneficial in minimizing delays and stops within a coordinated zone. The Consultant will provide proposed coordinated zones for review by MSE with logical breaks in the corridor that will provide for better optimized field conditions.

The following are examples of conditions where zone splitting should be considered:

- Where a transition occurs from a median-divided to undivided roadway
- At a highly-congested intersection where congestion prevents progressive movement, even when a common cycle length is used. This intersection is typically assigned the master or reference intersection within a group of coordinated signals that the signals will be referenced to. The maximum green bandwidth at the master or reference intersection will provide for the minimum green time on the mainline through movement for all signals within the coordinated zone.
- Where unique geometric conditions necessitate signal phasing not consistent with other intersections within the project corridor.
- Where a natural break in progression occurs, such as a corridor terminating at a “T” intersection, the crossing of a freeway, or a long segment of roadway without a signalized intersection.
- Where a signal is to have variable cycle lengths and will operate in the “free” mode and will therefore, not be coordinated with any other signal in the corridor.

Zone assignments must be approved by MSE before continuing with the optimization process.

F.5.2. Coordination with Adjacent Signals

Extensive efforts will be made by the MSE Project Manager and the Consultant to have the project limits such that coordination with adjacent signals is not required and no other coordinated zones will be impacted by the intersection timing revisions performed within the corridor’s coordinated zone. However, coordination with adjacent signals, outside the project scope, should be investigated under certain conditions so that the optimization project causes the least possible disruption to the surrounding signal network. The following are some examples of when coordination with adjacent signals should be investigated:

- When a signal is closely adjacent (less than 1/4 mile) to the project area/corridor.
- When the optimized cycle length for the corridor’s coordinated zone is the same as the surrounding signal network, and cross-progression could be accommodated.
- When there is a major traffic generator or nearby thoroughfare that is highly dependent on numerous signals acting together in unison to provide adequate progression, (e.g. a mall, bridge, shopping center, etc.).
- When single intersections adjacent to the corridor are left isolated (not coordinated with any signal or system) by the optimization project.

The extent of coordination may vary from proposed changes in offsets to a complete re-timing. Every effort should be made to determine coordination requirements in advance of proceeding with a Traffic Signal Optimization Project. The extent of coordination should be discussed and determined in the early stages of the Traffic Signal Optimization Project by the Consultant in conjunction with MSE.

F.5.3. Phasing

NJDOT applies a standard NEMA phasing sequence wherever possible in order to provide sequential operation. Signal phasing should not be changed unless special conditions exist where other phasing

strategies are required, or would result in a substantial improvement over standard phasing. As a general rule, NJDOT provides these standard phasing sequences or guidelines and the Consultant should follow these. Any deviations must be approved by MSE.

The following phasing sequences are typically used:

- Left turns should precede the through movement where left turn protected-only and left turn protected-permitted phasing is used, unless indicated otherwise.
- Split phasing represents an assignment of the Right of way (ROW) to all movements of a particular approach, followed by all of the movements of the opposing approach. Split phasing may be necessary when intersection geometry results in partially conflicting vehicle paths through the intersections or where the approaches are offset such that left turning vehicles from opposite approaches would have to occupy the same space to complete their turns. Existing split phase sequence should be adhered to as much as possible. Any proposal to change the order shall be discussed with MSE prior to being modeled with information on perceived benefits.

F.5.4. Splits

A signal phase “split” generally refers to the sum of the Green, Yellow and All-Red time for any given phase. For simplicity, the green interval, clearance intervals, and splits determined during the optimization process should be whole numbers (i.e. 32 seconds vs. 31.7 seconds).

F.5.5. Optimization Techniques

The optimization functions in the traffic model may not provide timings consistent with NJDOT's preferences. Care should be taken by the Consultant to manually adjust the timings based on the following general guidelines:

- Cycle Lengths: Cycle lengths should generally be evaluated first based on the quality of progression for the mainline corridor, and secondly based on the resulting local intersection delay. Typically, cycle lengths that provide optimum progression for a high-volume corridor will yield the best overall network performance.
 - The progression and splits must be reviewed during the process of selecting a cycle length as the splits and offsets that the traffic model provides may be impractical and/or provide excessive time to minor movements and thus may point to a less than ideal cycle length. The model should simply be taken as a guide, and then engineering judgment and local knowledge should make the final determination for all splits and cycle lengths.
 - It is possible to eliminate certain cycle lengths that are unsuitable for the corridor.
 - If a corridor has a high volume with multiple left turn phases, a 60-70 second cycle length can typically be eliminated.
 - High volume corridors with high volume cross-street traffic should avoid high cycle lengths to avoid excessive delays for minor street movements.
- Splits: Signal phase splits should be manually adjusted in general to favor the mainline corridor (typically the higher volume roadway), while maintaining acceptable LOS on the intersecting roadway. When adjusting splits, LOS should not be negatively impacted (made worse) from the existing conditions. If an existing approach has a LOS F, the optimized approach could be LOS F, as long as the delay is improved over the existing conditions. Special attention should be paid to locations where a major arterial crosses the mainline corridor.
- Offsets: If traffic is highly directional, offsets should generally be adjusted to provide optimal progression for the predominant peak direction, while maintaining the best possible progression in the direction with less volume. If the cycle length remains the same in optimized conditions as in existing conditions, a common reference point should be established for ease of comparing the

existing and optimized offset plan. A reference intersection should be selected (typically a major crossroad or a signal at one end of the corridor per coordinated zone) and the existing offset at that location held constant for the optimized condition with all other offsets developed around it.

- Generally overnight cycle lengths should be low due to low queues to avoid long wait times at any approach.

In addition to signal timing considerations during optimization, oversaturated intersections also should be analyzed in detail. An oversaturated traffic intersection is defined as one where traffic demand exceeds the capacity (i.e., $v/c > 1.0$). The detrimental effect is characterized by a residual queue at the end of a cycle, which will require a portion of green time in the next cycle; or by a spill-over from downstream traffic whereby usable green time is reduced because of the downstream blockage. One must carefully analyze the partitions and signal groupings in order to avoid exacerbating oversaturated conditions within a corridor.

The Consultant must ensure that the proper software package(s) are being used to properly analyze oversaturated conditions where queuing is a contributing factor.

F.5.6. Measures of Effectiveness

Measures of Effectiveness (MOEs) should be evaluated to determine the effectiveness of the optimization process. MOEs to be considered vary between the local intersection and network levels.

Local Intersections:

Intersection delay, LOS, and queues should be evaluated as the primary MOE at the local intersection level. Wherever possible, LOS should remain the same as existing conditions or be improved for all approaches. However, engineering judgment should be used to balance approach Levels of Service (LOS) based on relative traffic demand.

Network/System:

Progression bandwidth should be evaluated as the primary MOE at the network/system level utilizing a time/space diagram. The optimization should aim not only to provide the maximum bandwidth along major corridors, but to position the band to provide progression for the leading vehicles in the platoon (leading edge bandwidth) wherever possible. While other MOEs should be evaluated as part of the optimization and reporting process (discussed in later sub-sections), the above MOEs should be considered the most important when making optimization decisions and adjustments. Due to the unique characteristics of each corridor, the Consultant should discuss various other strategies/techniques for optimizing each corridor, due to the unique characteristics of each, with MSE before the optimization process begins. Such characteristics could include oversaturated intersections and the Consultant should employ techniques to mitigate such conditions.

F.5.7. Time-of-Day Schedules

The Time-of-Day (TOD) schedule for the coordinated zone should be updated as part of the optimization process to designate when the various timing plans should be in effect. The following guidelines should be followed in determining the TOD schedule:

- Signals typically operate under the following timing plans: AM peak period, PM peak period, a Midday peak period, and a Weekend period.
- 24-hour counts from ATR data should be used to determine when timing plan changes should occur based on the traffic flow pattern. Figure F-2 presents an example of a typical 24-hour traffic flow pattern of an average weekday and illustrates where timing plan changes may be appropriate.
- Certain locations may require special mid-day, night, or weekend timing plans to accommodate unique conditions, such as school dismissal or shift changes. In such cases, coordination should be maintained whenever possible with adjacent signals operating on a standard TOD schedule.

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- Other special cases may require timing plans for seasonal periods. This is typically used on recreational routes that may experience increased vehicular demands during summer or winter seasons.
- When a signal comes out of flash mode, the signal must go through a period of correction or transition where the controller adjusts the timings to move the offset to the desired time. Another example is when you have an oversized ped movement – when your pedestrian clearance exceeds the green time for the same phase. During this correction the controller is “offset seeking” and progression will not be maintained. Depending on the cycle length, the amount of clock time adjustment needed to correctly position the offset, and how much clock time adjustment correction the controller can make per cycle will determine how many cycles will be required for the mainline’s progression to be restored (up to 10-15 minutes). In the AM peak period, starting the timing plan while volumes are still relatively low, but growing quickly, is often beneficial. This allows all the controllers to be in coordination when the peak volumes arrive. There may be situations where this is beneficial for the PM peak period, but the midday volumes are typically substantially higher than the very early morning volumes (typically before 6:00 AM) and the PM peak is typically more of a gradual increase in volumes as opposed to the sharp spike typically seen in the AM time period.

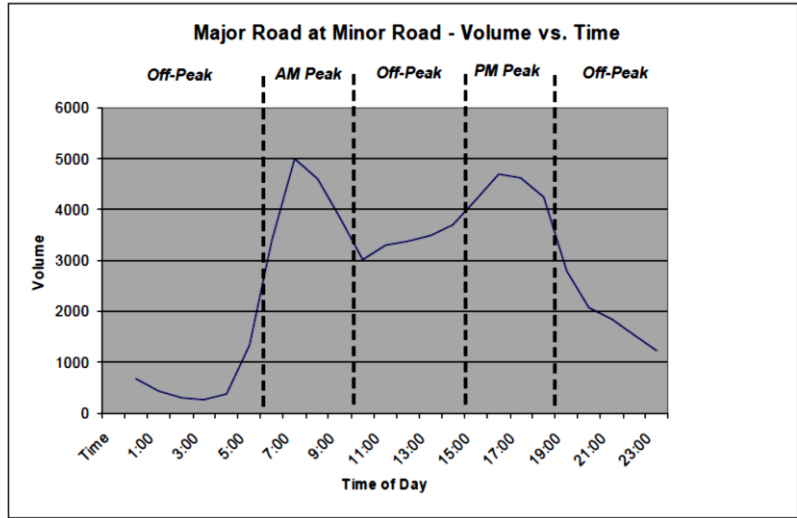


Figure F-3: Timing Plan Changes by Time of Day

Source: Michigan Signal Optimization Guidelines 5th Edition, October 2008 –Michigan Department of Transportation

F.6. Micro-Simulation

When required and upon approval of MSE, micro-simulation should be conducted using appropriate software suites such as SimTraffic, VISSIM, Paramics, or other as approved by MSE to further evaluate the network performance both before and after optimization. This evaluation should focus on the effectiveness of progression along major corridors and identification of potential storage issues due to bottlenecks along a corridor. The following sections document specific procedures to be followed when conducting micro-simulation.

F.6.1. Items of Interest in Micro-Simulation

Micro-simulation when required should not be utilized to replicate the functions of macro-models but instead, should be used to identify areas along a corridor that cannot be easily identified through the use of macro-models (e.g., oversaturated conditions).

F.6.2. Simulation Timeframe

A full hour of analysis is typically used per peak for all micro-simulation analyses in addition to an adequate period for network seeding. However, duration may be evaluated and determined on a project-by-project basis as simulation of large networks may become prohibitively long.

F.6.3. Measures of Effectiveness

Measures of Effectiveness (MOEs) should be collected and evaluated as a means of further assessing the results of the optimization process. The following MOEs should be reviewed during the analysis process and should be included in the final report:

- Average Network Speed
- Total Network Travel Time
- Total Network Stops



F.7. Timing Directives and Final Report

F.7.1. Timing Directives

Once timing plans are approved in the software model, a timing directive should be prepared documenting the timing parameters to be entered into the applicable controller(s). The Consultant shall submit to MSE the timing directives in Microsoft Word format in both an electronic and hard copy medium. If applicable, the Consultant shall also submit the timing directives in NEMA format on a flash drive.

If the project is a CTSS Project where Adaptive Signal Control Technology is being used, The Consultant must develop the Timing Directive in accordance with the sample provided below.

The reference document below is a sample of a typical NJDOT format Timing Directive to be developed in MS Word.

MANUAL REFERENCE:		Sample Timing Directive Format Appendices\MSE621.pdf
MANUAL REFERENCE:		Sample ASCT Timing Directive Format Appendices\MSE621.pdf


Optimized Timing Directive Review

Once the optimized timing directive(s) are obtained, they must be carefully reviewed to determine the extent of work needed for implementation. If they can be implemented within the existing controllers' hardware/software environment, they are implemented by the Regional Electrical Operations unit of NJDOT.

CTSS/Adaptive Timing Directive Review

Once timing plans are approved in the software model, a CTSS/Adaptive timing directive should be prepared documenting the timing parameters to be entered into the applicable controller(s) and CTSS/Adaptive software, where applicable. The Consultant shall submit to MSE the timing directives in Microsoft Word format in both an electronic and hard copy medium. If applicable, the Consultant shall also submit the timing directives in NEMA format on a flash drive.

An Optimized Timing Directive may be utilized as a back-up for a CTSS/Adaptive System. If an Optimized Timing Directive is not utilized, the Timing Directive is adjusted for safety minimums/clearances. Refer to the CTSS Sample Timing Directive Format.

MANUAL REFERENCE:		CTSS Sample Timing Directive Format Appendices\CTSSSampleTimingDirective.docx
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F.7.2. Implementation

Common practices in NJDOT are to review the optimized timing directives. During the bench testing process Regional Electrical Operations may come across a directive within the optimized timing directive(s) that the hardware is not capable of performing. Regional Electrical Operations will then provide recommendations and either MSE or the Consultant can revise the timing directive accordingly. Major hardware deficiencies or infeasibilities will be vetted out with Regional Electrical Operations during the early stages of the signal optimization process.

The following sub-sections describe the implementation process:

- Implementation entirely within the existing environment and

- Implementation with small changes in equipment and software.

F.7.2.1. Implementation Within the Existing Environment

Current implementation policy in NJDOT involves:

- Bench testing the optimized timing directives for satisfactory results.
- If unsatisfactory the optimized timings are reviewed and revised.
- Satisfactory bench test results will initiate the implementation process.
- Post-implementation signal timings are then studied and if found to be unsatisfactory, the implementation process is re-iterated.

After satisfactory post-implementation, the after study is performed. Once finalized, the Consultant prepares the final report for review and approval by MSE.

F.7.2.2. Implementation with Small Changes in Control Hardware and Software

Small changes in the hardware and software environment become necessary when traffic data analysis and optimizing the existing set of traffic signal controls result in infeasible solutions. For example:

- Timing plans go beyond the capabilities of the existing controller(s) requiring changes or new additions (say 1 or 2 controllers), or
- The desired results can only be achieved by more advanced software suites.

The implementation of such projects shall follow the same procedures described above with the addition of selecting and configuring new/updated hardware and control software as described in the following sub-sections. In addition, careful consideration and coordination with the Bureau of Traffic Engineering must be done to ensure that changes in hardware or software do not trigger ADA compliance regulations.

F.7.3. Field Adjustment

A field review of implemented timings is required for all projects in order to assure that timings have been implemented properly, and that the signal timings are facilitating traffic as they were designed. The field review of implemented timings should include the following steps:

- A timed check of the accuracy of phase splits should be conducted.
- Verification of offsets should be conducted by the Consultant by performing a driving check of the time-space diagram relationship by the Consultant. Sometimes, controller splits or offsets may “drift” so it is prudent to perform these checks two (2) weeks after the timing directives are implemented or in a time frame set by MSE. This will produce the best possible results from the optimization process. If the corridor is part of an existing CTSS or Adaptive System, the Consultant should request that the MSE staff check to see if the controller clocks are synchronized or that GPS clocks are installed at each intersection prior to performing a driving check.
- Any observed or unexpected conditions, such as cycle failures, incorrect splits, extensive queuing, spillbacks or starvation of storage bays should be noted and further reviewed by MSE in conjunction with the Consultant to determine whether reallocation of green time is required or appropriate.
- The time-space diagram relationship should be critically reviewed to determine whether progression is maintained as intended, and whether adjustments should be made to better facilitate coordinated traffic flow.

Any recommended adjustments after implementation should be documented in a brief memo, along with updated signal timing directives reflecting the proposed adjustments.

F.7.4. Project Benefits Analysis

A project benefits analysis should be performed for each project that quantitatively evaluates conditions both before and after the new timings are in place. This analysis will typically require collection of travel time or other data including, but not limited to, emissions, stops, dilemma vehicles, and LOS both before and after implementation. Specific procedures, however, will vary by project and will be determined in conjunction with MSE at the beginning of the project.

The benefit analysis can be performed using the following methodology:

- A second benefit analysis can be performed using results from a micro-simulation model. This method should be used when studying isolated intersections, small groupings of signals (typically 5 or fewer), or any other situation where before or after travel time runs are unavailable. The benefit analysis uses the following MOE's from the traffic simulation model:
 - Stop Delay (sec/veh)
 - Travel Time (hr)
 - Average Speed (mph)
 - Fuel Used (gal)
 - HC Emissions (g)
 - CO Emissions (g)
 - NOx Emissions (g)
 - Vehicles Exited

Several assumptions regarding average values are made as follows:

- Average Number of Work days per Year: 250
- Average Passenger Vehicle Occupancy: 1.6
- Average Truck Occupancy: 1.1

These values should be verified with the MSE Project Manager prior to completing the analysis.

F.7.5. Final Report

Each optimization project should deliver a final report documenting the project process and results as well as all data collected for the signal timing effort. The Consultant is to prepare the Final Report as shown in the sample Final Report Template at the end of this sub-section. At a minimum the Final Report should include the following sections:

- Project Purpose
- Background
- Before Conditions Data Collection
- Existing Conditions Analysis
- Optimization
- Implementation
- After Conditions Data Collection
- Anticipated Benefit Analysis or Reasoning Why Benefit Wasn't Achieved
- Future Recommendations

In addition to the above report sections, the Final Report is to include at a minimum the following Appendices:

- Background Data
- Before Data Collection
- General Data

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- Existing Conditions Results
- Optimization
- After Data Collection
- Anticipated Benefit Analysis

The following is a sample Final Report Template to be used by Consultants in preparing the Final Report for Signal Optimization Projects.

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G.1. Introduction

The Administrative Procedures section of this manual addresses the logistical and clerical processes that are in place in order to support the successful implementation and operation of the Department's Transportation Systems Management program. Administrative Procedures refer to those contributions which are not directly incorporated in the Transportation Systems Management operations, but rather support those activities.

Unlike the previous sections of this manual, which describe the technical aspects of Intelligent Transportation Systems from design through operation, this section serves as a guide to navigate the organizational and governmental structure of Transportation Systems Management and of the Department. In addition, the Administrative Procedures section includes detail relating to the processes, tools, databases, and procedures that relate to the back-end management of the Department's ITS program but do not control the ITS system directly.

The material in the Administrative Procedures section is intended exclusively for use by internal NJDOT personnel. It is made visible to external parties as a courtesy to aid in the understanding of the Department's administrative policies and procedures.

G.2. Consultant Agreement Administration

G.2.1. Definition

The term "Consultant Agreement Administration" refers to a uniform and consistent set of guidelines to be followed in administering contractual Agreements. For the purposes of this manual, these are Agreements established specifically between NJDOT Mobility and Systems Engineering (MSE) and consultants who have been retained to provide technical services to MSE.

This section applies solely to those Consultant Agreements that are managed by MSE. It does not apply to Agreements that are managed by other units within the Department, even if those Agreements contain elements of Intelligent Transportation Systems work. For information regarding MSE involvement in non-MSE Agreements, such as those administered by Capital Program Management or the NJDOT Bureau of Research, refer to section G.2.11.

Where the term "consultant" is used in the context of an actual Agreement, this term refers to the primary entity with whom MSE has entered, or intends to enter, into such an Agreement, and who holds ultimate responsibility for the deliverables produced. The singular term is inclusive of all sub-consultants or other entities that have been engaged by the primary consultant.

G.2.2. Purpose

The purpose of this section is to develop and document a uniform and consistent approach to all MSE Consulting Agreements. Establishing such a consistency will lead to a more efficient administration of Consultant Agreements, while also developing clear expectations among the consultants themselves. This section is intended to be organizational and procedural, but not technical, in nature.

G.2.3. Department-wide procedures

Many of the methods and processes that guide the selection and interactions with consultants are common throughout the Department. A description of these general arrangements is defined on the Department's Professional Services web page. The information in this section will supplement, but not replace or supersede, the information found there.

The Professional Services page includes information and forms both for consultants and for the Department. Resources on the page can assist with items including, but not limited to:

- Qualifying and selecting consultants
- Cost basis approval and title concurrence for consultants
- Goal compliance and DBE/ESBE/SBE information
- Consultant evaluation
- Documenting Agreement changes
- Types of Agreements (i.e. Project Specific Agreement, Task Order Agreement)
- Billing terms (cost plus fixed-fee, fixed price)

NJDOT REFERENCE:		NJDOT – Professional Services http://www.nj.gov/transportation/business/procurement/ProfServ
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In addition to the information on the Professional Services website, information on Agreement Development, Execution, Management, and Closure of Consultant Contracts is in Policy/Procedure #312, available in Appendix H.25.

G.2.4. Roles and Responsibilities

At the start of a Consultant Agreement, the Department and the consultant shall assign and identify personnel for the following key roles.

G.2.4.1. NJDOT Mobility and Systems Engineering

MSE has two distinct roles defined for management of a Consultant Agreement. These two roles may either be performed by the same individual, or they may be served by two different people who work closely with one another. Personnel filling these roles will be selected and assigned by MSE management. Both roles are integral in successfully completing a project on-time and on-budget. These roles and the respective responsibilities are identified below:

- **Project Manager:**
 - Provides technical guidance and review of consultant service
 - Receives reports, drawings, or other deliverables provided by the consultant and analyzes them as it pertains to the ultimate purpose of the work
 - Reviews project schedule and ensures technical progress is consistent with the schedule
 - Performs or oversees technical reviews
 - Enforces and holds responsibility for compliance with schedule and budget
- **Contract Manager:**
 - Manages correspondence relating to the Agreement itself
 - Receives and processes standard consultant deliverables (Agreements, progress reports) in accordance with MSE and Department procedures.
 - Reviews consultant invoices
 - Verifies compliance with budget.

The positions noted above are functional roles within the context of actual Consultant Agreements, and are not actual job titles which may share the same name.

G.2.4.2. Consultant

A consultant organization structure may vary depending on the type of Agreement as well as its size. While the consultant is free to establish its own organizational structure, there are two explicit roles which are defined by MSE and shall be identified by the consultant.

- **Program Manager:** The consultant shall designate a Program Manager who is responsible for all work performed under the Agreement between the consultant and MSE. The Program Manager will interface mostly with the MSE Director and the Contract Manager, but ultimately is accountable for all aspects of work performed under the Consultant Agreement.
- **Consultant Project Representative:** The Program Manager may designate one point-of-contact who will be responsible for day-to-day communications with MSE project management. For projects under a Task Order Agreement, the Program Manager may choose to assign one or more Consultant Project Representatives to lead the various Task Orders.

Individuals in the above consultant roles may choose to delegate responsibilities such as specialty technical expertise, scheduling, and administrative tasks to others within the organization. These delegates will interface primarily with the corresponding Subject Matter Experts within MSE. However, the consultant must be diligent in keeping the MSE Project Manager included in discussions, particularly those with impacts on the scope, schedule, or delivery of the assigned work's requirements. Such delegation is not required by MSE.

G.2.5. Categories of Consultant Agreements

MSE may engage consultants to perform a variety of tasks to supplement MSE's internal efforts. This section differentiates between the types of Consultant Agreements and the applicability of these Agreements within the scope of larger projects.

This section defines the various Consultant Agreements that are used by MSE. The activities and decisions that factor into establishing these Agreements are defined in the sections that follow.

G.2.5.1. Types of Consultant Agreements

Consultant Agreements may be advertised and awarded in the form of either a Task Order Agreement or a Project Specific Agreement.

G.2.5.1.1. Task Order Agreement

Task Order Agreements (TOAs) are used to retain firms who can quickly take action, if needed, on specific Task Orders without going through a full advertisement/selection process for each task, and who have the resources to work on multiple projects (Task Orders) simultaneously.

A Task Order Agreement does not guarantee that any work will actually be awarded.

Task Orders generally involve work that is smaller in size and value and sometimes require a quicker response than a Project Specific Agreement. The cost of a Task Order is limited as described in section G.2.6.3. Traffic Signal Optimization is an example of consultant work that is often performed under a Task Order.

In order for a TOA to be federally funded, the potential projects expected to be performed under the TOA must be identified in the public advertisement for the technical proposal.

G.2.5.1.2. Project Specific Agreement

A Project Specific Agreement is an agreement with a specific, defined boundary. It is often, though not required to be, larger in size than a Task Order.

Project Specific Agreements take time to go through an advertisement and selection process, and therefore are generally suitable for work that does not have an immediate, pressing need or for work with costs exceeding the Task Order Ceiling.

Project Specific Agreements can be used for Construction Inspection services or for design purposes.

G.2.5.2. Scope of Consultant Agreements

Individual Consultant Agreements (Specific Project Agreements or Task Orders) pertain to one of the following topics:

- Concept Development
- Design
- Construction Support
- Construction Inspection
- Miscellaneous Services

G.2.5.2.1. Concept Development

The first step of an infrastructure project is the Concept Development (CD) phase. The major objectives of this phase are to identify and compare reasonable alternatives and strategies that address the purpose and needs of the project. The CD phase will provide the information to determine whether or not the study can be advanced to the next phase of the process and to provide the framework for advancing the project into the Design Engineering phase. Prerequisites to the design phase, including matters relating to environmental documentation, are completed during the Concept Development phase.

Specific details on the objectives and deliverables of the Concept Development phase can be found in Part B of this manual.

G.2.5.2.2. Design

The second step of an infrastructure project is the Design. The major objective of this phase is to produce the project's construction contract documents (i.e., PS&E package) for use in soliciting bids from prospective contractors, and moving the project to construction.

During Design, it is important to maintain the project's scope as defined by the products completed during the CD phase. Early in this phase, the project's scope, the main goals and objectives, schedule, and budgetary constraints should be clearly established and documented.

The MSE Design process is usually broken down into three sub-components:

- Interim submittal (60% completion)
- Final design
- PS&E: Plans, Specifications, and Estimates

Specific details on the objectives and deliverables of the Design phase can be found in Part C of this manual.

G.2.5.2.3. Construction Support

Construction Support is intended to provide a Contractor with design support during the construction phase of a project. Tasks which fall under a Construction Support Agreement typically include, but are not limited to

- Response to contractor Requests for Information (RFIs)
- Review of contractor-submitted Shop Drawings
- Technical resolution of unanticipated design-issues or field-conflicts discovered during construction

Construction Support is not necessarily awarded to the contract designer, but the selected firm should have, at a minimum, an equivalent level of expertise relating to the technology being deployed and the manner in which it will be used by the Department.

G.2.5.2.4. Construction Inspection

Consultants who are awarded Construction Inspection Agreements operate as an extension-of-staff for MSE and will oversee field activities performed by a contractor during the construction phase of an infrastructure project. In addition to performing Construction Inspections of the contractor's work, the scope may include Resident Engineer duties, in which the consultant is responsible for coordinating all aspects of field work and managing interactions between the Contractor and the Department.

G.2.5.2.5. Miscellaneous services

Miscellaneous services include work that does not pertain directly to an infrastructure design/construction project. Examples of miscellaneous services may include

- Develop or modify standard drawings, specifications, and sample plans
- Write manuals or procedures
- Compile training materials
- Any other work that MSE does not have the time, personnel, or equipment to perform in-house

G.2.6. Initiating Consultant Agreements

The sequence of steps to initiate a Consultant Agreement is as follows. The steps are detailed in the sections that follow and in Figure G-1 through Figure G-4.

- Unit determines a need for consultant
- Unit decides if federal or State funded
- Unit decides requirements
- Unit decides if Task Order or Project Specific
- Unit prepares posting document
- Unit sends posting document to Professional Services
- Professional Services reviews and assigns a Technical Proposal number (TP#), and then posts document.
- Consultants submit responses
- Responses reviewed and evaluated
- Evaluations formalized and sent to Professional Services
- Professional Services prepares documents for Consultant Selection Committee (CSC)
- CSC meets and decides on a selection
- Agreement gets executed
 - Draft to consultant
 - Consultant signs and returns 2 originals to NJDOT
 - Circulate through department

G.2.6.1. Initiation of Consultant services

New MSE projects that are initiated may be based on one of the following sources:

- Input from Traffic Operations, based on historic data and/or projected events
- Published goals in MSE's ITS Ten Year investment Strategy
- The Congested Corridor list, a searchable internal database maintained by the Bureau of Systems Planning
- A Problem Statement, based on input from the public and found to justify the installation of ITS assets

The MSE Design process does not entirely follow the Capital Project Delivery (CPD) process, although guidance from CPD can be used to supplement MSE procedures.

TSM REFERENCE:		NJDOT ITS Investment Strategy – 10-Year Program http://www.nj.gov/transportation/eng/elec/ITS/pdf/10yearplan.pdf
NJDOT REFERENCE:		Capital Project Delivery – Overview http://www.nj.gov/transportation/capital/pd/

G.2.6.2. Objectives of Consultant Agreement

At the start of the process to retain a consultant for a particular task, the following questions must be considered:

- Is MSE seeking a consultant for a specific task or for an on-call Task Order Agreement (TOA)?
- Is the task to be performed best assigned to a consultant already retained by a TOA or selected based on a Technical Proposal submitted in response to a Project Specific advertisement?
- Will the anticipated cost exceed a Task Order ceiling? (See section G.2.6.3)
- Will federal funding be sought for the project?

G.2.6.3. Task Order Ceiling

The cost of a Task Order is limited by a Task Order ceiling, which varies based on the task being performed. The Task Order ceilings described in this section and shown in Table G-1 are accurate as of the publication of this manual. Verify these values prior to initiating new Task Orders, verify the ceiling.

No more than \$500,000 may be expended on each phase involving Concept Development/Preliminary Engineering. This can be accomplished either in one Task Order or in multiple Task Orders not to exceed \$500,000 for each phase.

No more than \$750,000 may be expended on an individual project involving Final Design/Construction Engineering Services, Construction Inspection Services and Right of Way Services. This can be accomplished either in one Task Order or in multiple Task Orders not to exceed \$750,000 for an individual project.

No more than \$500,000 may be expended on an individual project or study during the Agreement duration. This can be accomplished either in one Task Order or in multiple Task Orders not to exceed \$500,000 on an individual project or study.

Table G-1: Task Order Ceilings

Task	Maximum Cost
Preliminary Engineering	\$500,000
Concept Development	\$500,000
Final Design	\$750,000

G.2.6.4. Preparation of Advertisement for a Consultant service

Once MSE decides that a consultant is needed, the following steps are taken:

1. Determine if the Agreement will be a Task Order Agreement or a Project Specific Agreement (refer to Section G.2.5.1)
2. Determine if the Agreement will be State funded or federally funded, and what consultant goals (such as DBE/ESBE/SBE) may apply. These goals will be included in the Technical Proposal template.
3. Prepare the posting. The posting must include any goals that apply and, for federally funded TOAs, the potential tasks to be performed under the TOA, and the technical expertise requested.
4. Forward the posting to Professional Services, who will assign a Technical Proposal number (TP#) and put the posting under the “Technical Proposals” section of the Department’s Professional Services web site.
5. Technical Proposals are received

NJDOT REFERENCE:		<p>NJDOT – Professional Services</p> <p>http://www.nj.gov/transportation/business/procurement/ProfServ</p>
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G.2.6.5. Consultant Selection


After proposals are received, they are evaluated and scored by a Technical Evaluation Committee (TEC). The TEC is a selected group of people within the unit with the necessary expertise to evaluate Technical Proposals. Minimum criteria for those on a TEC are identified in Policy/Procedure 312, located in Appendix H.25.

Results are then forwarded to the Consultant Selection Committee (CSC) who selects a consultant in accordance with the Department’s Professional Services process.

- The Consultant Selection Committee, consisting of Assistant Commissioners, meets every two weeks
- An MSE Project Manager or MSE Contract Manager will make a presentation to the CSC describing the project, the proposals, and the evaluation project
- The CSC selects a consultant
- The CSC and the presenter sign the appropriate documents

After the Consultant Selection process is complete, including signature from the Deputy Commissioner, an email is sent to the Contract Manager informing the CM that the selection is complete. At this time, the Contract Manager is able to begin working on the Agreement.

Additional information is available in the Consultant Selection section of the Professional Services website and in Policy/Procedure 312, located in Appendix H.25.

NJDOT REFERENCE:		<p>NJDOT – Professional Services – Consultant Selection</p> <p>http://www.nj.gov/transportation/business/procurement/ProfServ/ConsulSelections/</p>
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G.2.6.6. Funding for Consultant Agreements

Project Specific Agreements and Task Order Agreements may be either federally-funded or State-funded.

G.2.6.6.1. Federal funding

For projects where federal funds are sought, preliminary contact should first be made with the FHWA's New Jersey Division Office to provide advance notice of an upcoming request. This will allow the FHWA to advise MSE of any modifications or supplemental information that may be required in order to expedite approval of a formal submission. Upon preliminary submission and receipt of approval, the formal submission for authorization to use federal funds may be made.

Requests for federal funds must include information, as applicable to the project, which includes:

- Federal program under which the project falls, identified as a line item from the Capital Program
- Project name, description, federal project number, and job number for the Agreement.
- Consultant scope of work under the Task Order or Project Specific Agreement
- Names and salaries of in-house Department staff that will support the project
- Total funds requested
- Whether the project is a PoDI, a PoCI, or neither
- End date of the project

This information shall be sent to the Capital Programming unit within the Department. Capital Programming will submit the request to FHWA.

MSE should use discretion in seeking federal funding for design Agreements. If federal funds are used to formulate a design that does not get constructed, those funds will need to be paid back to the FHWA.

The process described here shall be used separately for funding of consultants during the design and construction phases of a project. Federal funds may only be used for Construction Support Agreements if the design of the projects they support was also federally funded.

A flowchart depicting the process for securing of federal funding for Consultant Agreements can be found in Figure G-4 and also in Appendix H.23.

Prior to seeking Federal Funding, the Contract Manager should make note of FHWA involvement, as the work may be categorized as a Project of Divisional Interest (PoDI) or Project of Corporate Interest (PoCI). Such projects may involve additional requirements and efforts relating to the interaction with FHWA, and speed of funding can be impacted if this information is not properly delivered to FHWA.

G.2.6.6.2. State funding

State funding for a project is secured by first obtaining a Job Number, if necessary, via form AC-1643 to Capital Programming, and then by securing funds via form AD-12.

If the work is being accomplished through a Task Order, the AD-12 may need to be packaged along with the Task Order. If money has been "pre-loaded" into a Task Order Agreement, the AD-12 will have been processed separately, and prior to the Task Order being written.

If the work is being accomplished through a Project Specific Agreement, the AD-12 will be packaged with the Agreement.

When establishing Task Order Agreements, consideration may be given to pre-loading the Agreement with more funds than are initially needed in anticipation of additional tasks; however the pre-loading of funds does not influence the mechanism of getting the work done.

G.2.6.7. Obtain Job Numbers and Federal Project Numbers

Job numbers and Federal Project Numbers (FPNs) are used to provide a common reference for all documentation relating to an ongoing or planned work item. Job numbers and, if required, project numbers must be obtained prior to executing a Project Specific contract.

These numbers are used for organizational purposes. Issuance of a job number or FPN neither guarantees nor implies funding commitments for the job.

G.2.6.7.1. Job Numbers

Prior to executing a Consultant Agreement, a Job Number may need to be obtained. The process to obtain a Job Number begins with submittal of Form AC-1641 to Capital Programming.

Job numbers are assigned by NJDOT Capital Programming and are used exclusively by the Department; however the manner in which they are requested and issued depends on the funding source.

For State-Funded projects, a single Job Number may be used for any Agreement, regardless of the amount of work being performed under that contact.

For Federally-Funded projects, each task must be assigned a separate Job Number, thus forming a one-to-one relationship between Job Number and Project Number. For instance, Smart Moves 15, 16, and 17 would all get unique Job Numbers, even though they are part of the same overall program.


G.2.6.7.2. Federal Project Numbers

Federal Project Numbers are applicable only to jobs that have Federal funding. They are provided to MSE by Capital Programming and must be obtained prior to advertisement of the project.

In order to obtain a Federal Project Number, send the following information to Capital Programming:

- Name of project
- Available Federal funding source – Federal Program Line
 - Identify federal program from Strategic Transportation Improvement Program (STIP)
 - Note that, at this stage, identification of a funding source does not mean that funding will be provided

NJDOT REFERENCE:		FY 2014 - 2023 Statewide Transportation Improvement Program (STIP) http://www.nj.gov/transportation/capital/stip1423/
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EXTERNAL REFERENCE:		FHWA: A Guide to Federal-Aid Programs and Projects https://www.fhwa.dot.gov/federalaid/projects.cfm
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G.2.6.8. Executing Agreement

After selection of a consultant is complete, Professional Services assigns an Agreement Number based on the Technical Proposal number (TP#), year, and unit. The Agreement Number is in the format *YYYY UUU TP#*, where *YYYY* is the year of the TP# and *UUU* is the unit ID. If multiple Agreements result from a single Technical Proposal, a letter (A, B, etc.) is suffixed to the TP#.

The Agreement Number is placed into a template, along with other required information to create the draft Agreement.

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Each Agreement then is issued a Contract ID, which is year and then sequential number that, for TSM, starts with 09500. A sample would be 15 09501.

The Agreement is executed by following the flowcharts in Figure G-1 (For Task Order Agreements) or Figure G-2 (for Project Specific Agreements).

The forms required to execute Consultant Agreement are as per the Professional Services process, and can be found on the NJDOT Forms Catalog – Procurement Forms web page on the NJDOT Intranet.

For an example of the NJDOT Forms Catalog Intranet page, see Appendix H.20

During execution of the Agreement, funds are assigned to the job, whether federal- or State-sourced, via form AD-12. Form AD-12 can be found on the NJDOT Intranet.

G.2.6.8.1. Process flow

Refer to the flowcharts in Figure G-1 through Figure G-4 for a detailed breakdown of the process used to secure the various types of Consultant Agreements. These flowcharts can also be found in PDF form in Appendix H.23.

PART G - ADMINISTRATIVE PROCEDURES

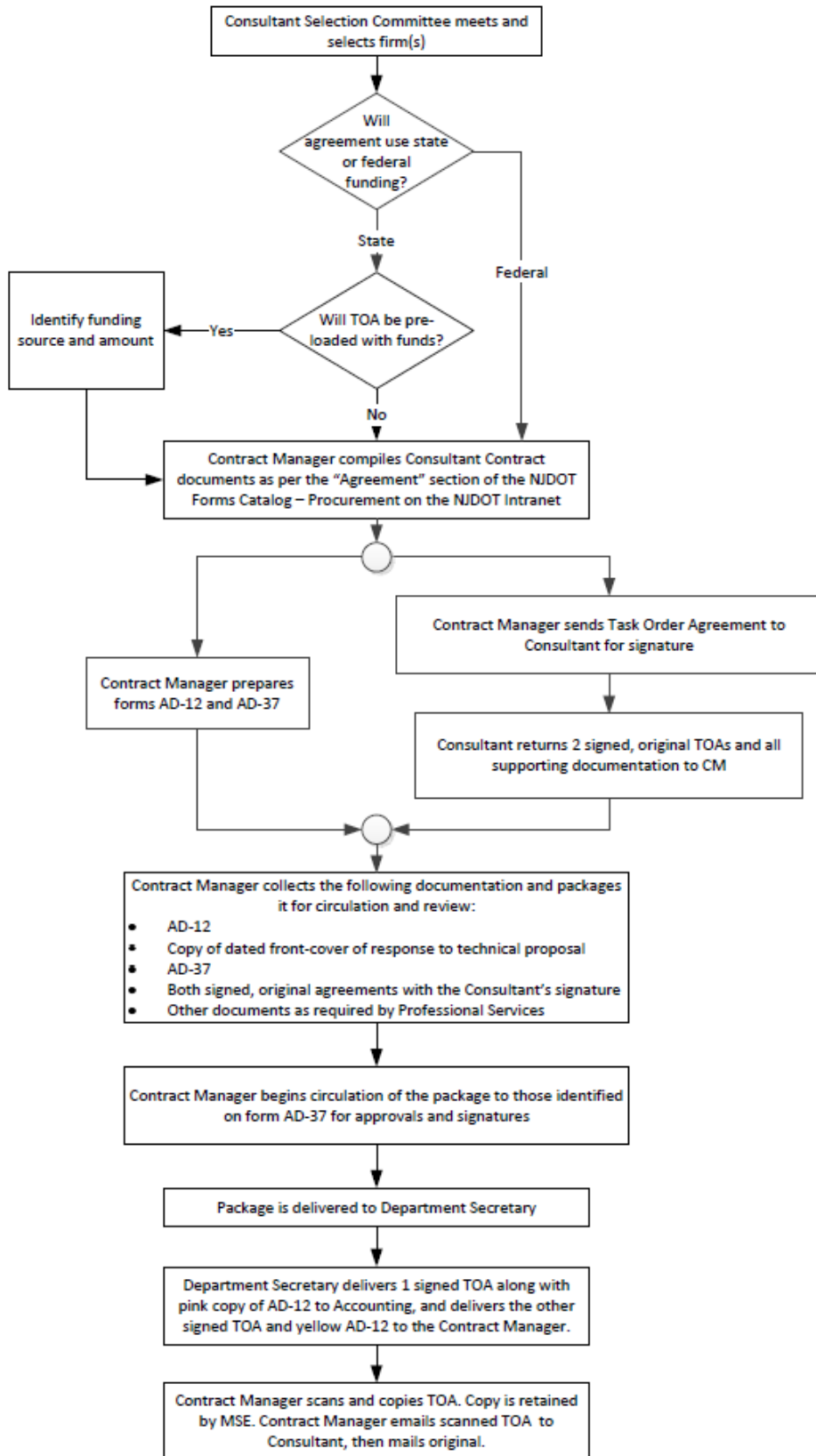


Figure G-1: Establish Task Order Agreement Flowchart

PART G - ADMINISTRATIVE PROCEDURES

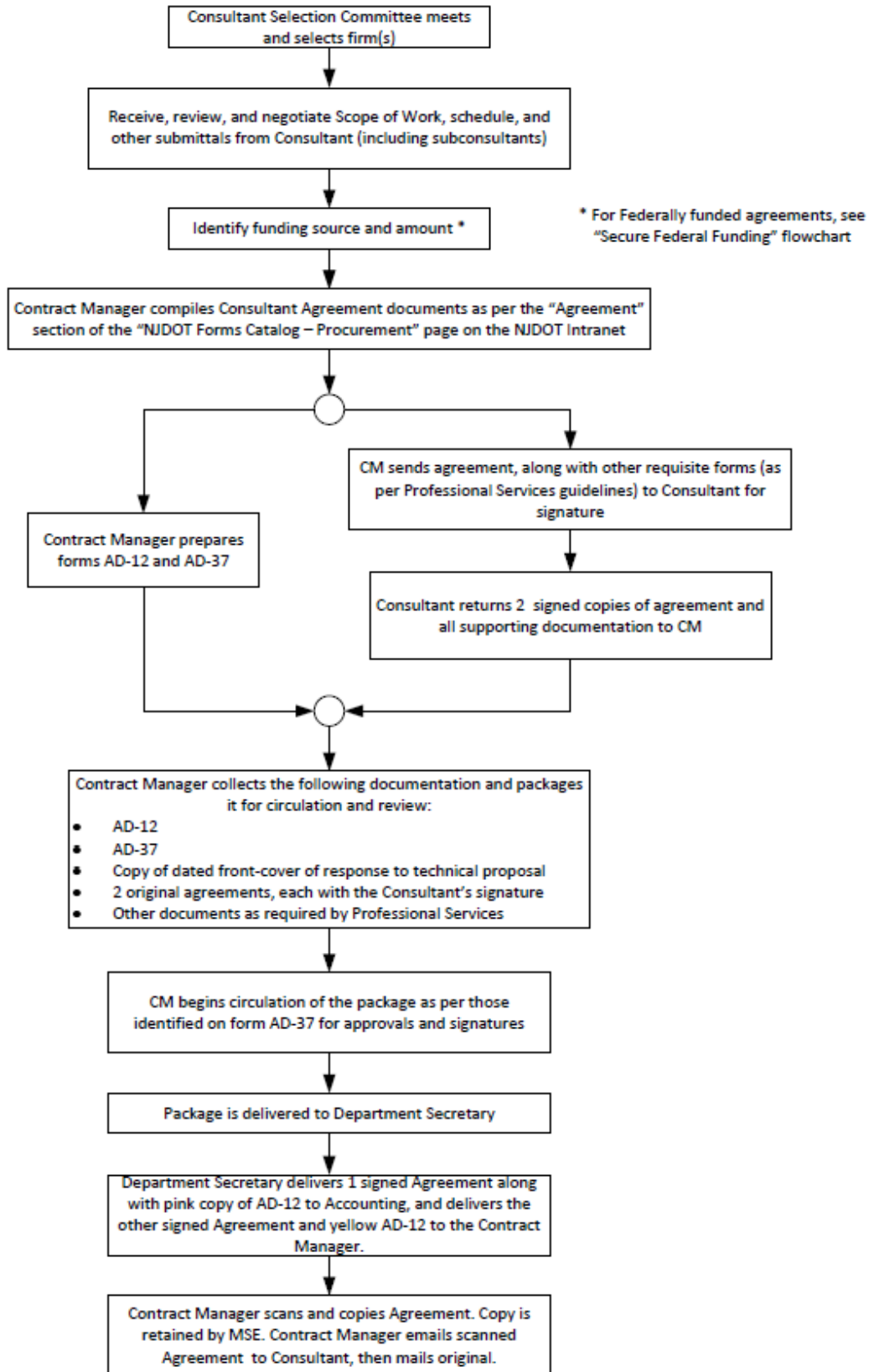


Figure G-2: Establish Project-Specific Agreement Flowchart

PART G - ADMINISTRATIVE PROCEDURES

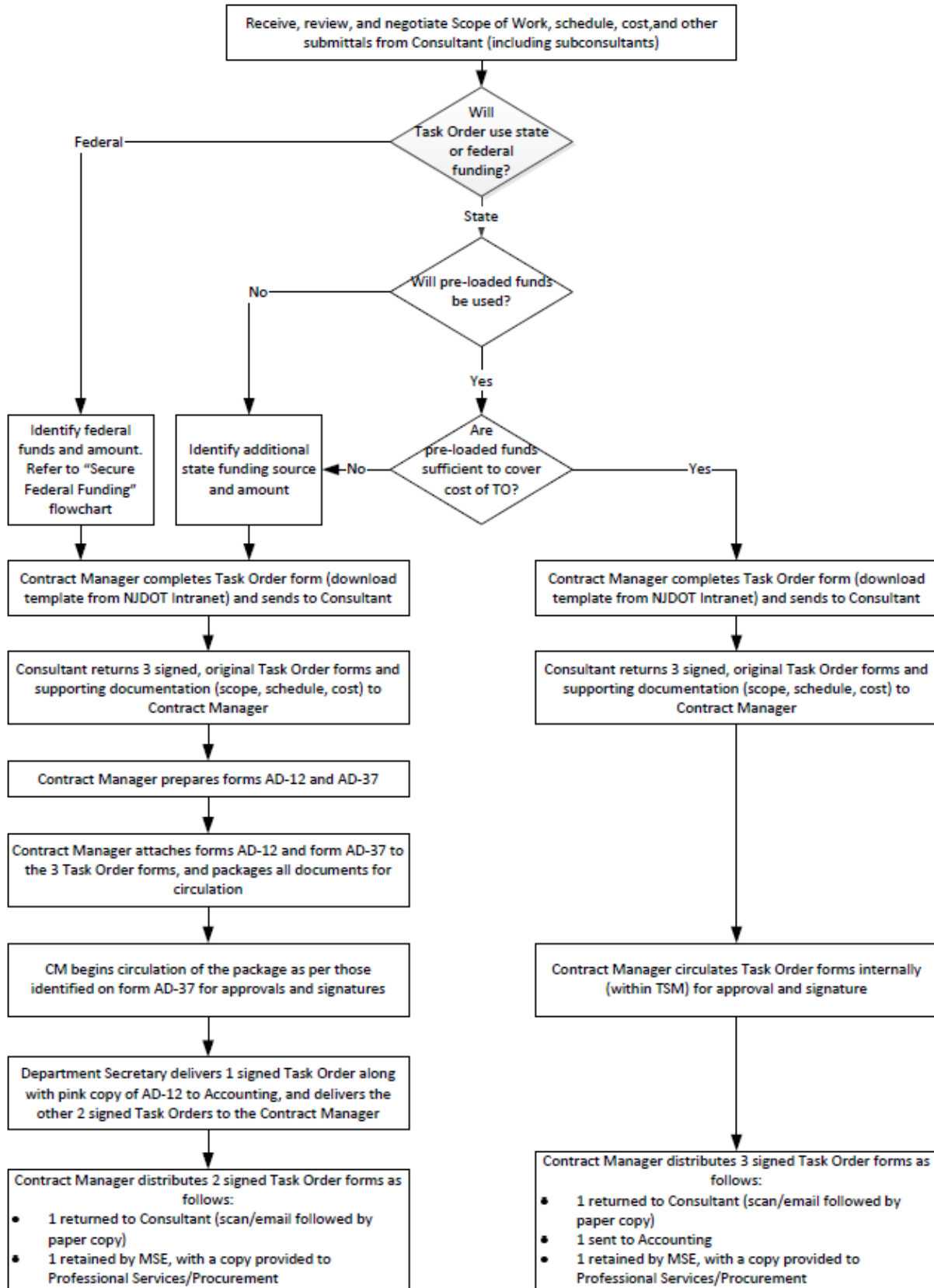


Figure G-3: Execute a Task Order Flowchart

PART G - ADMINISTRATIVE PROCEDURES

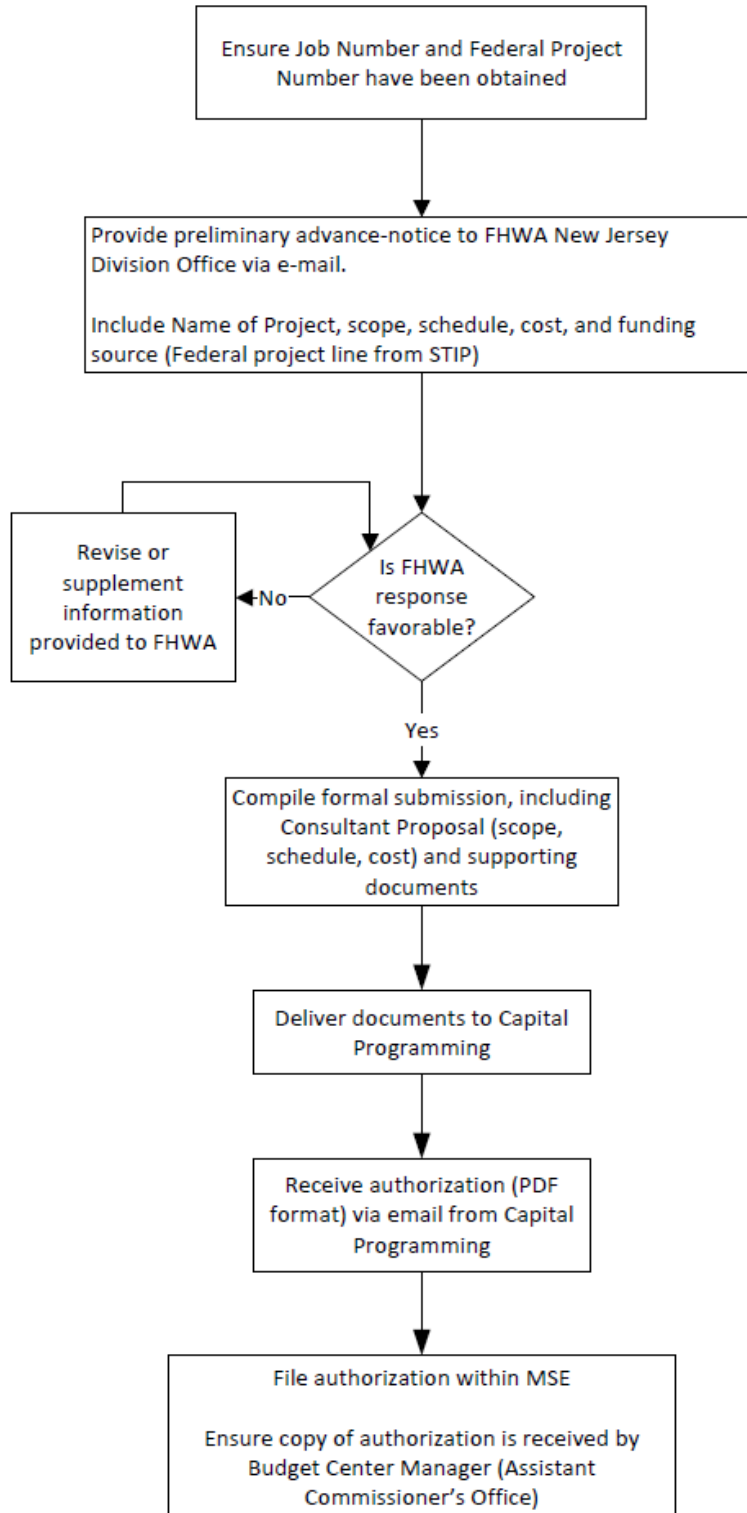


Figure G-4: Secure Federal Funding for Consultants Flowchart

G.2.6.8.2. Agreement approvals

A fully executed Agreement requires, at a minimum, the following:

Department:

- Signature of MSE Director
- Signature of Assistant Commissioner
- Signature of Department Secretary
- Official seal applied by Department Secretary

Consultant:

- Signature of consultant Program Manager or other Authorized representative
- Signature of Notary
- Seal applied by Notary
- Business Registration Certificates (Prime and subconsultants)
- Corporate resolution (with raised seal)

G.2.7. Managing a Consultant Agreement

G.2.7.1. Establishing Task Orders

Task Orders are formalized by completing the Task Order Form, an editable version of which can be downloaded from the Department Intranet web page, and obtaining the necessary signatures. The entire process can be found in the flowchart in Figure G-3: Execute a Task Order Flowchart.

For a sample of one type of Task Order form, see Appendix H.19. For an example of the NJDOT Forms Catalog Intranet page, see Appendix H.20.

G.2.7.2. Payments and Invoicing

When consultant invoices are received, they are put into a 10-day (maximum) review process for the receiving unit to evaluate the work performed as compared to the amount billed.

Consultants must submit invoices on a monthly basis to the Contract Manager. Invoice Submittals, in addition to the invoice itself, must include a Payment Voucher PV(C), an MSE Progress Report, and a Project Expenditure Graph to be used as justification for the invoice. Two sets, including the invoice and supporting documentation, shall be submitted by the consultant.

If there is no billable work performed during the month, submission of an invoice and a PV(C) is not required. However, the consultant is still required to submit an MSE Project Report and a Project Expenditure Graph.

Upon receipt of an invoice, MSE should prepare an Expense Distribution Form AC-1641 to initiate payment. This is one of the forms used by NJDOT to authorize a payment.

The Department must act on a submitted invoice within thirty days, of which MSE is allocated a maximum of ten days to either advance it for payment or return it to the consultant for additional information or clarification.

A flowchart depicting the invoicing process is included in Figure G-5, as well as in Appendix H.24:

G.2.7.2.1. Invoice package

When a consultant submits an invoice package, it should contain two sets of the following documents:

- **Invoice** – Generated by the consultant, using their own format
- **Payment Voucher PV(C)** – Each set should contain an original signature. Refer to Section G.2.12.5.





- **MSE Progress Report** – Using a standard MSE template. Refer to section G.2.12.8.
- **Project Expenditure Graph** – A graph showing amount expended and amount forecasted at the beginning of work. Refer to section G.2.12.9.
- **Information required by Accounting:** Amount spent, ceiling, subconsultants, categories if billing terms are cost plus fixed-fee.

As MSE reviews the invoice, the following documents are added to the package:

- **Expense Distribution Form AC-1641** – Completed by MSE, using a standard NJDOT template
- **Contract Manager (CM) Checklist** – Completed by the Contract Manager, using a standard NJDOT template

Refer to Section G.2.12 for additional information and links to these forms.

Within NJDOT, all of the above forms are circulated via paper copies, not electronically.

NJDOT REFERENCE:		State of New Jersey – Form PV(C) http://www.nj.gov/transportation/business/vendorhelp/docs/pv(c).rtf
		Form AC-1641 (Electronic fill-in) http://www.nj.gov/transportation/capital/pd/documents/MPA_Form_AC1641_Electronic.pdf
		Form AC-1641 (Blank form for manual fill-in) http://www.nj.gov/transportation/capital/pd/documents/MPA_Form_AC1641_Blank.pdf
		Form AC-1641 (Sample) http://www.nj.gov/transportation/capital/pd/documents/MPA_Form_AC1641_Sample.pdf

G.2.7.2.2. Invoice review

The Project and Contract Manager shall review the invoice and the MSE Progress Report, using the accompanying documentation as a guide.

Prior to submitting invoices for payment, the Contract Manager should use the CM Checklist to verify that all documents have been filled out correctly and consistently. Additionally, the CM should make sure the Invoice and work performed are consistent with that shown in the MSE Progress Report.

If, at any time during processing, an invoice is deemed deficient and does not qualify for payment, the Contract Manager will return it to the consultant or request additional information. The received documentation is filed and the mail log entry closed with a note stating that the invoice was returned to the consultant. The form AC-1641 is discarded.

CM should check FMIS to ensure money is there for payment. After an invoice is reviewed and approved (has obtained the necessary signatures), and all other documentation has been completed, the Contract Manager should submit printed documentation to Accounting for payment (nothing is submitted electronically to Accounting).

G.2.7.2.3. Invoice processing


Payment of invoices is a multi-step process that involves careful tracking and record-keeping. MSE retains copies of all documentation in order to rectify, and hopefully minimize, any errors in processing. The step-by-step process is as follows:

1. Two copies of the invoice arrive at the Department’s offices, either by mail, courier, or in person. For clarity, this process-flow description will refer to them as “copy A” and “copy B”.
2. An MSE secretary makes a record of the receipt of the invoice in the computerized mail log and begins generating form AC-1641 with the project-description information.
3. The secretary forwards the partially-completed form AC-1641 and “copy A” of the invoice to the Project Manager. “Copy B” of the invoice is sent to The Contract Manager.
4. The Project Manager reviews “copy A” of the invoice along with supporting documentation, and signs-off on the Payment Voucher PV(C) and form AC-1641 in the appropriate place.
5. The Project Manager delivers form AC-1641 and “copy A” of the invoice, and the Payment Voucher PV(C) (with signatures) to the Contract Manager.
6. The Contract Manager reviews both the invoice package and Form AC-1641, checks them for completeness, fills out the Contract Manager Checklist (“CM Checklist”), and signs-off where required.
7. The Contract Manager makes copies of the signed-off pages of the Payment Voucher PV(C), form AC-1641, and the CM Checklist and attaches them to “copy B” of the invoice. These are retained by MSE for recordkeeping indefinitely. A second copy of the signed Payment Voucher and AC-1641 is provided to Budget Center Manager.
8. The original invoice package (with signatures), the CM Checklist, and completed form AC-1641 are sent to Accounting for payment.

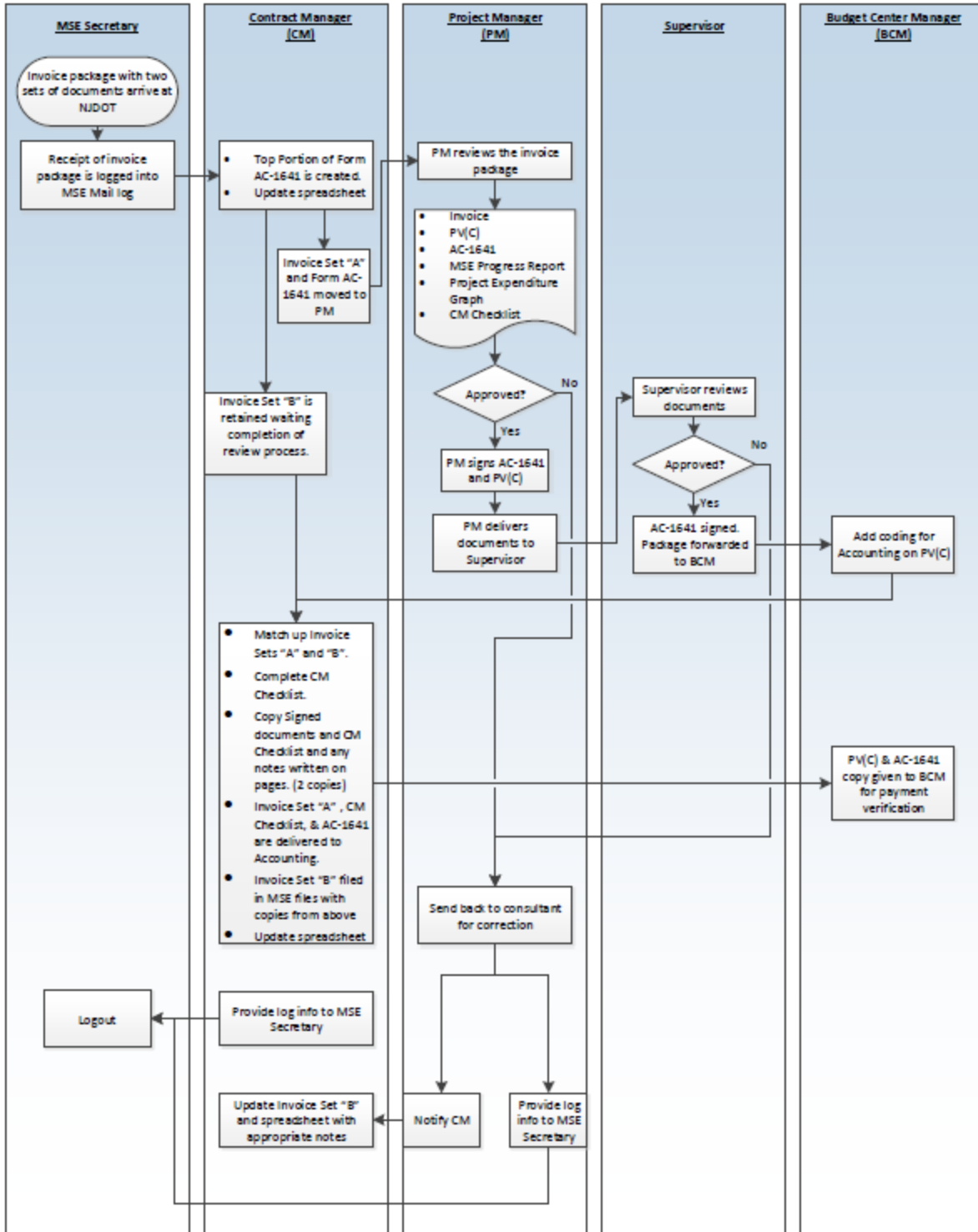
G.2.7.2.4. Consultant questions regarding invoices

If the consultant has questions or issues relating to the payment or processing of an invoice, they are asked to fill out the necessary forms on the NJDOT website. They are requested not to contact MSE directly, as that will not generate a record of the request and will not permit time to investigate the issue of concern.

The NJDOT Vendor Help-Desk FAQ web page contains information pertaining to the means and frequency by which a consultant may invoice the Department and request the status of submitted invoices. Some of the information therein has been extracted and used in this document.

NJDOT REFERENCE:		<p>NJDOT Vendor Help Desk – Frequently Asked Questions</p> <p>http://www.nj.gov/transportation/business/vendorhelp/faq.shtm</p>
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Revision Date: May 10, 2017

Figure G-5: Invoice Processing Flowchart

G.2.7.3. Consultant Agreement Changes

There may be cases in which changes to a previously defined and awarded Consultant Agreement or Task Order scope are either required or proposed. In such cases, the merits and effects of the change must be evaluated, and if acceptable, the funding and/or schedule must be modified.

Consultant Agreement changes may be issued for the following reasons:

- Changes requested by NJDOT
- Additional work proposed by consultant
- Resolution of disputes pertaining to scope

Changes to Project Specific Agreements and Task Orders that result in a change in the overall cost will require the Contract Manager to initiate an Agreement Modification process. Changes that shift money from one task within an assigned project to another within the same Project Specific Agreement or Task Order without affecting the overall value of the Project Specific Agreement or Task Order do not need to follow this process, provided both parties agree to the shift.

If the project is using federal funds, re-obtain approval and authorization as per Section G.2.6.6.1 and Figure G-4.


The Agreement Modification should be created by the Contract Manager, and then signed by both the consultant and the Department. While obtaining the required signatures from within the Department, an AD-12 must accompany the modification if additional funds are needed. Additionally, if the project is using federal funds, approval and authorization for the change is required as per Section G.2.6.6.1 and Figure G-4. Once funding is approved, the information should be entered into the Contract Maintenance Section of FMIS. Additional information on FMIS can be found in Section G.2.9.

In addition to funding considerations, a descriptive change of the work to be performed must also be documented.

The forms required to formalize the modification of a Consultant Agreement or Task Order are found on the Professional Services web page.

EXTERNAL REFERENCE:		Professional Services – Procurement: Model Agreements/Standard Articles/Agreement Modification/Task Order Forms http://www.nj.gov/transportation/business/procurement/ProfServ/agreements.shtm
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The Department’s Change Control Board process applies to roadway design and construction exceeding a specified dollar amount, and not to MSE Consultant Agreements. Although it is not directly applicable to this section, a link to the Capital Program’s Change Control Board Procedures is provided as a reference, as it may offer guidance and suggestions on how to review potential Agreement changes.

NJDOT REFERENCE:		NJDOT Change Control Board Procedures http://www.nj.gov/transportation/eng/documents/CCB/CCB_Procedure.shtm
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G.2.7.4. Consultant evaluations

Consultants are evaluated annually by the Department and rated based on performance. Consultant evaluations are compiled in aggregate and are supplied to Professional Services. Professional Services uses these evaluations throughout the Department in the evaluation of Technical Proposals.

The consultant evaluation process is described on the Department’s Professional Services website.

In addition to the Department's annual review, MSE performs consultant evaluations on a quarterly basis and retains the results internally. At the end of the annual rating cycle, these evaluations are compiled and given to Professional Services. If the workload was unevenly distributed over the year, then the quarterly periods may be weighted in proportion to the work effort.

MSE evaluations are conducted for each Task Order or by Project Specific Agreement and are performed by the Project Manager with input from the supporting staff in accordance with the guidelines provided by Professional Services. MSE staff is required to provide justification (such as schedules, emails, transmittals) to support their evaluations.

<p>NJDOT REFERENCE:</p>		<p>NJDOT Consultant Evaluations</p> <p>http://www.nj.gov/transportation/business/procurement/ProfServ/ces.shtm</p>
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G.2.7.5. Scheduling and submittals

At the start of each project, schedules shall be developed and will comprise one item against which the consultant's progress will be evaluated. The schedule shall be composed of project milestones and shall define the commitments of the consultant as well as of the supporting personnel within NJDOT, through the end of the project.

In addition, a predictable schedule of recurring events shall be developed. This may include (but is not limited to) progress meetings and invoice due-dates. This recurring schedule is independent of the consultant's progress and is not tied to the completion of certain tasks.

Project schedules shall incorporate the elements noted below.

G.2.7.5.1. Progress Meetings

The frequency of scheduled progress meetings will vary depending on the size and type of project. The recurrence should be defined at the start of the project.

G.2.7.5.2. Agreement deliverables

The types and intervals of submittals (such as percent-complete submissions) vary from project to project and are defined in the terms of the Agreement or Task Order.

G.2.7.5.3. Invoices

Invoices, accompanied by Payment Voucher form PV(C), should be submitted to NJDOT on a monthly basis following NJDOT guidelines. If an invoice is rejected, it may be resubmitted in the same month, and the consultant must indicate that the billing is a resubmission based on a rejected invoice.

If no billable work is done in a particular month, the consultant is not required to submit an invoice according to the monthly cycle. However, that billing cycle should be reflected on the next invoice that does have associated work so as to account for all time while the Agreement is in effect. Therefore, it is possible that several months may go by without a consultant invoice being received by the Department.

G.2.7.5.4. MSE Progress Reports

Consultant Invoices shall be accompanied by MSE Progress Reports, using the standard MSE Progress Report template found in Appendix H.21. These reports will be used to evaluate the extent of work performed to-date with respect to the invoice, work planned for the upcoming review period, the expected time to complete the job, and any other outstanding issues.

MSE Progress Reports should be submitted on a monthly basis along with invoices. If an invoice is not submitted for a particular month, an MSE Progress Report is still to be submitted.

G.2.7.6. Oversight

In addition to regular progress meetings, the monthly MSE Progress Report that accompanies invoices will be used to monitor and document the consultant's work. Since the Progress Report is a snapshot in time, it should be viewed in the context of the previous Progress reports to determine work done in a specified time period.

Prior to approving ("signing-off") invoices, the Project Manager should thoroughly review both the invoice and the Progress Report to ensure the project is advancing appropriately. A project going off-schedule or beyond its original scope is not necessarily a reason to reject an invoice. However, it should precipitate the development of a recovery plan to bring the project back on-track.

Reviews of these invoices and Progress Reports should include inspection of all of the aspects listed below. Note that the review of a Progress Report will evaluate the Department's proper support of a project and not only the consultant's work, so these reviews should be performed thoroughly.

- Work progressing according to project schedule
- Budget progressing according to plan
- Consistency between work performed and work billed
- Evidence of completed work or submittals
- Adherence, divergence, or omissions relating to the project scope
- Planned/anticipated work
- Outstanding requests from the consultant to the Department

Additionally, review of the Progress Reports should prompt the Project Manager to obtain any additional information that is needed, other than from the consultant, to complete a review of the consultant's submittals.

G.2.8. Closing out a Consultant Agreement

For the process to close out a Consultant Agreement, refer to Policy/Procedure 328 in Appendix H.26.

G.2.9. Financial Management Information System

The Financial Management Information Systems (FMIS) is the accounting system used by the Department to track financial allocations and expenditures on a job, project, or Agreement basis. Access to FMIS requires log-in credentials which may be assigned by the Department.

The Contract Manager adds information to FMIS when adding Task Orders, Agreements, or modifications.

All Project Specific Agreements and Task Order Agreements are assigned an Agreement Number based on the calendar of award, unit initials, and a unique three-digit identifier assigned by Professional Services. A contract ID is also assigned to each Agreement, that is comprised of the last two digits of the year and five digits that are assigned sequentially within assigned number blocks per unit. The TSM block is "09500", and the numeric sequence restarts each year.

The Technical Proposal number (TP#) appears on the advertisement. The consultant must also place the Agreement Number and Contract ID on submitted invoices and Payment Voucher forms PV(C). The Contract Manager must verify these numbers before sending the signed invoice package to Accounting.

New entries are added to FMIS by following Process CP05. Upon award and Agreement, the Vendor ID of the selected consultant is added to the record under the specified Contract ID. If no Vendor ID exists for the consultant, one can be assigned by others (not within by MSE) using a separate process within FMIS.

When Accounting processes an approved invoice, they will draw funds from the identified Contract ID to make payment. Contract Managers with valid FMIS credentials can log in to FMIS at any time to verify the total dollar amount of the Agreement, the amount paid, and the balance remaining by looking at CP40.

The process for review and approval of invoices can be found in Section G.2.7.2.

FMIS also provides an accounting ledger for construction contracts using a similar process; however Data Processing (DP) numbers are used in place of Contract IDs. DP numbers are assigned by MSE based on the year of advertisement and a three-digit number assigned by the specific unit. For TSM projects, the three digit number, by convention, is in the range 600 to 699. DP numbers are used by Accounting and cannot be tracked directly using FMIS.

G.2.10. Mitigating Exposure to Liability



When administering Consultant Contracts, care must be taken to avoid errors, actions, or omissions which could expose NJDOT to certain unexpected financial or legal liabilities.

G.2.10.1. Specification of a Sole-Source in Design

In general, it is preferable for design Agreements to avoid naming specific vendors or manufacturers for procurement, and to instead specify characteristics and requirements. In some cases, however, sole-sourcing is needed because of an item’s unique characteristics or for compatibility with existing equipment.

For projects which receive federal funding and contain sole-source specifications, justification must be given and submitted to the FHWA for approval as per Title 23, CFR 635.411. This is done via the Request for Approval of Patented/Proprietary Items on Federally Funded Projects form, commonly referred to as PIFF.


The PIFF is developed for either project-wide or State-wide efforts and is submitted to the FHWA for approval. While the FHWA does not grant immunity to NJDOT for specific product selections, it does indicate their concurrence that the product stated is the only one suitable for a particular application.

EXTERNAL REFERENCE:		FHWA: Questions and Answers Regarding Title 23 CFR 635.411 http://www.fhwa.dot.gov/programadmin/contracts/011106qa.cfm
NJDOT REFERENCE:		Form DF15: Request for Approval of Patented/Proprietary Items on Federally Funded Projects (PIFF) http://www.nj.gov/transportation/eng/forms/docs/design/df15.pdf

G.2.10.2. Clear Definition of a Job Scope




Many disputes or budget overruns are a result of an inconsistent understanding of the work a consultant is asked to perform. Because of this, it is important to make sure the written scope of a job is clear, concise, and complete.

Although MSE Consultant Agreements are not governed by the NJDOT Program Management Office (PMO), the PMO web page offers the following Scope Management Guidelines.

<p>NJDOT REFERENCE:</p>		<p>NJDOT Program Management Office – Scope Management Guideline http://www.nj.gov/transportation/capital/pd/documents/ScopeMgtGuideline.pdf</p>
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G.2.10.3. Prompt Payment of Invoices

Effective September 1, 2006, New Jersey enacted a Prompt Payment Law (N.J.S.A. 2A:30A-1 and 2) that requires prompt payment by public and private owners to contractors and by contractors to subcontractors and material suppliers. After 30 days, the delinquent party will be liable for interest at a rate equal to prime plus 1 percent on Agreements written after the effective date. All other invoices require a 60-day prompt payment as noted in the New Jersey Prompt Payment Act N.J.S.A. 52:32-32 et seq.

<p>EXTERNAL REFERENCE:</p>		<p>Prompt Payment of Invoice - N.J.S.A 2A:30A-1 http://lis.njleg.state.nj.us/cgi-bin/om_isapi.dll [...] &record={965}&softpage=Document42</p>
		<p>Prompt Payment of Invoice - N.J.S.A 2A:30A-2 http://lis.njleg.state.nj.us/cgi-bin/om_isapi.dll [...] &record={967}&softpage=Document42</p>
		<p>Prompt Payment of Invoice - N.J.S.A. 52:32-32 http://lis.njleg.state.nj.us/cgi-bin/om_isapi.dll [...] &record={16F5E}&softpage=Document42</p>

G.2.11. Professional Services Agreements external to TSM

While TSM often administers Consultant Agreements to perform professional services for the unit, there are cases where such services are retained by other units of the Department and therefore do not follow the above procedures. This section describes these types of relationships and MSE’s responsibilities in these relationships.

G.2.11.1. Research Studies

Research studies are performed by institutions of higher education that have an executed Basic Agreement with NJDOT. One consultant contract, procured through the Treasury Department, exists to conduct quick turn-around research studies. Research studies may encompass a broad range of topics. As examples, they may study new technologies and applications, or may study the real-world effectiveness of previously untested applications (for instance, assessing the validity and accuracy of traffic detection systems on dualized inner/outer roadways). In general, projects which help to generate direction for future ITS work but do not directly affect the existing ITS network are categorized as research studies.

Research studies may be requested by TSM using the forms on the NJDOT Bureau of Research web site. The Bureau of Research will engage the academic institutions who will perform the project, which will be funded via State Planning and Research funds. TSM will co-manage the research projects that are initiated by its unit.

<p>NJDOT REFERENCE:</p>		<p>Bureau of Research http://www.nj.gov/transportation/refdata/research/</p>
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G.2.11.2. Non-MSE Agreements involving ITS

Consultant Agreements that are handled by other units within NJDOT such as Capital Program Management or other units may also contain ITS components. Such Consultant Agreements are guided by the direction of the respective units and do not necessarily correlate to the procedures outlined in this section.

For those types of Agreements, MSE will assign a Subject Matter Expert (SME) to provide guidance relating to the ITS aspects of the project. This SME may be asked to sit on a Technical Review Committee or to answer questions that are presented by the project's management. The SME will operate in a technical advisory capacity only, with all elements of management handled by the unit that owns the project.

G.2.12. Forms

A summary of all of the forms used for Consultant Agreement Administration is summarized in Table G-2 : Consultant Agreement Administration – Summary of forms, and is detailed below.

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Table G-2 : Consultant Agreement Administration – Summary of forms

Form	Name	Purpose	Filled out by	Location/Link
AC-1641	Expense Distribution Form	Identifies accounts from which funds for payment will be drawn	MSE secretary, PM & CM	http://www.nj.gov/transportation/capital/pd/documents/MPA_Form_AC1641_Electronic.pdf
AC-1643	Job Number Requisition Form	Obtain job number	CM	NJDOT Intranet
AD-12	NJDOT Department Action Slip	To reserve funds for project, add funds to project	CM, signed by others within NJDOT	NJDOT Intranet
AD-37	Referral form	List of those to whom documents are circulated for approval and to whom they are circulated for information	CM	NJDOT Intranet
Task Order Form	Task Order Form	Execute Task Orders under a TOA	CM, signed by consultant, also signed by DOT staff	Several types – example in Appendix H.19 / Intranet
PV(C)	Payment Voucher	Department form used to request and authorize payment	Initiated by consultant, signed by PM & CM, then to Accounting	http://www.nj.gov/transportation/business/vendorhelp/docs/pv(c).rtf
PIFF	Request for approval of Patented/Proprietary Items on Federally Funded projects	To request approval of a sole-sourced item in a federally funded construction contract	Developed by consultant, reviewed/completed by PM	http://www.nj.gov/transportation/eng/documents/BDC/documents/PIFF-RequestForm.docx
CM Checklist	CM Checklist	Used to assist the Contract Manager in review of invoices	CM, then Accounting	Appendix H.22

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Form	Name	Purpose	Filled out by	Location/Link
MSE Progress Report	MSE Progress Report	To document what has been done on the project during the invoice period and what is anticipated for next invoice period	Consultant	Appendix H.21
Project Expenditure Graph	Project Expenditure Graph	Consultant-provided graph of projected versus actual spending	Consultant	none

G.2.12.1. AC-1641

Form AC-1641 is used to initiate payment to a consultant and to identify the job number from which they will be paid. It is downloaded from the Department Intranet or public web page and may be completed electronically, but paper copies are used to circulate the form and obtain the necessary signatures.

This form is intended to be completed in-house. Although it is available to the public, completion of this form shall not be delegated to the consultant. It is made visible to consultants simply for information in understanding the process.

Completed paper AC-1641 forms are sent to Accounting along with the PV(C) and any other necessary accompanying documentation.

G.2.12.2. AC-1643

Form AC-1643 is used to request a new NJDOT job number for new programs and projects. The program or project is identified directly on the form and no supplemental information is required. This form is used for all types of jobs and is not restricted to MSE jobs or to Consultant Agreements.

Completed AC-1643 forms are completed and sent electronically to Capital Programming. Capital Programming responds by providing an NJDOT job number to the submitter.

G.2.12.3. AD-12

Form AD-12 is used to establish an account for a particular project and/or to add funds to a project's account. It may also be used to establish a Memorandum of Understanding or Memorandum of Agreement. In the context of Consultant Agreements, reasons for submitting an AD-12 include:

- Establishing a new Project Specific account and assigning funds to it
- Establishing a new Task Order Agreement without assigning funds to it (i.e. not "pre-loaded")
- Establishing a new Task Order Agreement and assigning funds to it (i.e. "pre-loaded")
- Funding a Task Order under a TOA that is not pre-loaded
- Adding additional funds to an existing Agreement

Form AD-12 is downloaded from the NJDOT intranet, completed electronically, and printed for paper circulation. Paper copies shall be printed on the appropriate color paper as stated in the top-left corner of the form and handled and circulated as stated.

G.2.12.4. AD-37

Form AD-37 is a referral form that is used to identify those to whom a document or document package is circulated. The form may accompany a wide variety of documents and is used in a variety of Department processes. When establishing Agreements or Task Orders, the AD-37 is attached to the documents that are circulated for review. The form identifies those who will need to approve the Agreement, and also those who will receive copies of the Agreement for information but do not have to sign-off on it. The individuals or units within NJDOT who will typically need to sign-off on an AD-37 form include:

- Professional Services (Agreements, not Task Orders)
- Deputy Attorney General (Agreements, not Task Orders)
- Department Manager/Director
- Capital Program Coordination
- Accounting
- Assistant Commissioner
- Department Secretary

The Department Secretary is the last person to whom the package is circulated. At this point, the secretary receives, logs, and signs the documents that are routed with the AD-37, and distributes the signed documents as appropriate.

G.2.12.5. PV(C)

Form PV(C) is a Payment Voucher that is submitted by the consultant. The form states the dollar-amount in the invoice, the dates and Agreement(s) under which the cost was incurred, and an address to which for payment should be sent. The form also provides space for the consultant (payee) to include any of its own accounting numbers or project codes that will assist the consultant in applying the received payment to the appropriate accounts.

Form PV(C) is accessible publicly via the NJDOT website. The form is first completed electronically, and then printed for signatures and submittal to the Department.

G.2.12.6. PIFF

The Request for Approval of Patented/Proprietary Items on Federally Funded Projects (PIFF) form is used to petition the FHWA to fund projects containing sole-sourced or proprietary devices and/or services under the conditions stated in Title 23 CFR 635.411. Additional information regarding the use of the PIFF is in paragraph G.2.10.1 of this manual.

The PIFF may be downloaded from the public NJDOT website. The designer (either the consultant or MSE, as applicable) completes the form electronically and then prints it for signature. MSE then reviews the document. If done for a specific project, the form should include the certification. If the PIFF is statewide, the manager should sign it and forward the document to FHWA.

G.2.12.7. CM Checklist

The Contract Manager (CM) Checklist is a form developed by MSE that is used to assist Contract Managers in thoroughly reviewing invoices for completeness and correctness prior to submitting them for payment. The CM Checklist references other forms and activities that are prerequisites to payment and are to be verified prior to approval. Additionally, the CM Checklist is used to identify the deadline by which payment must be made under the State's Prompt Payment Law (see section G.2.10.3).

The CM Checklist is available in Appendix H.22 of this manual. It may either be completed on paper or electronically, but the completed form shall be printed and attached to the requisite documentation when circulating an invoice for approval and submitting it to Accounting.

G.2.12.8. MSE Progress Report

The purpose of the MSE Progress Report is to detail work performed to justify payment requested in the invoice, as well as to provide an overall project status. A properly completed MSE Progress Report will contain:

- Work done during the Invoice Period
- Work anticipated during the following Invoice Period
- Advance notice of anticipated requests of the Department, so that appropriate preparations can be made
- Estimated level of overall completion (in percent) of the project objectives
- Percentage of time in agreed-upon schedule that has elapsed
- Total amount (in dollars and in percent of budget) of the submitted invoice
- Total amount (in dollars and in percent of budget) that has been invoiced to-date
- Expected savings or overages relating to budget
- Expected changes to the schedule

- Any other information that may be appropriate to clarify or justify the above items

The graph that is to be included in the MSE Progress Report is to have two lines: projected spending by month and actual spending by month. The time should be shown along the horizontal axis and dollar amount along the vertical axis.

If work is being invoiced for the month, the MSE Progress Report is to be completed by the consultant and submitted, in paper form, with the invoice, Project Expenditure Graph (see G.2.12.9 below) and PV(C). It shall accompany the invoice as it is circulated for review and ultimately forwarded to Accounting.

If no work is being invoiced, the MSE Progress Report and Project Expenditure Graph are submitted alone.

G.2.12.9. Project Expenditure Graph

The Project Expenditure Graph is a depiction of money spent over time compared to the initial scheduled expenditure. It should have two lines: projected spending by month and actual spending by month. The time should be shown along the horizontal axis and dollar amount along the vertical axis.

The graph is included with each invoice.

G.3. Construction Contract Administration

G.3.1. Purpose

The purpose of this section is to describe the overall process by which TSM construction contracts are initiated and administered.

G.3.2. Systems

The following electronic systems are used during the Construction Contract Administration process.

- **Trns•port** (often referred to as “Web-T”: a suite of software modules that supports the New Jersey Department of Transportation (NJDOT) construction programs and is for use by NJDOT, consultants and contractors
- **Bid Express** (often referred to as “Bid-X”): The secure environment by which online bids are submitted
- **Expedite**: The **Trns•port** software module used to manage the bidding and bid letting process
- **FMIS**: Stands for Financial Management Information System, this is the accounting system used by the Department to track financial allocations and expenditures on a job. Refer to Section G.2.9 for additional information on FMIS.

G.3.3. Preparations for contract advertisement

At the conclusion of the Design phase, the designer uploads the Engineer’s Estimate (item numbers, descriptions, unit costs, quantities) into Web-T. Additionally, the designer submits plan sheets printed on Mylar and specifications. If designed by a consultant, the submission is in accordance with the requirements in the Consultant Agreement or Task Order.

The MSE Project Lead enters a letting date in Web-T, and then proceeds to obtain approvals and funding authorization.

G.3.3.1. Identify consultant service needs

Early in the process, the MSE Project Lead should evaluate the need for Consultant Services (Construction Support or Construction Inspection, see sections G.2.5.2.3 and G.2.5.2.4, respectively) that may be needed to support the contract. The MSE Project Lead should first identify what resources are already available, either in-house or via existing Agreements. If none are available, a new Consultant Agreement should be initiated via the process described in Section G.2.

G.3.3.2. Project and contract identification

Accounting uses Data Processing (DP) numbers to track construction projects. DP numbers are assigned by the originating NJDOT unit based on the year of advertisement and a three-digit number assigned by the specific unit. For TSM projects, the three digit number, by convention, is in the range 600 to 699. DP numbers are used by Accounting and cannot be tracked directly using FMIS. Additional information about FMIS can be found in Section G.2.9.

G.3.3.3. Submit for preliminary approval

Once the final design has been completed and properly recorded, the MSE Project Lead then assembles all necessary materials for the authorization request, using the Capital Program Coordination Memorandum as a guide.

The Capital Program Coordination Memorandum is used to request federal funds for a construction project. It is only included with the formal authorization, but the information it contains should be included while submitting for preliminary approval. This information includes:

- Federal Project Number
- Job Number
- Project Name
- Dollar Amount
- Funding Source (from STIP)
- Project Scope and Schedule

An example of a Capital Program Coordination Memorandum can be found in Appendix H.18.

The MSE Project Lead then submits the assembled documents to the FHWA ITS Lead for preliminary approval.

G.3.3.4. Activities while awaiting preliminary approval

While the authorization package is awaiting preliminary approval from FHWA, the MSE Project Lead shall ensure that all materials are ready and prepared for the formal submission for authorization.

- The Roadway & Bridge Contract Administration unit should be notified with sufficient advance notice such that sufficient time is available to create the Bid Express files for the project.
- The Department creates the contract proposal and attaches a letting date in Web-T, then export the Web-T information into a text file. The information in the text file is used to create an Expedite Bid Submittal (EBS) file using the program "Expedite". The EBS file is then uploaded to Bid Express.
- The MSE Project Lead should ensure that all design information on Web-T is accurate.
- The MSE Project Lead completes the Capital Program Coordination Memorandum and obtains signature from the Director of MSE.
- The Key Sheet, which is the top sheet in the plan set, should be signed by the Director of MSE and submitted to the State Transportation Engineer for signature.

G.3.3.5. Submit for formal authorization

The FHWA ITS lead will provide either a preliminary approval or will suggest revisions. If revisions are required, another preliminary submission will need to be made. Depending on the revisions suggested, other activities in G.3.3 may need to be repeated as well.

Once the MSE Project Lead has preliminary approval from the FHWA ITS Lead, the assembled printed documents should then be submitted in an authorization request package to the Capital Program Coordination unit.

G.3.4. Advertise contract

After formal FHWA authorization is received, the advertisement package may be circulated.

The advertisement package should be accompanied by Form AD-12 (refer to section G.2.12.3) and a memo describing the package. The package should then be circulated for signature so that the Bureau of Construction Services receives it no later than the Thursday prior to when advertisement begins.

Usually, the advertisement time is usually three weeks, with bids being received on the fourth week. However, the MSE Project Lead should coordinate dates with the Bureau of Construction Services to avoid too many projects receiving bids on the same day.

Electronic files of the bid documents (plans in .TIF format, specifications in .PDF format) should be provided to the Roadway & Bridge Contract Administration unit for uploading to Bid-X. Once the documents are posted on Bid-X, they cannot be modified directly. Any future changes must be in the form of an Addendum.

If copies of plans have not been provided as part of the submission, the MSE Project Lead should create a purchasing request (F1) to have copies created. A sufficient number of copies should be made to accommodate the field office, MSE Trenton office, and MSE ITS Maintenance staff. The contractor obtains his own copies from Bid-X without the involvement of NJDOT.

G.3.5. Bid process

Once the contract is advertised and information is posted on Bid-X, all questions related to the contract are submitted via Bid-X and directed to the Bid-X Coordinator, who is with the Roadway & Bridge Contract Administration unit. The Bid-X Coordinator forwards applicable questions to MSE for responses, and MSE directs responses back to the Bid-X Coordinator. The Bid-X Coordinator will compile all responses and addenda as needed, and will confer with MSE as required.

G.3.6. Awarding contract

Bids are received by the Bureau of Construction Services.

Once bids are received, the Deputy Attorney General reviews them for compliance and completeness.

MSE will request the bid data from the Bid-X Coordinator, and will then prepare an analysis of the bids in a Bid Analysis Memo. MSE then sends the Bid Analysis Memo to Procurement/Construction Services, who handles the award process.

G.3.7. Construction Contract Management

After the contract is awarded, the ongoing management of the Construction Contract is as described in Part D of this manual.

G.4. ITS Maintenance Contracts

G.4.1. Traditional ITS Maintenance Contracts

MSE advertises ITS Maintenance Contracts (IMCs) which are intended to supplement Statewide ITS Maintenance's efforts on specific tasks that are finite in quantity. IMCs do not include an "on-call" component.

An ITS Maintenance Contract may include, but is not limited to, the following types of work:

- Installation of tracer-wire in existing conduits
- Cleaning of camera lenses
- Recalibration of devices
- Replacement of devices
- Replacement of individual components
- Fiber Optic Cable Splices
- Installation of safety catwalks

- Verification/realignment of antennas in wireless links

G.4.2. Job Order Contracts

MSE also uses Job Order Contracts. For these contracts, contractors utilize the Job Order Contract catalog that provides fixed costs for each standard, specified type of repair. This allows Statewide ITS Maintenance to assign maintenance tasks to contractors based on a fixed-price “menu” structure.

Job Order Contracting uses a pre-set unit cost for each task. The competition among bidders is based on the adjustment factor that they add, one for “normal working hours” and one for “other than normal working hours.”

G.5. ITS Database Administration

G.5.1. Regional Readiness Reporting Manager (RRRM) Database

The Regional Readiness Reporting Manager database, commonly known as the “ITS Checklist”, contains information on all ITS devices under NJDOT jurisdiction, whether operational or not. This database is used to power Daily ITS Device Functionality checks (performed by Traffic Operations as described in Section E.1.2.1), to track maintenance Work Orders, and to develop reports showing in-service metrics and other device KPIs. Additionally, it is used to feed the publicly-accessible ITS Inventory database on the NJDOT website.

MSE is responsible for maintaining the database.

G.5.2. Permanent Devices

When a new device is **planned**, a System Administrator (who works under the Mobility and Systems Engineering group) shall input the new device as ‘Proposed’ with the following information:

- Assigned device ID
- Type of device (see Section A.4.4)
- Text description of device and location
- Approximate geographic coordinates (latitude/longitude)
- Functionality of the device (for instance, if the camera has PTZ capability, via a separate linked table)
- Region assignment (North or South)
- Status assignment (“Proposed”)
- Owner (such as NJDOT, Contractor, Port Authority)
- Operational flag (“No”)

When **construction** begins on a planned device, the status shall be changed to “U/C” (Under Construction) and the geographic coordinates shall be refined to the precise location. At the point when the device is integrated with the TOC and is usable by Traffic Operations, the “Operational” flag shall be changed to “Yes”, even if the device has not yet been turned over to NJDOT.

When the project is closed and the device is fully operational and **turned over** to NJDOT, the status shall be changed to “Existing”, and the owner changed to “NJDOT”.

If a device is decommissioned, the status shall be changed to “Abandoned” or “Removed”, as applicable. *The device entry shall not be deleted from the database.*

G.5.3. Portable Devices

Portable devices, such as PVMSs, do not have a permanent location. Upon each relocation of such a device, MSE shall update the geographic coordinates and, if necessary, the regional assignment of the device in the database. If the device is no longer needed and is taken out of service, its status shall remain “Existing”, but the “Operational” flag shall be changed from “Yes” to “No”, and the coordinates shall be modified to reflect the device’s actual storage location.

G.5.4. Contractor-owned Devices

Some contracts may require the contractor to provide ITS equipment for use during the duration of the project (typically a PTMCCA or PVMS), and this equipment may require integration with existing Traffic Operations software. This equipment will remain property of the contractor following completion of work.

For these devices, the same procedure shall be used as for permanent devices; however the “Owner” field would be set to “Contractor”.

G.5.5. Device replacements

Maintenance upgrades or replacements could be reflected in a number of ways, depending on the actual scenario. An in-kind replacement of a faulty device may require only a device’s Serial Number to be updated. An upgrade of a faulty, out-of-production device may introduce new functionality which is best handled by following the Additions/Removals process.

G.5.6. User Permissions

The checklist contains a list of users as well as permissions, preferences, and functional roles (Operator, ITS Engineer, Work order manager, etc.). There is not a one-to-one correlation between functional roles and Civil Service job titles, so it is up to the organization to determine who is responsible for performing these tasks.

The permissions within a user restrict the user to signing-off on device checks only to which he or she is authorized. The preferences will determine which users are on the email distribution list for the Daily and Monthly reports that are generated by RRRM.

G.6. Maintenance of Manual

This Procedures Manual deals with an aspect of transportation management which is highly technical and rapidly changing. Therefore, it is expected that the procedures described herein are highly susceptible to revision, expansion, and evolution.

The information in this section is provided as a guide to maintain the integrity of the information in this manual and to ensure its content remains relevant.

NOTE: Before edits are made to the Microsoft Word version of this manual, ensure that the options in Word are set up as described in Section G.6.5. If the document is saved without the proper configuration, hyperlinks to other files (i.e. appendices) will change and the links will not function properly when accessed from other computers.

G.6.1. Reasons for Manual Change

G.6.1.1. Adoption of new technology

This manual addresses specific types of ITS devices. As newer or enhanced devices are developed and their use adopted by NJDOT, this manual will need to be augmented in order to include guidelines for the new device's design and operation.

G.6.1.2. Discontinuance or obsolescence of existing technology

Similarly, certain types of infrastructure may be phased-out of NJDOT use. In this case, only the sections describing the device-selection process should be revised. If the device is still available, the sections describing the design of a system around such devices shall remain. Similarly, the sections describing the maintenance of these devices shall remain.

The actual design guidelines for an ITS device should only be removed if the particular device is no longer in production and if there are no active existing devices of this type under control of NJDOT. This information shall remain under the chance that an obsolete but functional installation may need to be re-built, or that NJDOT may re-adopt the use of a particular device.

Similarly, the steps relating to the maintenance of a device shall remain up until such a point as that there are no existing assets of that type and it is unavailable to procure in the future

G.6.1.3. Refinement in processes

Throughout the course of following this manual, TSM may find that the procedure listed in this manual may not be the actual best-practice for performing a particular task, or that the listed procedure does not provide an appropriate level of detail for performing the task. A change of this type will modify or expand on existing sections of the manual.

G.6.1.4. Error correction

Any material errors found in the document that may affect actual work procedures should be corrected promptly. Errors that do not adversely affect the procedure described, such as typographical or grammatical errors should only be corrected during a full re-issuance of the Manual.

G.6.1.5. Organizational change

This manual makes extensive references to, and assigns responsibility to, members of various functional organizations. When the organizational structure within or beyond TSM changes, so may the roles and responsibilities of the various stakeholders in the success of ITS design and operation. Such changes will require prompt updates to the manual to maintain accuracy.

However, if the organization change is in name-only with no change in function or responsibility, the modification to the manual is not of any urgency and may wait for the next re-issuance (although the name change could have other repercussions, see "Maintenance of hyperlinks" below).

G.6.1.6. Administrative change

Processes which have been enacted Department-wide are generally mentioned only briefly in this manual, along with a hyperlink to the referenced procedure or form (for instance, the form used to initiate a payment). This manual is generally constructed in such a manner that any changes to those forms or procedures will not require any modification to this manual, and the hyperlink will automatically lead the reader to the most up-to-date information. However, some Department-wide changes may be of such a magnitude that it may require changes to this manual to maintain consistency.

G.6.1.7. Maintenance of hyperlinks

This manual contains numerous hyperlinks to resources which are not under the control of TSM. Therefore, they may change or become invalid without notice. To avoid the proliferation of “dead links”, hyperlinks that no longer refer to the intended destination should be corrected or removed upon discovery.

G.6.2. Roles and Responsibilities

G.6.2.1. Initiation

Although this manual is applicable to the entire Transportation Systems Management organization, it is owned and maintained by Mobility and Systems Engineering. Therefore, any changes should be written by, or under the direction of, MSE. This would include the use of consultants who are tasked with contributing to the manual.

G.6.2.2. Authorization

Before a change to the manual can be published, it must obtain the approval of the Director of Mobility and Systems Engineering or another individual authorized by the Director of MSE to grant such approval.

G.6.2.3. Implementation

The responsibility of maintaining the manual, including modifications to the baseline document and publication and distribution of all changes, shall be assigned to a member of MSE.

G.6.3. Document Management

The TSM Procedures Manual shall be issued as a single file (“Baseline Document”) inclusive of all sections, to be updated periodically as described below. Appendices such as large-sheet flowcharts or forms that are not conducive to being placed within the manual shall each be stored as separate files and linked from the baseline document.

A series of Baseline Document Change (BDC) Announcements, each as separate files, shall accompany the baseline document.

When a new version of the Baseline Document is issued, all previous versions and corresponding Baseline Document Change announcement shall be retained as a publicly-accessible archive to permit traceability to the effective policy on any particular date.

G.6.3.1. Naming, numbering, and storage standards

Changes to this document shall be recorded by version number, identified on the front page in the format “Version X.Y”.

The whole-number portion (X) of the version should be incremented for major revisions. A major revision is one that includes procedural changes that either replace or supplement those which are already included in the previous version.

The decimal-portion (Y) of the version number should be incremented for minor revisions. These may include (but is not limited to) clarifications, correction of hyperlinks, or changes in terminology. As a general rule-of-thumb, if one were to disregard the changes in a revision without causing any detriment to the project, equipment, or organization, it would be categorized as a minor change.

The name of the file shall be “TSMProcedures_vX.Y_yyyy-mm.pdf”, where:

- X.Y refers to the version number, as stated on the front page of the document
- yyyy refers to the four-digit year in which the manual becomes effective

- *mm* refers to the two-digit year month which the manual becomes effective

G.6.3.2. Baseline document changes



Between issued versions of the Baseline Document, there may be a need to introduce changes to the document. In this case, a Baseline Document Change Announcement shall be issued.

Baseline Document Change (BDC) Announcements are notices that a Baseline Document (current version of the Procedures Manual) has been modified in part or in whole. A Baseline document is defined as any official document that has gone through an initial approval process and was approved for use as intended. Thus a BDC is an alteration to or rewriting of any officially approved document.

Furthermore, new documents, such as the release of a new Version of the TSM Procedures Manual, are also announced via BDC.

As this Procedures Manual is considered a Design Document, the BDC process is initiated by completion of the Design Document Change Request (DDC-RQST) form. The form is completed by MSE and delivered to the Manager of Quality Management Services.

BDC Announcements shall be developed and issued in accordance to the CPM process for Baseline Document Changes.

NJDOT REFERENCE:		Design Document Change Request (DDC-RQST) http://www.nj.gov/transportation/eng/forms/docs/design/ddcrqst.pdf
		Baseline Document Change Announcements http://www.nj.gov/transportation/eng/documents/BDC/

G.6.3.3. Re-issuance of manual

Periodically, the Baseline Document (manual) will need to be revised and a new issue distributed. Such instances shall be initiated when:

- The current issue has been supplemented with ten BDCs, making the procedures therein difficult to follow
- The procedures introduced in a BDC are rescinded by a subsequent BDC.
- At least one year has passed since the previous issue, and at least three BDCs have accumulated.
- A significant change in content or manual structure makes a re-issue preferential to a BDC.

When the Baseline Document is re-issued, it shall be edited to include the content of all applicable prior BDCs, as well as any new required changes. In addition, all embedded hyperlinks should be tested to ensure they remain valid.

For tracking and recordkeeping, the Version Number on the front page shall be incremented as described above. The new version shall also be added to the Revision History on the second page, along with a brief description of the change. The description may refer to the BDCs incorporated or the sections being updated, but should not directly include the procedural change.

The document shall be saved and named as described previously and published on the appropriate MSE website. As per the BDC policy, a BDC Announcement shall be issued to inform interested parties that the previous version and the applicable BDC Announcements are now obsolete and is superseded by the new version. This BDC will be the final BDC attached to the previous version.

Multiple versions of the manual shall not be issued within the same calendar month except under extenuating circumstances.

G.6.3.4. Manual accessibility

This manual shall be accessible via an easily accessible and appropriate NJDOT Internet web page. This page shall contain a highly visible link to the most recent version of the TSM Procedures manual, as well as links to previous versions of the manual and all Baseline Document Changes (BDCs).

BDCs shall be listed beneath the Baseline Document version to which they apply, along with a date and a brief summary of the sections affected.

To ensure continuity, any external references to the TSM Procedures Manual shall point to this page and not to any particular version of the manual directly, unless the reference explicitly requires it.

G.6.4. Quality Assurance/Quality Control

A checklist that identifies the major components or topics in this Manual appears at the back of this manual in Part I. The checklist consists of a table identifying all Specifications, Standard Input, Standard Drawings, or sections within this Manual that relate to the noted topic.

While editing the Manual (or any of the other documents shown), the editor shall use this checklist to verify that any updates in one location, document, or file are correspondingly addressed in the other listed locations, documents, or files so as to reduce the chance of conflicts or contradictions.

Upon completion of edits, the table shall be printed in its entirety and the editor shall check the box next to each reference to certify that has been checked to verify consistency. If the table itself is changed, the table from the original version (the current version prior to any edits) should be used.

Additionally, all hyperlinks in the document that reference NJDOT or external web pages should be checked for validity, and should be corrected as needed. An automated process may facilitate this task.

The box at the end of the checklist will be used to ensure compliance with this policy. Both the original version number and the new, proposed version number should be noted, as well as a brief summary of the edits performed. Then, the editor will sign and date the checklist followed by another person who will check the editor's work for consistency and correctness. Finally, the Director of MSE will sign the bottom of the checklist, authorizing its publication and public distribution.

G.6.5. Maintenance of File Hyperlinks

The TSM Procedures Manual is written in a format compatible with Microsoft Word 2007/2010/2013. By default, Word will save hyperlinks to other files in Absolute format, meaning the address is applicable only to the computer on which it was saved. The complete location of a file (such as "c:\username\my documents\ TSMProcedures_v1.0_2016-01-01.docx") will be embedded within the document, and therefore the links will be invalid when the file is edited by others or when posted on the web. This is particularly problematic when dealing with links to Appendices, which are stored in a subdirectory named "Appendices" immediately beneath the directory containing the main Procedures Manual file.

In order to maintain these links, Word must be configured to allow Relative hyperlinks. The process for making this change to Word is detailed below. **Editors are hereby cautioned that if the following setting is not properly configured on any computer that is used to save the document, whether or not the file hyperlinks were actually changed, all of these links will be converted to Absolute format and may become non-functional to other readers or editors.**

To configure Microsoft Word to maintain relative hyperlinks on any computer, perform the following steps:

PART G - ADMINISTRATIVE PROCEDURES

1. Click **File** (Word 2010/2013) or the **Microsoft Office Button** (Word 2007)
2. Click **Options**

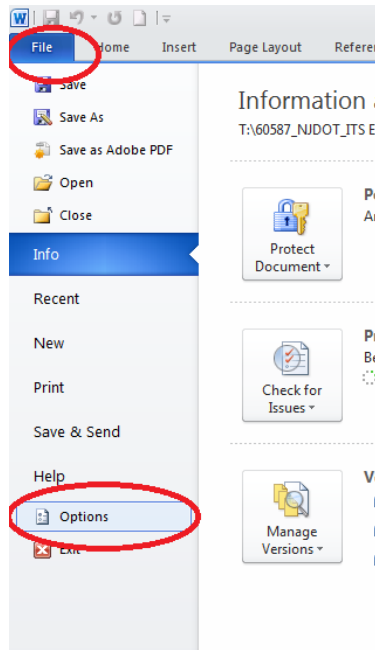


Figure G-6: Enable relative hyperlinks (Steps 1-2)

3. Click **Advanced**
4. Scroll down to the “General” group and click **Web Options**

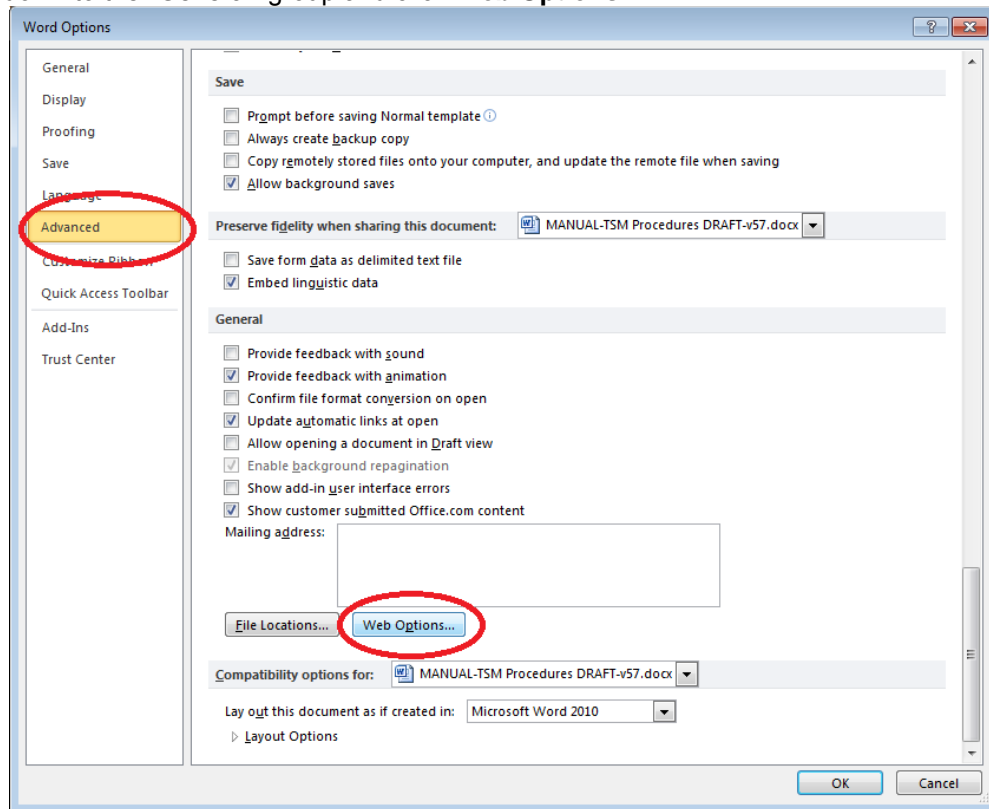


Figure G-7: Enable relative hyperlinks (Steps 3-4)

5. Click the **Files** tab
6. Un-check the box for **Update links on save**

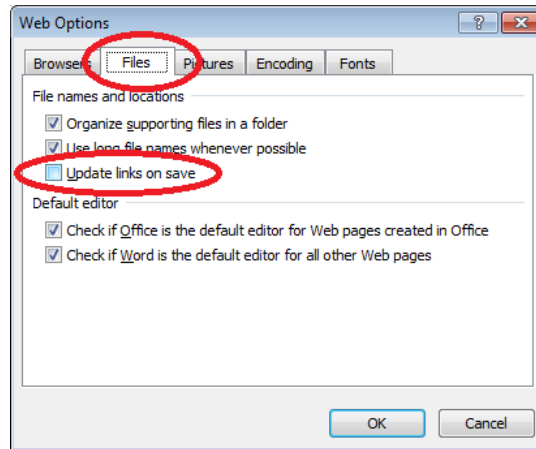


Figure G-8: Enable relative hyperlinks (Steps 5-6)

7. Click **OK** two times

H. APPENDIX – Glossary, Abbreviations, Attachments

H.1. Glossary of Terms

Term	Meaning
Central Dispatch Logs	A log of incidents to which police departments are summoned to respond
CitiLog	Video analytics used in the Route 29 tunnel
Contract Manager	Functional role of the individual within MSE responsible for managing, directing, or coordinating the necessary consultant service
Garden State Network	The multi-agency, multi-protocol network supporting State agencies across New Jersey, built and managed by the Office of Information Technology
Statewide ITS Maintenance	The organization within MSE that is responsible for the maintenance of the ITS network
OpenReach	The central, regional operational database that agencies in the region use to enter, monitor, disseminate, and manage roadway activities
Project Manager	Functional role of the individual within MSE responsible for the technical guidance and review of the consultant service
Traffic Operations	The organization within TSM that monitors, informs, and controls traffic and ITS devices in real-time

H.2. Acronyms and Abbreviations

Acronym/Initialism	Meaning
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AAM	Advanced Arterial Management
ACE	Atlantic City Electric

PART H - APPENDIX – GLOSSARY, ABBREVIATIONS, ATTACHMENTS

Acronym/Initialism	Meaning
ADT	Average Daily Traffic
AMC	Arterial Management Center
ATR	Automatic Traffic Recorder
ASCT	Adaptive Signal Control Technology
BTDS	Bureau of Transportation Data and Safety
BTE	Bureau of Traffic Engineering
CAIT	Center for Advanced Infrastructure and Transportation
CD	Concept Development
CM	Contract Manager
COP	Change of Plan
CPD	Capital Project Delivery
CPM	Capital Program Management
CSS	Camera Surveillance System
CTSS	Controlled Traffic Signal System
DCP	Data Collection Program
DCR	Design Communications Report
DCR (Section F)	Data Collection Report
DMS	Dynamic Message System
DOS	Degree of Saturation
EDU	Engineering Documents Unit
FDW	Flashing Don't Walk
FHWA	Federal Highway Administration
GSN	Garden State Network
GPS	Global Positioning System

PART H - APPENDIX – GLOSSARY, ABBREVIATIONS, ATTACHMENTS

Acronym/Initialism	Meaning
HCM	Highway Capacity Manual
HPMS	Highway Performance Monitoring System
IM	Incident Management
IMC	ITS Maintenance Contract
IMRT	Incident Management Response Team
IMTG	Incident Management Timing Guidelines
IR	Implementation Review
IT	Information Technology (NJDOT internal)
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
ITSIMM	Intelligent Transportation Systems Inspection and Maintenance (Acceptance) Manual
IVR	Interactive Voice Recording
JCP&L	Jersey Central Power and Light
KPI	Key Performance Indicators
LCR	Lane Closure Request/Report
LED	Light Emitting Diode
LIDAR	Light Detection And Ranging
LOS	Level of Service
MAP	Major Access Permit
MCM	Maintenance and Construction Management
MCV	Maintenance and Construction Vehicle
MM	Mobility Management
MOA	Memorandum of Agreement
MOE	Measure of Effectiveness

PART H - APPENDIX – GLOSSARY, ABBREVIATIONS, ATTACHMENTS

Acronym/Initialism	Meaning
MOU	Memorandum of Understanding
MPH	Miles Per Hour
MSE	Mobility and Systems Engineering
MUTCD	Manual on Uniform Traffic Control Devices
N/A	Not Applicable/Does Not Apply
NEMA	National Electrical Manufacturers Association
NJDOT	New Jersey Department of Transportation
NJMC	New Jersey Meadowlands Commission
NJTA	New Jersey Turnpike Authority
NTCIP	National Transportation Communications for ITS Protocol
NTOR	No Turn On Red
OB	Operations Bulletin
OIT	Office of Information Technology
OSHA	Occupational Safety and Health Administration
P/P	Policy/Procedure
PANYNJ	Port Authority of NY & NJ
PDU	Power Distribution Unit
PEOSHA	Public Employees Occupational Safety and Health Act
PHF	Peak Hour Factor
PI	Physical Inventory
PIFF	Patented/proprietary Items on Federally Funded projects
PM	Project Manager
PoE	Power over Ethernet
POI	Point of Interest

Acronym/Initialism	Meaning
PPB	Pedestrian Push Button
PS&E	Plans, Specifications, and Estimates
PSE&G	Public Service Electric and Gas
PTMCCA	Portable Trailer Mounted CCTV Camera Assembly
PTZ	Pan-Tilt-Zoom
PVMS	Portable Variable Message Sign
PVMSRC	Portable Variable Message Sign with Remote Control
QA/QC	Quality Assurance/Quality Control
QPL	Qualified Product List
RDM	Roadway Design Manual
RE	Resident Engineer
RIMIS	Regional Integrated Multi-modal Information Sharing
ROW	Right of way
RSS	Real Simple Syndication
RTWZTS	Real-Time Work Zone Traffic System
RWIS	Roadway Weather Information System
SAR	System Architectural Review
SERF	Systems Engineering Review Form
SIM	Statewide ITS Management
SLD	Straight Line Diagram
SME	Subject Matter Expert
SRI	Standard Route Identifier
SSP	Safety Service Patrol
STIP	Strategic Transportation Improvement Program

Acronym/Initialism	Meaning
STMC	Statewide Traffic Management Center
TDCC	Traffic Data Collection Contractor
TMC (Section F)	Turning Movement Count
TMC	Traffic Management Channels
TMP	Traffic Management Plans
TOC	Traffic Operations Center
TOC-S	Traffic Operations Center – South
TOD	Time of Day
TP#	Technical Proposal Number
TSM	Transportation Systems Management
TSWS	Truck Safety Warning System
TTS	Travel Time System
TVS	Traffic Volume System
VCC	Vehicle Classification Counts
VSLs	Variable Speed Limit System
WIMS	Weigh-In-Motion System
XML	Extensible Markup Language

H.3. List of Manual Hyperlinks

MANUAL REFERENCE:		List of Manual Hyperlinks Appendices\TSMManualHyperlinks.docx
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H.4. MSE-Major Access Permit Process Flowchart

MANUAL REFERENCE:		MSE-Major Access Permit Process Flowchart Appendices\ChartPermitProcess.pdf
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H.5. TSM Limited Scope Project Delivery Process Network Diagram

MANUAL REFERENCE:		TSM Limited Scope Process Network Diagram Appendices\TSMLimitedScopeProjectNetworkDiagram.pdf
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H.6. TSM Limited Scope Project Delivery Process Activity Descriptions

MANUAL REFERENCE:		TSM Limited Scope Project Delivery Process Activity Descriptions Appendices\TSMLimitedScopeProjectDeliveryProcessActivityDescriptions.pdf
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H.7. ITS Device IP Request Form

MANUAL REFERENCE:		IP Request Form Appendices\ITSIPDeviceListProjectDesc.xlsx
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H.8. ROW Clearance Letter

MANUAL REFERENCE:		ROW Clearance Letter Appendices\ROWClearanceLetter.pdf
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H.9. ITS Submission Checklists

MANUAL REFERENCE:		ITS Submission Checklist Appendices\AppendixITSSubmissionChecklists.pdf
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H.10. ITS Design Checklists

MANUAL REFERENCE:		ITS Design Checklists Appendices\AppendixITSDesignChecklists.pdf
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H.11. TSM Limited Scope CD Checklist

MANUAL REFERENCE:		TSM Limited Scope CD Checklist Appendices\TSMLimitedScopeCDChecklist.doc
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H.12. Excerpt – ITS Engineering Checklist / Limited Scope

MANUAL REFERENCE:		EXCERPT – Traffic Ops/ITS Engineering Checklist from Limited Scope project Appendices\TrafficOpsITSEngChecklist.pdf
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H.13. ITS Systems Device Integration Form

MANUAL REFERENCE:		ITS Systems Device Integration Form Appendices\AppendixITSSystemsDeviceIntegrationForm.pdf
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H.14. Sample ITS System Block Diagram

MANUAL REFERENCE:		Sample ITS System Block Diagram Appendices\SampleITSSystemBlockDiagram.pdf
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H.15. MM-ITS Testing Protocol

MANUAL REFERENCE:		MM-ITS Testing Protocol Appendices\MMITSTestingProtocol.pdf
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H.16. ITSIMM: ITS Inspection and Acceptance Manual

MANUAL REFERENCE:		ITS Inspection and Maintenance/ Acceptance Manual Appendices\ITSIMM.pdf
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H.17. TMC Operator Training Course Slideshow

MANUAL REFERENCE:		TMC Operator Training Course Slideshow Appendices\NJDOTTMCTraining.pdf
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H.18. Sample Capital Program Coordination Memorandum

MANUAL REFERENCE:		Sample Capital Program Coordination Memorandum Appendices\SampleCapitalProgramCoordinationMemo.pdf
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H.19. Blank Task Order Form

MANUAL REFERENCE:		Blank Task Order Form Appendices\TaskOrderForm.pdf
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H.20. NJDOT Forms Catalog Intranet Page - Procurement

MANUAL REFERENCE:		NJDOT Forms Catalog Intranet Page - Procurement Appendices\IntranetFormsCatalogProcurement.pdf
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H.21. MSE Progress Report Template

MANUAL REFERENCE:		MSE Progress Report Template Appendices\MSEProgressReportFormat.docx
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H.22. Contract Manager Checklist

MANUAL REFERENCE:		Contract Manager Checklist Appendices\CMChecklist.dotx
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H.23. Consultant Agreement Process Flowcharts

MANUAL REFERENCE:		Consultant Agreement Process Flowcharts.pdf Appendices\FlowchartEstablishingConsultantAgreements.pdf
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H.24. Invoice Processing Flowchart

MANUAL REFERENCE:		Invoice Processing Flowchart Appendices\FlowchartInvoiceProcessingTSMManual.pdf
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H.25. Policy/Procedure #312: Consultant Selection Process

MANUAL REFERENCE:		Policy/Procedure #312: Consultant Selection Process Appendices\312.pdf
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H.26. Policy/Procedure #328: Agreement, Development, Execution, Management, and Closure of Consultant Contracts

MANUAL REFERENCE:		Policy/Procedure #328: Agreement, Development, Execution, Management, and Closure of Consultant Contracts Appendices\328.pdf
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H.27. CTSS Project Guidelines

MANUAL REFERENCE:		CTSS Project Guidelines Appendices\CTSSProjectGuidelines.pdf
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H.28. CTSS Adaptive Testing Forms

MANUAL REFERENCE:		CTSS Adaptive Testing Forms Appendices\CTSSAdaptiveTestingForms.pdf
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I. ITS Cross-Reference Checklist

Keyword	Description	Specifications	Standard Input	Standard Drawings	Procedures Manual
DMS	Dynamic Message System	<input type="checkbox"/> 704.03.07	<input type="checkbox"/> 704.03.07	<input type="checkbox"/> ITS-704-24	<input type="checkbox"/> A.4.4 List of ITS Devices and Assets used by TSM <input type="checkbox"/> C.3.2 Dynamic Message System (DMS) <input type="checkbox"/> E.1.2.3 Operation of ITS Devices
PVMS	Portable Variable Message Sign	<input type="checkbox"/> 1001.02 <input type="checkbox"/> 1001.04	<input type="checkbox"/> 1001.04		<input type="checkbox"/> C.6.5 RTWZTS Guidance on System Setup
P-CCTV	Portable Camera	<input type="checkbox"/> 1001.05	<input type="checkbox"/> 1001.05		<input type="checkbox"/> C.6.5 RTWZTS Guidance on System Setup
CSS	Camera Surveillance System	<input type="checkbox"/> 704.03.02 <input type="checkbox"/> Camera <input type="checkbox"/> IP Camera <input type="checkbox"/> Camera Lowering System <input type="checkbox"/> Controller Camera <input type="checkbox"/> Hardened Video Encoder <input type="checkbox"/> Hardened Video Encoder Decoder Pair <input type="checkbox"/> Multi-Channel Video Encoder	<input type="checkbox"/> 704.03.02	<input type="checkbox"/> ITS-704-11 <input type="checkbox"/> ITS-704-12 <input type="checkbox"/> ITS-704-13 <input type="checkbox"/> ITS-704-14 <input type="checkbox"/> ITS-704-15 <input type="checkbox"/> ITS-704-16 <input type="checkbox"/> ITS-704-17 <input type="checkbox"/> ITS-704-38 <input type="checkbox"/> ITS-704-39 <input type="checkbox"/> ITS-704-41 <input type="checkbox"/> ITS-704-44 <input type="checkbox"/> ITS-704-45 <input type="checkbox"/> ITS-704-46 <input type="checkbox"/> ITS-704-47	<input type="checkbox"/> C.6.5 RTWZTS Guidance on System Setup <input type="checkbox"/> C.3.4 Camera Surveillance System (CSS)

PART I - ITS CROSS-REFERENCE CHECKLIST

Keyword	Description	Specifications	Standard Input	Standard Drawings	Procedures Manual
TTS	Travel Time System	<input type="checkbox"/> 704.03.05	<input type="checkbox"/> 704.03.05	<input type="checkbox"/> ITS-704-18 <input type="checkbox"/> ITS-704-19 <input type="checkbox"/> ITS-704-20 <input type="checkbox"/> ITS-704-38 <input type="checkbox"/> ITS-704-40 <input type="checkbox"/> ITS-704-42	<input type="checkbox"/> C.6.5 RTWZTS Guidance on System Setup <input type="checkbox"/> C.3.5 Travel Time System (TTS)
TSWS	Truck Safety Warning System				<input type="checkbox"/> C.3.6 Truck Safety Warning System (TSWS)
VSLs	Variable Speed Limit	<input type="checkbox"/> Controller VSLs		<input type="checkbox"/> ITS-704-43	<input type="checkbox"/> C.3.3 Variable Speed Limit System (VSLs)
Controller Cabinet		<input type="checkbox"/> 704.03.01 <input type="checkbox"/> 918.09 <input type="checkbox"/> Controller Camera <input type="checkbox"/> Controller ITS <input type="checkbox"/> Controller VSLs	<input type="checkbox"/> 704.03.01	<input type="checkbox"/> ITS-704-21 <input type="checkbox"/> ITS-704-22 <input type="checkbox"/> ITS-704-23 <input type="checkbox"/> ITS-704-24 <input type="checkbox"/> ITS-704-25 <input type="checkbox"/> ITS-704-26 <input type="checkbox"/> ITS-704-33 <input type="checkbox"/> ITS-704-43	<p>I.1. <input type="checkbox"/> C.2 Gap Assessment Gap Assessment</p> <p><input type="checkbox"/> C.3.10 ITS Cabinets (Controllers and Electrical Service) <input type="checkbox"/> C.4.2 Efficiency</p>
TVS	Traffic Volume System	<input type="checkbox"/> 704.03.09 <input type="checkbox"/> Traffic Volume System	<input type="checkbox"/> 704.03.09	<input type="checkbox"/> ITS-704-32	
WIMS	Weigh-In Motion System	<input type="checkbox"/> 704.03.08 <input type="checkbox"/> Weigh-In-Motion System	<input type="checkbox"/> 704.03.08	<input type="checkbox"/> ITS-704-31 <input type="checkbox"/> ITS-704-33	<input type="checkbox"/> C.3.8 Weigh-in-Motion System (WIMS)
RWIS	Roadway Weather Information System	<input type="checkbox"/> 704.03.06	<input type="checkbox"/> 704.03.06	<input type="checkbox"/> ITS-704-34 <input type="checkbox"/> ITS-704-35 <input type="checkbox"/> ITS-704-36	<input type="checkbox"/> C.3.9 Roadway Weather Information System (RWIS)

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<p>CTSS</p>	<p>Controlled Traffic Signal System</p>	<p><input type="checkbox"/> 704.03.04</p>	<p><input type="checkbox"/> 704.03.04</p>		<ul style="list-style-type: none"> <input type="checkbox"/> A.4.3 Facilities <input type="checkbox"/> A.4.4 List of ITS Devices and Assets used by TSM <input type="checkbox"/> A.5.2. FHWA Model System Engineering for ASCT <input type="checkbox"/> B.2.6.1.1 Concept of Operation I.2. <input type="checkbox"/> C.2 Gap Assessment Gap Assessment <input type="checkbox"/> C.3.7 Controlled Traffic Signal System (CTSS) <input type="checkbox"/> C.3.10 ITS Cabinets (Controllers and Electrical Service) <input type="checkbox"/> C.3.11 Communication System <input type="checkbox"/> C.6.5 RTWZTS Guidance on System Setup <input type="checkbox"/> C.7.1 Designer Responsibility <input type="checkbox"/> D.1.5 ITS Testing <input type="checkbox"/> D.5.1 Preparation for Substantial Completion/Acceptance/Close out <input type="checkbox"/> E.1.2.2 Assisting Maintenance <input type="checkbox"/> E.2.1 IT/OIT Coordination <input type="checkbox"/> E.2.2 CTSS Server and Security Requirements <input type="checkbox"/> E.2.3 CTSS Template for System Architecture Review (SAR) <input type="checkbox"/> F.1.1 Definition <input type="checkbox"/> F.2 Signal Optimization Guidelines <input type="checkbox"/> F.2.1.1 Scope Development <input type="checkbox"/> F.7.1 Timing Directives
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PART I - ITS CROSS-REFERENCE CHECKLIST

Keyword	Description	Specifications	Standard Input	Standard Drawings	Procedures Manual
					<input type="checkbox"/> F.7.3 Field Adjustment <input type="checkbox"/> H.27 CTSS Project <input type="checkbox"/> H.28 CTSS Adaptive Testing Forms
511NJ	511 System				<input type="checkbox"/> C.8 511NJ <input type="checkbox"/> D.4 511NJ <input type="checkbox"/> E.3 511NJ <input type="checkbox"/> E.3 511NJ
Communications Systems	Various methods of communications, including cable, fiber, and wireless	<input type="checkbox"/> 704.03.01 <input type="checkbox"/> 704.03.03 <input type="checkbox"/> Ethernet Cable <input type="checkbox"/> Fiber Optic Cable <input type="checkbox"/> Fiber Optic Patch Panel <input type="checkbox"/> Fiber Optic Splice Enclosure <input type="checkbox"/> Wireless Link	<input type="checkbox"/> 704.03.03	<input type="checkbox"/> ITS-704-06	<input type="checkbox"/> C.3.11 Communication System <input type="checkbox"/> C.5 Network <input type="checkbox"/> D.2 Network
Electrical Wire		<input type="checkbox"/> 701.03.15 <input type="checkbox"/> 918.02 <input type="checkbox"/> 918.04 <input type="checkbox"/> 918.15	<input type="checkbox"/> 701.03.15		<input type="checkbox"/> C.3.13 Wiring
Raceway Systems		<input type="checkbox"/> 701.03.02 <input type="checkbox"/> 701.03.03 <input type="checkbox"/> 701.03.04 <input type="checkbox"/> 701.03.05 <input type="checkbox"/> 701.03.06 <input type="checkbox"/> 701.03.07 <input type="checkbox"/> 701.03.04 <input type="checkbox"/> 704.03.01 <input type="checkbox"/> 918.01	<input type="checkbox"/> 701.03.01 <input type="checkbox"/> 918.01	<input type="checkbox"/> ITS-704-01 <input type="checkbox"/> ITS-704-02 <input type="checkbox"/> ITS-704-03 <input type="checkbox"/> ITS-704-04 <input type="checkbox"/> ITS-704-05	<input type="checkbox"/> C.3.12 Raceway System

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Keyword	Description	Specifications	Standard Input	Standard Drawings	Procedures Manual
Junction Box		<input type="checkbox"/> 701.03.08 <input type="checkbox"/> 701.03.09 <input type="checkbox"/> 701.03.10 <input type="checkbox"/> 701.03.11 <input type="checkbox"/> 704.03.01 <input type="checkbox"/> Stainless Steel Junction Box	<input type="checkbox"/> 704.03.01	<input type="checkbox"/> ITS-704-04 <input type="checkbox"/> ITS-704-07 <input type="checkbox"/> ITS-704-09 <input type="checkbox"/> ITS-704-10	
Communication Hub		<input type="checkbox"/> 704.03.01	<input type="checkbox"/> 704.03.01	<input type="checkbox"/> ITS-704-27 <input type="checkbox"/> ITS-704-28 <input type="checkbox"/> ITS-704-29 <input type="checkbox"/> ITS-704-30	
Control Center System		<input type="checkbox"/> 704.03.01	<input type="checkbox"/> 704.03.01		

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FOR MSE USE ONLY WHEN EDITING THIS MANUAL (See section G.6.4)

Brief description of change:

Version of Manual: (Original) _____ (Revised) _____

Edited by: _____ Date _____

Checked by: _____ Date _____

Authorized by: _____ Date _____