ITS Design Guidelines

11/11/2020
Revision 1.3
Atlanta, GA 30308

Georgia Department of Transportation

This document was developed as part of the continuing effort to provide guidance within the Georgia Department of Transportation in fulfilling its mission to provide a safe, efficient, and sustainable transportation system through dedicated teamwork and responsible leadership supporting economic development, environmental sensitivity and improved quality of life. This document is not intended to establish policy within the Department, but to provide guidance in adhering to the policies of the Department.

Your comments, suggestions, and ideas for improvements are welcomed.

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DISCLAIMER

Revision History

Revision Number	Revision Date	Revision Summary
1.1	6/19/2020	Draft 1 of first major update
1.2	9/18/2020	Draft 2 of first major update
1.3	11/11/2020	Final of first major update

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List of Effective Chapters

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Chapter 1. Acronyms, Terms, and Definitions

This chapter provides a list of acronyms and definitions to assist the designer in understanding the language used in these guidelines.

1.1 Acronyms

AASHTO – American Association of State Highway and Transportation Officials

AID – Automatic Incident Detection

BG – Barrier Gates

CCTV – Closed-Circuit Television

C-V2X – Cellular Vehicle-to-Everything

DLCS – Dynamic Lane Control Signs

DMS – Dynamic Message Signs

DOT – Department of Transportation

DSRC – Dedicated Short-Range Communications

EAG – Emergency Access Gate

ELNIOM – Express Lanes Network Implementation and Operations Manual

EMI – Electromagnetic Interference

ESS – Environmental Sensor Station

ECB – Electrical Communications Box

FHWA – Federal Highway Administration

FDU – Fiber Distribution Unit

FPP – Fiber Patch Panel

GDOT – Georgia Department of Transportation

GLSS – Gate Lifting and Swinging System

GTIR* – General Tolling Infrastructure Requirements

HD – High Definition

HOT – High Occupancy Toll

HOV – High Occupancy Vehicle

HVAC – Heating, Ventilation, and Air Conditioning

ICWS – Intersection Collision Warning System

ID – Identification

IEEE – Institute of Electrical and Electronic Engineers

IP – Internet Protocol

ITS – Intelligent Transportation Systems

IVDS –Video Detection System

LED – Light-Emitting Diode

MPH – Miles per Hour

MUTCD – Manual on Uniform Traffic Control Devices

MVDS – Microwave Vehicle Detection System

OSI – Open Systems Interconnection

OSP – Outside Plant

POE – Power Over Ethernet

PTZ – Pan-Tilt-Zoom

QPL – Qualified Product List

QSFP – Quad Small Form-factor Pluggable

RPU – Remote Processing Unit

RSU – Roadside Unit

ROW – Right-of-Way

SFP – Small Form-factor Pluggable

SIN – Site Identification Name

SRTA – State Road and Tollway Authority

TMC – Transportation Management Center / Traffic Management Center

UPS – Uninterruptible Power Supply

VLAN – Virtual Local Area Network

VSL – Variable Speed Limit

WG – Warning Gates

1.2 Definition of Terms

Acceleration Distance – Amount of distance (in feet) required for a vehicle to safely accelerate from the stop bar at a ramp meter to the merge point of traffic along a highway**.**

Automatic Incident Detection (AID) – AID is a software overlay that requires the use of a camera. AID uses computer vision to monitor traffic conditions, detect incidents and traffic queues, and detect any abnormal activity. AID should be deployed in areas with high accident rates or high levels of congestion.

Blank-Out Sign – A type of dynamic message sign that typically displays a fixed message and is blank when not in use. In addition, it is typically smaller than a dynamic message sign.

Clear Zone – The American Association of State Highway and Transportation Officials' Geometric Design Manual defines this as the unobstructed traversable area beyond the edge of the traveled way. This offset distance from the travel way is dependent on the speed, traffic volume, and embankment slope. Clear zone distances can be obtained in the 4000W standard of the GDOT Construction Standards and Details.

Closed-Circuit Television (CCTV) – A video monitoring device used to visually confirm a variety of roadway conditions or other intelligent transportation systems device operations.

Conduit – A tube used to protect and route electrical wiring and fiber optic cabling.

Conduit Duct Bank – A configuration of multiple runs of conduit. Reference GDOT detail ITS-07.

Demand Detector – A loop or microwave radar zone installed per lane on the ramp that detects the presence of one vehicle at or near the stop bar of a ramp meter signal. Demand detectors tell the ramp meter system that a vehicle is waiting for a green signal.

Drop Fiber – A smaller-strand count of fiber optic cable that provides the interconnection of network equipment inside a field cabinet and/or a hub building to the trunk or backbone fiber optic cable.

Dynamic Message Sign (DMS) – A sign used to inform drivers using a variety of messages.

Environmental Sensor Station (ESS) – A fixed location with one or more sensors measuring atmospheric, surface, and subsurface conditions.

Excessive Queue Detector – A loop or microwave radar zone installed per lane on the ramp that detects the presence of a vehicle stopped upstream of the ramp meter approach (80% of the distance from the stop bar to the upstream intersection).

Express Lanes – Optional priced lanes that run alongside existing interstates in some of the most congested corridors.

Fiber Optic Cable – Fiber optic cable uses glass or plastic strung into thin cables for transmittal of data using pulses of light to transmit machine language between devices. This allows remote communication to field devices.

Fiber Patch Panels/ Fiber Distribution Units (FPP/FDU) – Used for fiber optic termination. Specifically, these devices provide a connection point for ITS devices on the fiber optic cable.

Inductance Loop Detection System – A rack-mounted card inserted into the cabinet input file that supplies an electric current to a coil of wire embedded in the travel lane, which measures changes in the inductance when vehicles pass over the coil of wire.

Intermediate Queue Detector – A loop or microwave radar zone installed per lane on the ramp that detects the presence of a vehicle stopped near the middle of the ramp meter approach (40% of the distance from the stop bar to the upstream intersection). An alternate term is mid-queue detector.

Microwave Vehicle Detection System (MVDS) – This radar-based detection system involves microwaves being transmitted and received by the system to determine a vehicle's presence and other identifying characteristics. The device can provide information such as vehicle size, speed, and lane location.

Passage Detector – A loop or microwave radar zone installed per lane on the ramp that detects the presence of a vehicle passing through the ramp meter signal. Passage detectors tell the ramp meter system to terminate the green signal after a vehicle clears the stop bar.

Quad Small Form-factor Pluggable (QSFP) – A compact, hot-pluggable transceiver used for data communications applications. This device aggregates large amounts of data and is typically used in hubs.

Queue Storage Distance – Amount of distance (in feet) between the stop bar at the ramp meter signal and the near-edge of the traveled way of the cross street.

Remote Processing Unit (RPU) – A processor that collects, pre-processes, and archives ESS sensor and device data.

Trunk/Backbone Fiber – A multi-fiber count of fiber optic cable that provides the network interconnection and transport between field cabinets, hub buildings, the TMC, and other facilities.

Video Detection System (IVDS) – A video-based detection system that captures and processes video images to detect the presence of vehicles, vehicle counts, vehicle classification, detector occupancy, and/or speed information.

Chapter 2. Supplemental Documents and Design Guides

This section is to guide the designer to additional documentation that should be considered throughout the lifecycle of the design process. The following is not an all-inclusive list of documents to consider but provides a starting point. Lastly, the listed documents may be updated at any time; it is the responsibility of the designer to ensure the latest publication is referenced.

Federal Highway Administration MUTCD for Streets and Highways
https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm

Federal Highway Administration Ramp Management and Control Handbook
https://ops.fhwa.dot.gov/publications/ramp_mgmt_handbook/manual/manual/pdf/rm_handbook.pdf

Federal Highway Administration Research List of Online Reports and Technical Publications
https://www.fhwa.dot.gov/research/publications/technical/

Federal Highway Administration Road Weather Information System/Environmental Sensor Station Siting Guidelines
https://ops.fhwa.dot.gov/publications/ess05/index.htm

Federal Highway Administration Use of Freeway Shoulders for Travel Guide
https://ops.fhwa.dot.gov/publications/fhwahop15023/index.htm#toc

GDOT Construction Standards and Details
http://mydocs.dot.ga.gov/info/gdotpubs/ConstructionStandardsAndDetails/Forms/AllItems.aspx

GDOT CV Guidance Document
http://www.dot.ga.gov/PS/DesignManuals/DesignGuides

GDOT Design Policy Manual
http://www.dot.ga.gov/PartnerSmart/DesignManuals/DesignPolicy/GDOT-DPM.pdf#search=policy%20manual

GDOT Electronic Data Guidelines
http://www.dot.ga.gov/PartnerSmart/DesignManuals/ElectronicData/Electronic_Data_Guidelines.pdf

GDOT Plan Development Process
http://www.dot.ga.gov/PartnerSmart/DesignManuals/PDP/PDP.pdf

GDOT Plan Presentation Guide
http://www.dot.ga.gov/PartnerSmart/DesignManuals/Plan/Plan_Presentation_Guide.pdf

GDOT Ramp Meter Warrants and Guidelines
http://www.dot.ga.gov/PS/DesignManuals/DesignGuides

GDOT Standard Specifications Construction of Transportation Systems
http://www.dot.ga.gov/PartnerSmart/Business/Documents/GDOT_SpecBook_2013.pdf

GDOT Supplemental Specifications (2016) Modifying the 2013 Standard Specifications Construction of Transportation Systems
http://www.dot.ga.gov/PartnerSmart/Business/Source/special_provisions/2016%20Supplemental%20Specifications/2016SupplementalSpecBook.pdf

GDOT Supplemental Specifications Not Published in 2016 Edition
http://www.dot.ga.gov/PartnerSmart/Business/Source/

GDOT Standard Specifications Construction of Transportation Systems (2020)
http://www.dot.ga.gov/PartnerSmart/Business/Source/

GDOT Traffic Signal Design Guidelines
http://www.dot.ga.gov/PartnerSmart/DesignManuals/SignalDesignManual/Traffic%20Signal%20Design%20Guidelines-2016.pdf

GDOT Vehicle Preemption and Priority Application Guide
http://www.dot.ga.gov/PS/DesignManuals/DesignGuides

SRTA General Tolling Infrastructure Requirements (GTIR)
SRTA requirements for express lanes are included in the GTIR. The GTIR was created for Design Build projects in partnership with GDOT. The requirements of the GTIR must be included into projects that impact the express lanes. The designer should coordinate with SRTA to identify the sections of the GTIR that are applicable or any modifications required to support the tolling system. All projects regardless of the delivery method must be coordinated with SRTA to ensure that the requirements to support the tolling infrastructure are incorporated into the planning, design, construction and implementation of the project.

Chapter 3. Introduction

The purpose of these design guidelines is to provide every aspect a designer should need to consider when developing any ITS project within the State of Georgia. These design guidelines are intended to provide guidance to designers as a reference handbook. These guidelines will lead the designer through the process of identifying and placing ITS devices for any given project.

The key ITS features these guidelines include are ramp meters, DMS, vehicle detection, CCTV, and ESS. These devices should be located first on a full ITS buildout, and in that particular order so that devices can be co-located whenever possible. This allows for reduced project costs and effort related to operations, maintenance, and device replacement. Ramp meters are installed at fixed locations and thus should be the first system designed. Then, DMS should be placed because they are installed with the intent to alert drivers to certain events downstream. Designers should add in vehicle detection next and look to see if any existing infrastructure can be used to mount detection assemblies. CCTV and ESS are the final elements to be included in a full ITS buildout. Whenever possible, designers should try to utilize existing infrastructure and embrace co-location as long as it does not interfere with the effectiveness and goal of the device.

The general structure in each chapter is: introduction, types, placement, power, cabinet and network equipment, communication equipment, and conclusion and key points. With this structure, the designer will be fully informed about each device and everything that needs to be considered.

Additionally, there are chapters detailing more specific ITS devices, which include DLCS, electronically operated gates, VSL, ITS safety systems, and connected vehicle equipment. These devices are not as likely to be included on an ITS project.

There are a few chapters that detail some of the supporting aspects of an ITS device. They include power, communications, and naming schemes for ITS devices.

Appendixes provide further information for the designer. Appendix A, the designer checklist, is a way for the designer to step through each major decision in the design process. Appendixes B and C provide information regarding ramp meter installation details and standard cabinet wiring diagrams. Lastly, Appendix D provides some example plan sheets to aid the designer.

Projects that are new express lanes or modifications to existing express lanes have additional requirements for GDOT and SRTA that must be met. The Express Lane Implementation and Operations Manual, and the General Tolling Infrastructure Requirements (SRTA) document include requirements that are applicable to these facility types.

3.1 Updating the Guidelines

The discipline of ITS is an ever evolving and innovating industry. Thus, this is a living document that will change. Always reference the latest version of this document.

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Chapter 4. Ramp Meter

4.1 Introduction

Ramp meters increase the operational efficiency and safety of freeway corridors by breaking up platoons (clusters) of vehicles as they enter the mainline traffic stream. Ramp meters provide GDOT staff with the ability to control traffic flow on freeway entrance ramps, and thereby manage congestion on the freeway mainline lanes. Ramp meter objectives are as follows:

- Increase freeway mainline speed in the vicinity of the entrance ramp
- Minimize the speed differential between the lanes on the mainline freeway
- Improve weaving and merging conditions related to traffic entering via the entrance ramp
- Mitigate traffic queues and conditions on the arterial which feeds the entrance ramp

GDOT will consider the use of a ramp meter if one or both warrants described below are satisfied, and adequate acceleration distance is available. However, the warrants and acceleration distance criteria should be considered a starting point for justifying ramp meters. Other factors should also be considered, such as:

- Freeway interchange where mainline speeds are consistently less than free-flow speeds
- Short duration impacts of ramp vehicles entering the mainline freeway
- High percentages of truck volumes in the area
- Safety issues on the mainline freeway resulting from significant speed differentials
- Other factors that influence engineering judgment

Ramp metering should be considered as a system that manages a section of freeway that includes consecutive entrance ramps. As such, it may be appropriate to add a ramp meter based on the needs of the freeway downstream of the subject entrance ramp. Designers should coordinate with the GDOT ITS group to verify that a ramp meter is justified.

Ramp Meter Warrant 1 – Freeway Right Lane and Entrance Ramp Flow Rate

During a typical 15-minute period, the combined flow from the entrance ramp and right-most lane of the freeway is greater than 2,000 vehicles per hour and the entrance ramp has greater than 400 vehicles.

Ramp Meter Warrant 2 – Freeway Speed

During a typical 15-minute period, the general purpose lanes on the freeway (not including flex, entrance, managed, HOT, and HOV lanes) have an average speed less than 55 mph due to recurring congestion adjacent to the entrance ramp or within 2 miles downstream of the entrance ramp in question.

Relevant documents to this guide are mentioned for further reference in the design of ramp meter installations. These include the following:

- MUTCD for Streets and Highways, FHWA, 2009 Edition
- Ramp Management and Control Handbook, FHWA, January 2006
- Ramp Meter Warrants and Guidelines, GDOT, July 2017

4.2 Types

There are four different types of ramp meters discussed in this chapter, however they all fall under the lump sum ramp meter installation pay item below. Refer to section 647 of the GDOT specifications for more information regarding the lump sum pay item. The following pay items should be used for ramp meter installations:

647-XXXX	**Ramp Meter Installation No-**
942-1000	**Network Equipment Configuration and Integration**

Additional pay items needed to complete the ramp meter installation may include:

639-3004	**Steel Strain Pole, Type IV With ___' Mast Arm**
639-4004	**Strain Pole, Type IV**
653-XXXX	**Thermoplastic Solid Traffic Stripe, 6 Inch, White**
653-XXXX	**Thermoplastic Solid Traffic Stripe, 6 Inch, Yellow**
653-1704	**Thermoplastic Solid Traffic Stripe, 24 Inch, White**
653-1810	**Thermoplastic Solid Traffic Stripe, 10 Inch, White**
653-XXXX	**Thermoplastic Skip Traffic Stripe, 6 Inch, White**
654-1010	**Raised Pavement Markers, Type 10**
657-XXXX	**Preformed Plastic Solid Pavement Marking, 6 Inch, White, Type PB**
657-1104	**Preformed Plastic Solid Pavement Marking, 10 Inch, White, Type PB**
657-1244	**Preformed Plastic Solid Pavement Marking, 24 Inch, White, Type PB**
657-XXXX	**Preformed Plastic Skip Pavement Marking, 6 Inch, White, Type PB**
657-XXXX	**Preformed Plastic Solid Pavement Marking, 6 Inch, Yellow, Type PB**
682-XXXX	**Directional Bore, ___ Inch**
926-210X	**Wireless System, Type ___**
935-1111	**OSP Fiber Optic, Loose Tube, Single Mode, 6 Fiber**
935-4010	**Fiber Optic Splice, Fusion**
935-410X	**Fiber Optic Closure, Underground, ___ Splice**
935-420X	**Fiber Optic Closure, Aerial, ___ Splice**
935-450X	**Fiber Patch Panel, Wall Mount, 12 Port**
936-4XXX	**CCTV Camera System, Type ___**
936-490X	**CCTV Mounting Arm, Type ___**
936-4950	**Camera Lowering Device**
937-XXXX	**Inductance Loop Detection System, No.**
937-XXXX	**Video Detection System, No.**
937-XXXX	**Microwave Vehicle Detection System, No.**
939-23XX	**Field Switch, Type ___**

939-239X SFP Fiber Module, Type ___

939-41XX Field Cabinet, Type ___

4.2.1 Single Lane Entrance Ramp Meters

Single lane ramp meters will have pedestal-mounted signals as shown in the accompanying typical detail in **Appendix B**: one three-section signal display with 12-inch lenses facing ramp traffic approaching the ramp meter and one three-section signal display with 12-inch lenses facing the vehicle waiting at the stop bar. An enforcement display facing downstream will be provided for the upper signal head. This enforcement display will allow a law enforcement officer to see when the meter is red from the rear side of the display. The pedestal should be located on the left side of the ramp, unless significant concerns exist about the signal's proximity to the mainline travel lanes or if there are existing obstructions that would make a left side installation problematic. This pedestal shall be placed 6 feet downstream of the stop bar to provide drivers with a clear view of the 12-inch display. Pedestals will be mounted on breakaway bases. A "ONE CAR PER GREEN (ball)" (RM-2) sign will also be installed on the pole such that it is clearly visible to drivers. Cabinets for single lane ramp meters should be placed outside the clear zone or behind guardrail. Refer to **Figure 4-1** for a graphical illustration of the single lane ramp meter.

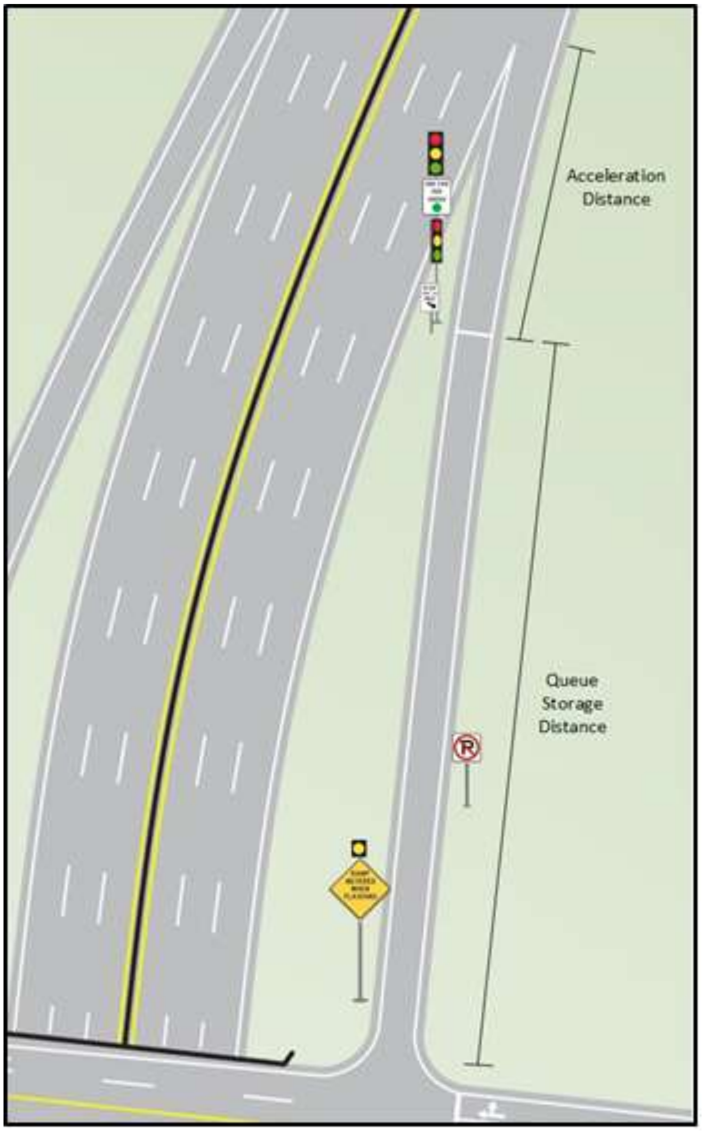


Figure 4-1: Single Lane Ramp Meter

4.2.2 Multi-lane Entrance Ramp Meters

If the existing ramp total pavement width is 24 feet wide or greater, the ramp should be striped as a multi-lane approach at the ramp meter stop bar. Skip striping (6-inches wide, 10-foot stripe with 30-foot gap) will be used to separate each lane. Multi-lane ramp meters will have one three-section signal per lane with 12-inch lenses mounted over the center of the applicable lane.

One signal per lane will have an accompanying enforcement indicator for downstream visibility. "LEFT LANE SIGNAL" (RM-1L), “RIGHT LANE SIGNAL" (RM-1R), “ONE VEHICLE PER GREEN (ball)” (RM-2) sign , and (if applicable) “CENTER LANE SIGNAL” (RM-1C) will be mounted on the mast arm as shown in the typical detail. The mast arm shall be located 60 feet (40 feet minimum, 80 feet maximum) downstream of the stop bar to allow good visibility from stopped vehicles.

The vertical clearance to the bottom of the signal head backplate should be between 17 and 19 feet. The mast arm pole may be mounted to either side of the ramp to minimize the need for directional boring conduit or new guardrail, but clear zone requirements must also be met in the placement of the pole. If possible, the cabinet for multi-lane ramps should be placed behind the same section of guardrail as the mast arm pole. All guardrail and roadside safety design elements shall meet GDOT and AASHTO design standards. Refer to **Figure 4-2** for graphical illustration.

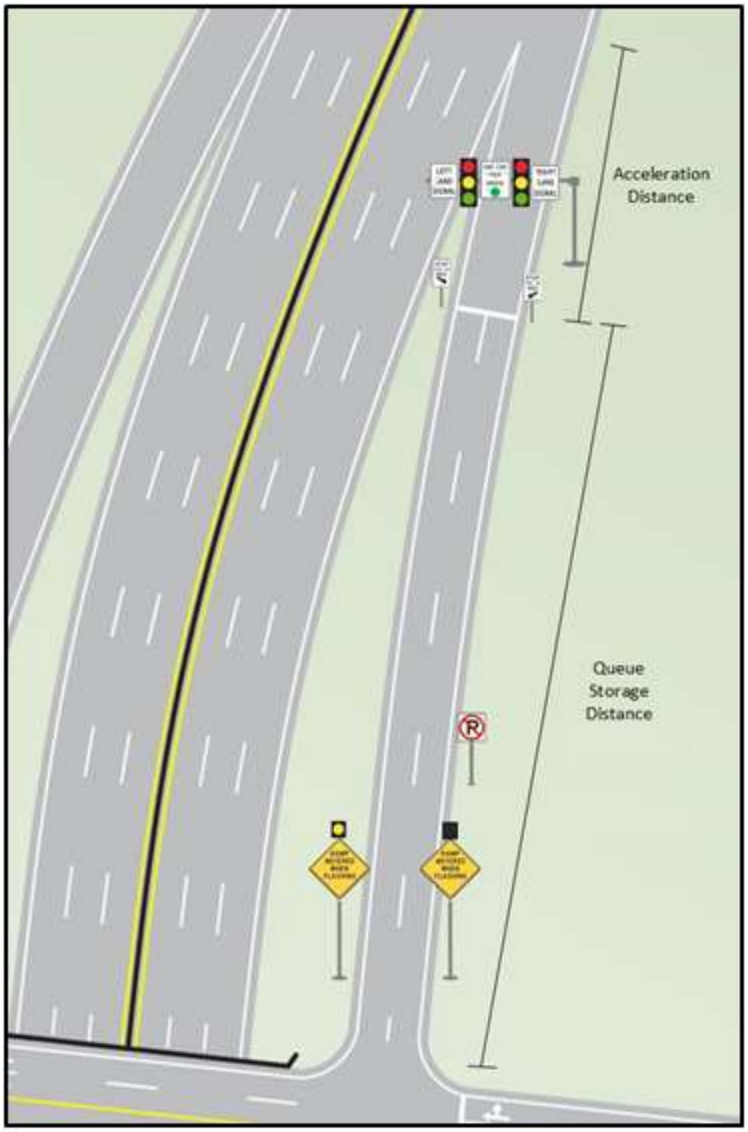


Figure 4-2: Multi-lane Ramp Meter

4.2.3 Form Two Lanes When Metered Ramp Meters

If the existing ramp total pavement width at the stop bar is 20-24 feet, the ramp may be striped as a "Form 2 Lanes When Metered" ramp meter.

The design is the same as the multi-lane ramp meter, however, it has some additional striping and signing requirements. Skip striping (6-inches wide, 2-foot stripe with 6-foot gap) will be used to separate each lane for a distance of 60 feet extending back from the stop bar. Additionally, a set of "Form 2 Lanes When Metered" signs are to be installed on either side of the roadway at the beginning of the skip striping, and at the intermediate queue locations. These signs are not in the MUTCD; therefore, a callout specifying "To be provided by GDOT ITS" must be provided on the plans for these signs.

This type of ramp meter may prove beneficial when trying to retrofit an existing ramp without widening. Refer to **Figure 4-3** for graphical illustration.

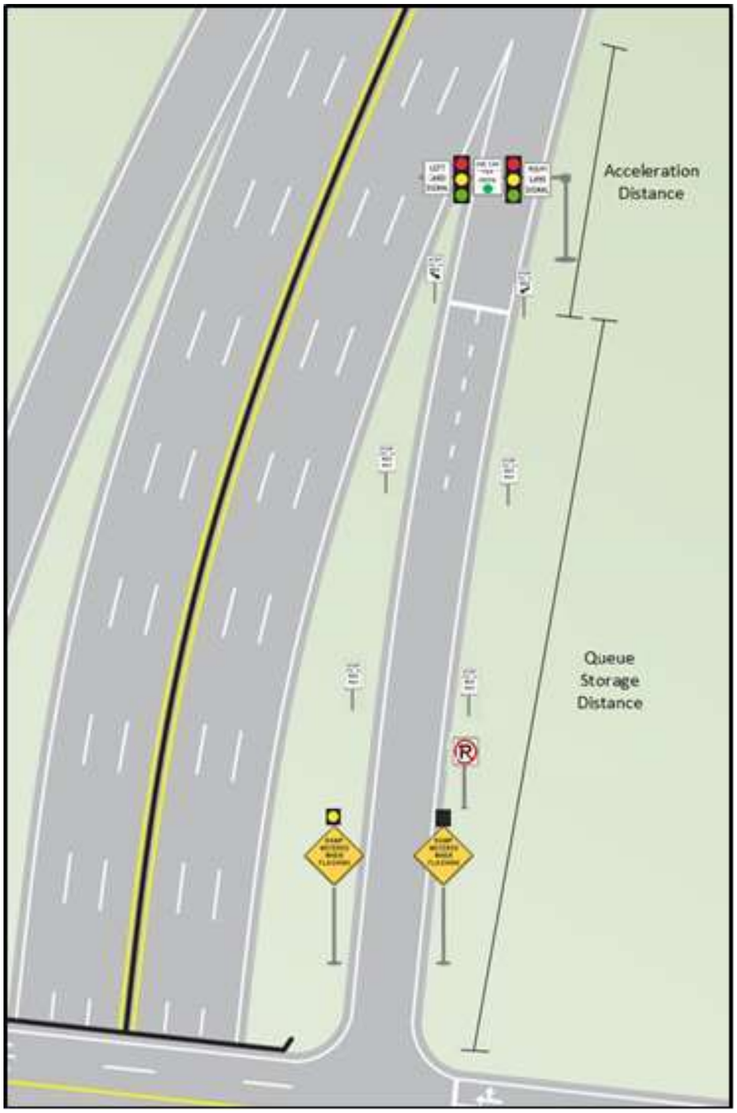


Figure 4-3: Form Two Lanes When Metered Ramp Meter

4.2.4 Freeway-to-Freeway Ramp Metering

Freeway-to-freeway ramp metering has yet to be implemented in Georgia. However, it should be noted that when freeway-to-freeway ramp metering opportunities are explored, further study may be required, such as traffic forecasting and/or software modeling. Freeway-to-freeway ramp metering consists of metering a ramp that connects one freeway to another and may be used when it is more advantageous to meter a freeway spur than nearby entrance ramps upstream of the location where the two freeways connect.

It is particularly critical for freeway-to-freeway ramp metering that adequate sight distance and sufficient advanced warning are provided for motorists, as motorists will likely not be expecting to stop. Factors to consider with respect to freeway-to-freeway ramp meter design include:

- Verify adequate sight distance is available for areas where stopped vehicles may be present.

- Provide sufficient advanced warning that the ramp meter is active for vehicles approaching the ramp metering area; for instance, a recommended practice is to install a sequence of two signs in advance of the metered freeway-to-freeway connector.
- Design the ramp meter to accommodate a flow rate that is appropriate for a freeway-to-freeway ramp, particularly if the ramp is commonly used as an alternate route for incident management purposes.
- Install cameras throughout the ramp area to provide remote monitoring from the TMC.
- Verify that adequate queue storage distance is available at the ramp due to high traffic demand.

4.3 Placement

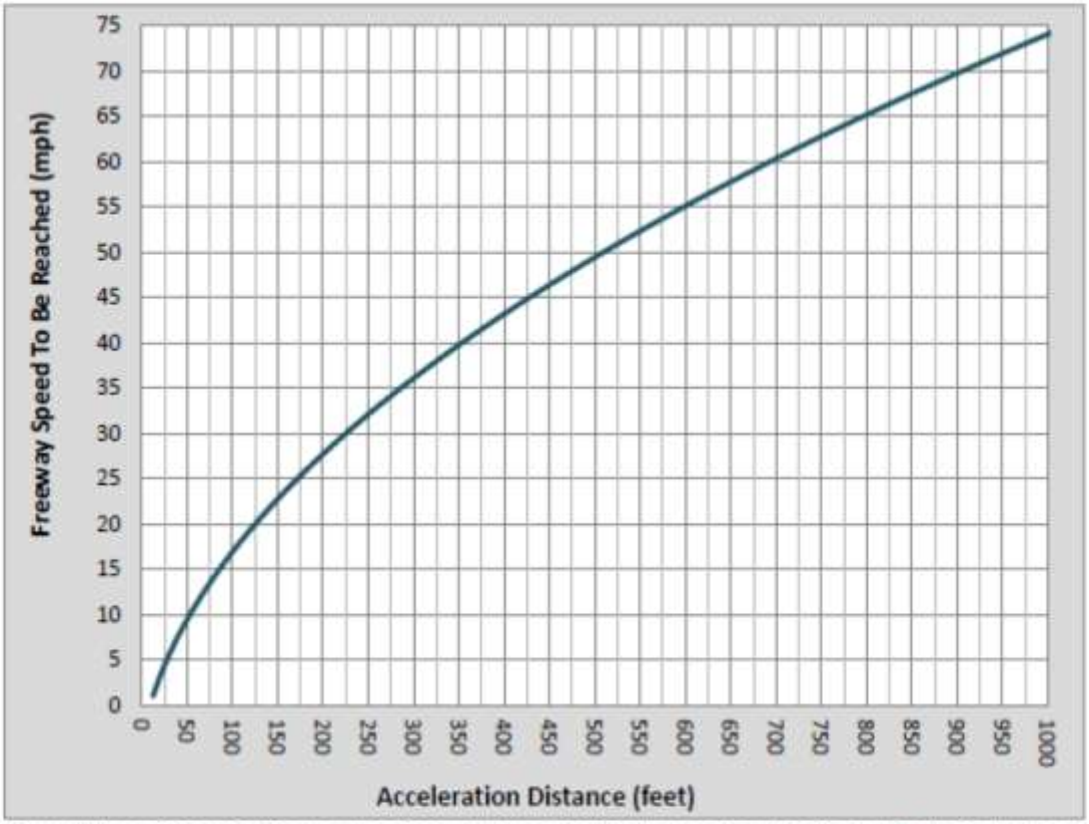
Proper placement of ramp meter devices is vital to safe and efficient ramp meter operation. Driver safety is the paramount concern when designing all roadway features and ramp meters should be designed with the same attention to driver safety. The latest edition of AASHTO's Roadside Design Guide and GDOT design and policy documents should be referenced to provide an adequate clear zone with respect to fixed objects adjacent to travel lanes.

4.3.1 Stop Bar Location and Acceleration Distance

The first step in the ramp meter layout process is correctly locating the stop bar. There are three criteria that determine stop bar location:

1. Provide adequate acceleration distance between the stop bar and the point where vehicles will be required to merge with mainline traffic, per **Figure 4-4**; the freeway speed used for stop bar placement will be 55 mph unless otherwise noted by GDOT;
2. Place the stop bar upstream of the physical gore, which is intended to discourage drivers from leaving the ramp meter queue and entering mainline traffic; and
3. Maximize the storage length on the ramp.

Freeway Speed to be Reached (MPH)	Acceleration Distance (feet)
55	600
65	800
70	900



Source: Lehman Center for Transporation Research. Integrated Database and Analysis System for the Evaluation of Freeway Corridors for Potential Ramp Signaling. *Florida Department of Transportion, 2011.*

Figure 4-4: Acceleration Distances

The minimum acceleration distance is measured from the farthest point a merging vehicle can travel down the entrance ramp and acceleration lane before it must merge with mainline vehicles. For practical purposes, the merge point is where the width of the acceleration lane drops below 12 feet. For entrance ramps that form an additional travel lane or auxiliary lane, some other point (a downstream exit gore, for example) must be selected as the basis for measuring the acceleration distance.

It is important that vehicles on a metered entrance ramp are controlled by the ramp meter signals. Therefore, the stop bar should be placed upstream of the physical gore. Guardrail, barrier walls, retaining walls, a concrete-lined ditch, or even a grassed area will discourage impatient drivers from leaving the ramp meter queue and merging directly into mainline traffic. This illegal behavior significantly reduces ramp meter effectiveness, undermining its ability to help manage mainline congestion.

Designers should note that stop bars are not included in the ramp meter installation lump sum pay item. Depending on the type of pavement, either 24-inch thermoplastic solid traffic stripe or 24-inch preformed plastic solid traffic stripe type PB should be included as an additional pay item. Thermoplastic is typically used on asphalt ramps, whereas preformed plastic is used on concrete ramps.

4.3.2 Ramp Meter Cross Sections

After determining approximate stop bar placement, designers should consider the preferred cross sections to determine what type of ramp meter is to be implemented. **Table 4-1** provides the typical ramp meter cross section requirements for lane widths and shoulders.

- For new entrance ramp construction, the desirable lane widths should be provided; shoulder widths should be provided that meet or exceed the minimum dimensions.
- For entrance ramps that have inadequate storage distance and/or would benefit from increasing the ramp metering rate, consideration should be given to increasing the number of metered lanes by widening the ramp. Ramp widening would effectively increase the storage capacity of the ramp and the flow rate of the metering system.
- There may be opportunities to retrofit existing entrance ramps without widening with the “Form Two Lanes When Metered” design. The ramp retrofit cross section may use the minimum lane widths and shoulder widths, particularly if this approach allows for additional metered lanes. A future opportunity is to use the shoulder as a temporary lane only when the ramp meter is active. However, designers should ensure the shoulder pavement is capable of handling vehicle traffic for this application.

Ramp Meter Cross Sections		
Inside Shoulder	**Ramp Meter Lanes**	**Outside Shoulder**
4 feet desirable; 2 feet minimum	12 feet desirable; 10 feet minimum	10 feet without guardrail / barrier wall (desirable); 2 feet where guardrail / barrier wall is present (minimum)

Table 4-1 – Typical Ramp Meter Cross Section Requirements

Source: 2018 AASHTO Green Book, page 10-122.

4.3.3 Ramp Meter Striping

After determining the number of lanes to be installed and the respective lane widths, designers should determine the type of ramp to be installed. **Table 4.2** illustrates the striping requirements for the different ramp meter types.

RMS Type	RMS Striping Requirements
Single lane	• 6-inch solid yellow stripe for the left most lane line • 6-inch solid white stripe for the right most lane line
Multi-lane	• 6-inch solid yellow stripe for the left most lane line • 6-inch skip (10-foot stripe with 30-foot gap) white stripe between adjacent lanes • 6-inch solid white stripe for the right most lane line
Form 2 Lanes When Metered	• 6-inch solid yellow stripe for the left most lane line • 6-inch skip (2-foot stripe with 6-foot gap) white stripe between adjacent lanes extending 60 feet back from the stop bar • 6-inch solid white stripe for the right most lane line

Table 4-2 – Ramp Meter Striping Requirements

As noted earlier, striping for ramp meters is not included in the ramp meter installation pay item and will need to be included separately. Designers should pay attention to the surface of the ramp to determine the striping pay items that are needed. Thermoplastic is used on asphalt ramps, whereas preformed plastic is used on concrete ramps. Refer to GDOT detail T-11B for additional information regarding pavement marking placement on limited access roadways.

4.3.4 Ramp Meter Signal Supports

Next, designers should consider ramp meter signal supports. The signal supports will vary depending on the type of ramp meter being designed. **Table 4.3** illustrates the signal support design criteria for the different RMS types.

<table>
<tr><th>RMS Type</th><th>RMS Signal Support Design</th></tr>
<tr><td>Single lane</td><td>• Signals are mounted on a breakaway designed pedestal pole
• Pedestal pole does not need to meet clear zone or be protected by guardrail because of the breakaway design
• Pedestal pole is offset 6’ downstream from the ramp meter stop bar
• Pedestal pole is included in the lump sum ramp meter pay item and should be illustrated in the list of materials</td></tr>
<tr><td>Multi-lane</td><td rowspan="2">• Signals are mounted on a strain pole with mast arm
• Mast arm can be a maximum length of 65 feet
• Mast arm pole must be outside of clear zone or be protected by guardrail; supports that are installed behind existing guardrail shall be installed a minimum distance of 6 feet from the face of guardrail
• Mast arm pole should be placed 60 feet (40 feet minimum, 80 feet maximum) downstream from the ramp meter stop bar
• A separate pay item is needed for the strain pole with mast arm</td></tr>
<tr><td>Form 2 Lanes When Metered</td></tr>
</table>

Table 4-3 – Signal Support Design

4.3.5 Ramp Meter Signal Heads

Designers should then consider details regarding signal head design. GDOT requires one signal head per lane for ramp meter systems, except for single lane ramp meters. Single lane ramp meters require two signal heads, one to serve the vehicle at the stop bar, and another to serve approaching traffic.

Backplates with retroreflective tape and enforcement lights should also be called out on the plans. Backplates increase the visibility of the signal heads, and enforcement lights allow for on-site patrol of ramp meter operations. Enforcement lights should be added onto the back of the signal head so a vehicle parked downstream from the stop bar can monitor the ramp meter operations.

Designers should note that signal heads, backplates, and enforcement heads are all included in the ramp meter installation lump sum pay item and should be illustrated in the list of materials. **Table 4.4** illustrates the signal head design criteria for the different RMS types.

<table>
<tr><th>RMS Type</th><th>RMS Signal Head Design</th></tr>
<tr><td>Single lane</td><td>• Two 12-inch LED signal heads should be installed on a single pedestal pole
• Only one backplate with retroreflective tape is installed on the signal head intended to serve approaching traffic.
• One enforcement light is installed
• Additional items to be included in the list of materials:
- One run of 5 conductor signal cable from the cabinet to the signal heads
- Hardware for pedestal pole mounting</td></tr>
<tr><td>Multi-lane</td><td rowspan="2">• One 12-inch LED signal head per lane should be installed on the mast arm
• One backplate with retroreflective tape per lane is installed
• One enforcement light per lane is installed
• Additional items to be included in the list of materials:
- 5 conductor signal cable from the cabinet to each signal head
- Hardware for mast arm mounting</td></tr>
<tr><td>Form 2 Lanes When Metered</td></tr>
</table>

Table 4-4 – Signal Head Design

4.3.6 Ramp Meter Cabinet Location

The ramp meter cabinet should be placed outside the clear zone or behind guardrail. The cabinet should ideally be located where signal electricians can simultaneously view the cabinet electronics and the ramp meter signal displays. The preferred location for the cabinet is on the right side of the ramp, rather than the gore area, at a location that would minimize the potential for knock-downs. This also allows for easy maintenance vehicle access and parking, allowing the field technician to move safely around the cabinet, poles, and pull boxes. In some cases, pole-mounted cabinets may be an option. The ramp meter cabinet is included in the ramp meter installation lump sum pay item and should be illustrated in the list of materials.

4.3.7 Ramp Meter Detection

4.3.7.1 Demand, Passage, Intermediate Queue, & Excessive Queue Detectors

Sufficient and accurate vehicle detection is a key aspect in the proper operation of ramp meters. **Table 4.5** illustrates the various detector types that are used for ramp meter installations. Additionally, the table illustrates the detector function, the detector area, and the placement criteria.

Detector Type	Definition	Detector Area (ft x ft)	Placement
Demand	Senses the presence of a vehicle at the ramp meter stop bar, and tells the ramp meter system to initiate a green signal	6x20	4 feet upstream of the ramp meter stop bar
Passage	Terminates the green signal after a vehicle clears the stop bar	6x6	4 feet downstream from the ramp meter stop bar
Intermediate Queue	Helps monitor the queue length near the midpoint of the ramp and adjusts the metering rate prior to the queue becoming excessive	6x6	40% of the queue storage distance
Excessive Queue	Senses the presence of vehicles near the end of the ramp. Determines when the queue storage has reached its limit, causing the ramp meter to flush traffic out of the queue	6x6	80% of the queue storage distance

Table 4-5 – Demand, Passage, Intermediate Queue, and Excessive Queue Detectors

Designers should note that queue storage distance is measured from the ramp meter stop bar to the near-edge of the cross street. For example, if the queue storage is 1,400 feet, the excessive queue detector should be placed 1,120 feet from the stop bar, and the intermediate queue detector should be placed 560 feet from the stop bar. Additionally, **Figure 4-5** contains an illustration of the types of detectors and their relative locations at ramp meters.

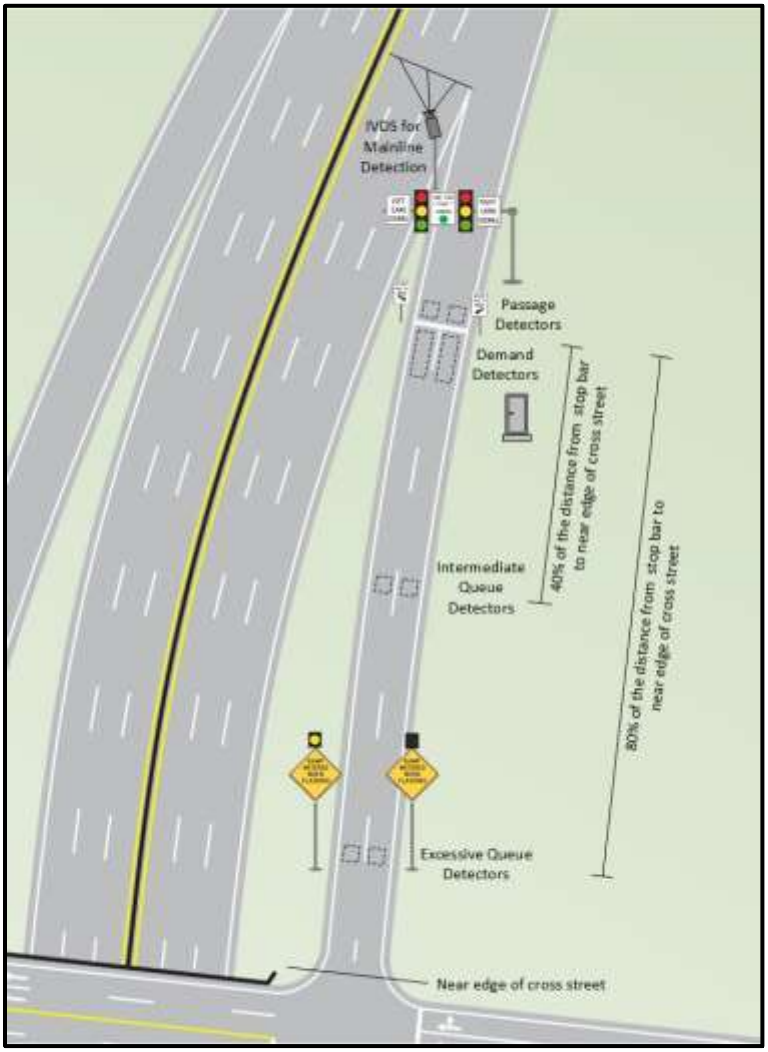


Figure 4-5: Types of Ramp Meter Detectors

Inductance loops are installed in the pavement and are typically utilized for demand, passage, intermediate queue, and excessive queue detectors. Center the detector areas in the lane for lanes 10 feet or wider. For lanes that are greater than 16 feet wide, designers should provide two loops to provide coverage of the lane. For narrow lanes, offset the detectors 2 feet from the shoulder. Loop lead-in cable connects the inductance loop to the ramp meter controller. Refer to GDOT detail TS-01 for more information.

Designers should use non-invasive detection rather than inductance loops for bridge deck applications. Saw-cutting in-pavement loops on a bridge deck is not feasible, but the non-invasive microwave radar or video detection areas can successfully operate. Designers should use one method of detection for demand, passage, excessive queue, and intermediate queue detectors: either inductance loops or non-invasive detection. **Table 4.6** below summarizes the two types of detection that can be used for demand, passage, intermediate queue, and excessive queue detectors.

Detection Type	Applications
Inductance Loop	• Most commonly used for demand, passage, intermediate queue, and excessive queue • A separate pay item is needed for the inductance loop detection systems. Refer to the Traffic Signal Design Guide to determine loop lead-in wire, loop detector wire, and loop saw cut quantities.
Non-invasive	• Used on bridge decks when in-pavement loops are not feasible • Microwave radar or video detection can be used • A separate pay item is needed for the detection systems

Table 4-6 – Inductance Loop and Non-invasive Detection Applications

4.3.7.2 Mainline Detectors

Mainline freeway detection units detect the presence of traffic within lanes along the mainline for the purpose of reporting the traffic flow at that location to the ramp meter controller. Mainline freeway detection units are intended to detect traffic at a distance of less than 200 feet from the merge point for the ramp meter. The designer should contact the State ITS Engineer in the GDOT Office of Traffic Operations if mainline detection cannot be achieved at a distance of less than 200 feet from the merge point.

The designer should place the detection unit to detect both the mainline and the entrance ramp for the direction of travel of the ramp meter. Although the mainline data is most important for the ramp meter operation, the use of zones allows for additional entrance ramp data to be obtained without requiring another detection unit. Microwave radar and video detection are the most common types of mainline detection used for ramp meters. If microwave radar is used and site conditions allow, the detection zone could be extended to pick up the mainline traffic and exit ramps on the opposite side of the road as well. Refer to **Chapter 6** of this document for further detail on mainline freeway detectors and their limitations.

Additionally, the mainline detection unit should not have its own field cabinet, but rather it should directly connect to the ramp meter cabinet. The mainline detection data cables should be designed so they do not route through any other cabinet between the device and the ramp meter cabinet. Consequently, mainline detectors should be placed less than 500 feet from the ramp meter cabinet. Mainline detectors are commonly installed on ramp meter mast arms, or on new strain poles. Mainline freeway detection units are not included in the ramp meter installation lump sum pay item and will need to be included separately.

4.3.8 CCTV Cameras

While it is desirable to have a PTZ- style CCTV camera for viewing as much of the entrance ramp as possible, the most important viewing goal for the ramp meter CCTV is the face of the ramp meter signals. Designers should first identify if there is an existing CCTV camera that can view the signal indications before proposing to install a new CCTV camera. Wherever co-location is possible, these cameras should be mounted on the same pole as the mainline freeway detection units. However, the designer should ensure the viewing goal of the CCTV is not compromised with co-location.

CCTV cameras operate using CAT6 cabling; therefore, the camera must be located within 328 feet of the POE injector within the field cabinet. Designers should note that a CCTV can operate off of the ramp meter cabinet as long as it is within the 328-foot requirement. However, to allow for slack, designers should aim for a maximum distance of 300 feet. If the distance is greater than 328 feet, the CCTV will require its own field cabinet and other network equipment. Refer to **Chapter 7** for additional information. CCTV cameras are also not included in the ramp meter installation lump sum pay item and will need to be included separately.

4.3.9 Conduit and Pull Boxes

Table 4.7 illustrates the two types of pull boxes that are most commonly used for ramp meter installations. The Type 2 & Type 4s pull boxes are not traffic rated and shall only be installed in un-paved shoulders. For locations where conduit is being installed in the paved shoulder, the designer shall call out an ECB, Type 5. For further guidance on the design of conduit and pull box placement for ramp meters, refer to the ramp meter details in **Appendix B** of this document. Designers should note that Type 2 pull boxes, Type 4s pull boxes, and conduit are included in the ramp meter installation lump sum pay item and will need to be reflected in the list of materials.

Pull Box Type	Applications
Type 2	• At the base of all “Ramp Metered When Flashing” signs • Adjacent to in-pavement inductance loops
Type 4s	• At the base of the: - Ramp meter cabinet - Signal support structure - ITS device poles • Along the path connecting the ramp meter cabinet to the trunk fiber line

Table 4-7 – Pull Box Applications

4.3.10 Ramp Meter Signing

This section describes types of ramp meter signing to be installed at new ramp meter locations. For ramp meter retrofit locations, the designer will need to assess whether the existing signs need to be removed or relocated, depending on their condition and conformance to the design sign location(s). Moreover, **Appendix B** of this document contains ramp meter detail sheets for further reference.

4.3.10.1 <u>Ramp Metered When Flashing</u>

Table 4.8 illustrates the different sign placement criteria for the “Ramp Metered When Flashing” sign (W3-8) with flashing beacon. This is often referred to as the advanced warning sign/flasher.

RMS Type	Number of Signs	Sign Placement	Side of Road
Single lane	• One W3-8 sign with flashing beacon required	• Adjacent to the excessive queue loops or where visible to vehicles entering the ramp	• Left side of ramp preferred
Multi-lane	• Two W3-8 signs with flashing beacons required		• Both sides of the ramp
Form 2 Lanes When Metered			

Table 4-8 – "Ramp Metered When Flashing" Design

A yellow 12-inch flashing beacon shall be installed on top of each W3-8 sign and shall flash in an alternating manner during the active state of ramp meter operations. The flashing beacons will require conduits and conductor cabling to the sign location from the ramp meter cabinet. Each flashing beacon requires a separate 5 conductor signal cable run from the flasher to the ramp meter cabinet. The W3-8 sign with flashing beacon is installed on a breakaway designed pedestal pole, and therefore does not have to adhere to clear zone guidelines. All signs, pedestal poles, pull boxes, conduit, and conductor cabling required for the W3-8 installation are included in the ramp meter installation lump sum pay item, and should be reflected in the list of materials. **Figure 4-6** presents an image of the sign (W3-8) and a flashing beacon.

Figure 4-6: Ramp Metered When Flashing Sign (W3-8) with Flashing Beacon

4.3.10.2 Stop Here on Red

Table 4.9 illustrates the different sign placement criteria for the "Stop Here on Red" sign. The sign shall be visible to drivers approaching the ramp meter stop bar to clearly indicate the location of the stop bar. The "Stop Here on Red" sign is installed on a Type 7 post. Designers should note that all signs and Type 7 posts are included in the ramp meter installation lump sum pay item and should be reflected in the list of materials.

RMS Type	Number of Signs	Sign Placement	Side of Road
Single lane	• One "Stop Here on Red" static sign required	• Adjacent to the stop bar	• Same side of the road as the signal indications
Multi-lane	• Two "Stop Here on Red" static signs required		• Both sides of the ramp
Form 2 Lanes When Metered			

Table 4-9 – "Stop Here on Red" Design

Figure 4-7 presents an image of the signs (R10-6R and R10-6L) as depicted in the MUTCD. Additionally, **Figure 4-10** illustrates the sign placement typical detail for ramp meter systems.

R10-6R R10-6L

Figure 4-7: Stop Here on Red Signs

4.3.10.3 <u>One Car Per Green</u>

Table 4-10 illustrates the different sign placement criteria for the "One Car Per Green" sign (RM-2). As stated previously, all signs are included in the ramp meter installation lump sum pay item and should be reflected in the list of materials.

<table>
<tr><th colspan="2">RMS Type</th><th>Number of Signs</th><th>Sign Placement</th></tr>
<tr><td colspan="2">Single lane</td><td>• One RM-2 sign required</td><td>• Installed on the pedestal pole</td></tr>
<tr><td rowspan="2">Multi-lane</td><td>Dual lane</td><td>• One RM-2 sign required</td><td>• Installed on the mast arm, equidistant from the two signal heads</td></tr>
<tr><td>Triple lane</td><td>• Two RM-2 signs required</td><td>• Installed on the mast arm, immediately left of the center lane signal head
• Installed on the strain pole that supports the mast arm</td></tr>
<tr><td colspan="2">Form 2 Lanes When Metered</td><td>• One RM-2 sign required</td><td>• Installed on the mast arm, equidistant from the two signal heads</td></tr>
</table>

Table 4-10 – "One Car Per Green" Design

Figure 4-8 presents an image of the sign (RM-2) that reads “One Car Per Green (Ball)” at entrance ramps. Additionally, **Figure 4-10** illustrates the sign placement typical detail for ramp meter systems.

RM-2

Figure 4-8: One Car Per Green (Ball) Sign

4.3.10.4 <u>Left / Center / Right Lane Signal</u>

Table 4-11 illustrates the different sign placement criteria for the “Left Lane Signal,” “Center Lane Signal,” and “Right Lane Signal” signs. Designers should note that all signs are included in the ramp meter installation lump sum pay item and should be reflected in the list of materials.

<table>
<tr><th colspan="2">RMS Type</th><th>Left Lane Signal: Sign Placement</th><th>Center Lane Signal: Sign Placement</th><th>Right Lane Signal: Sign Placement</th></tr>
<tr><td colspan="2">Single lane</td><td>• N/A</td><td>• N/A</td><td>• N/A</td></tr>
<tr><td rowspan="2">Multi-lane</td><td>Dual lane</td><td rowspan="3">• Installed on the mast arm, immediately left of the left most signal head</td><td>• N/A</td><td rowspan="3">• Installed on the mast arm, immediately right of the right most signal head</td></tr>
<tr><td>Triple lane</td><td>• Installed on the mast arm, immediately right of the center lane signal head</td></tr>
<tr><td colspan="2">Form 2 Lanes When Metered</td><td>• N/A</td></tr>
</table>

Table 4-11 – Left / Center / Right Lane Signal Design

Figure 4-9 presents the images of the RM-1L, RM-1C, and RM-1R signs. Additionally, **Figure 4-10** illustrates the sign placement typical detail for these signs.

RM-1L RM-1C RM-1R

Figure 4-9: Left Lane Signal / Center Lane Signal / Right Lane Signal Signs

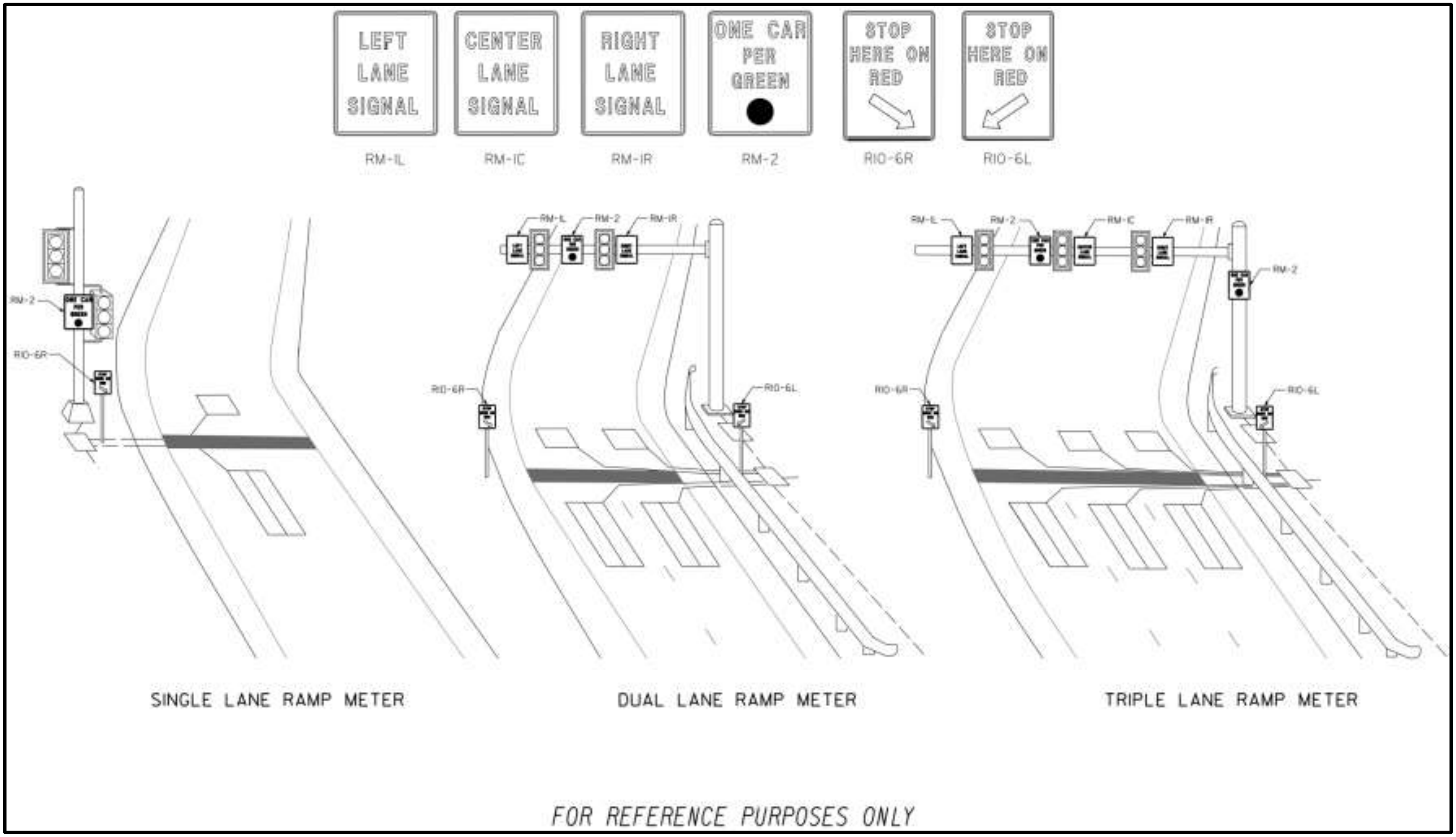
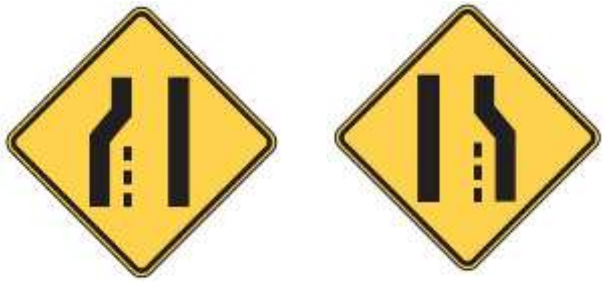


Figure 4-10: Sign Placement Typical Detail

4.3.10.5 Merge Sign

A merge sign (W4-2L or W4-2R) shall be installed downstream of the advance warning signs on all ramps with two or more lanes. Existing two-lane ramps may already have this sign, which can be removed and reset. Unless physical conditions dictate otherwise, a W4-2R sign shall be used on the right side of the ramp, and a W4-2L sign shall be used on the left side of the ramp. **Figure 4-11** presents an image of the signs (W4-2L and W4-2R) as depicted in the MUTCD.



W4-2L W4-2R

Figure 4-11: Merge Signs

Placement of the merge sign will depend on the storage length available on the ramp as noted under the following two conditions:

- Ramps with a storage length of less than 1,000 feet create a merge condition at lower speeds. Install the merge sign 325 feet upstream of the merge point/stop bar. The designer should verify the merge sign location is located at least 150 feet downstream of the advanced warning signs/flashers.
- Ramps with a storage length exceeding 1,000 feet create a high-speed merge condition near the merge point/stop bar. Install the merge sign 325 feet upstream of the merge point/stop bar and provide an additional merge sign 150 feet downstream of the advanced warning signs/flashers.

4.3.10.6 No Parking Signs

In locations that have a viable shoulder for parking, a "No Parking" sign should be added to the plans to discourage truck parking. Eliminating illegal parking on ramp shoulders will help improve the safety of the metered ramps. **Figure 4-12** presents an image of the "No Parking" sign (W8-3) as depicted in the MUTCD.

W8-3

Figure 4-12: No Parking Sign

4.4 Power

Power should be provided to every ITS device cabinet. This includes the ramp meter cabinet as well as the CCTV field cabinet. Refer to **section 4.3.8** to determine if a field cabinet is needed for CCTV installations on ramp meter projects.

With the exception of solar locations, power conduit shall be provided to the cabinets. Ramp meter cabinets should not use solar power due to the potential for high power consumption with the ramp meter system. However, standalone CCTV field cabinets may use solar power. See **Chapter 14** for more on power design.

4.5 Cabinet & Network Equipment

The sheet immediately following each ramp meter design shall illustrate the list of materials and non-standard cabinet input assignments. Cabinet input assignments are only required when the proposed design deviates from the standard cabinet pin-out that is reflected in **Appendix C** of this document. The non-standard cabinet input assignments are to be reflected on the left half of the sheet, leaving room for the list of materials on the right half of the sheet. As previously mentioned, if the ramp meter design follows the standard cabinet input assignments, the designer may leave the left half of the sheet blank.

Designers must identify the cabinet equipment needed for the ramp meter in the list of materials. Cabinet assemblies for a ramp meter typically include:

- Model 334 cabinet
- 2070 LX controller
- Switch packs (load switch)
- Loop detector cards (if applicable)
- Monitor unit
- Auxiliary output file
- 334 prefabricated controller cabinet base.

All new 334 cabinets will require a single 2070 LX traffic signal controller, a monitor unit, and 334 cabinet base regardless of the type of ramp meter being installed. Refer to **Table 4.12** to determine quantities for switch packs, loop detector cards, and auxiliary output files.

<table>
<tr><th colspan="2">RMS Type</th><th colspan="2">Switch Packs*</th><th colspan="2">Loop Detector Cards*</th><th colspan="2">Auxiliary Output File</th></tr>
<tr><td colspan="2">Single lane</td><td rowspan="4">• 1 switch pack for the “Ramp Metered When Flashing” signs (up to 2 flashing beacons can operate off a single switch pack)
• 1 switch pack per lane</td><td>2</td><td>• Slots 1, 5, and 13 are used</td><td>3</td><td rowspan="4">• When more than 3 switch packs are needed</td><td>N/A</td></tr>
<tr><td rowspan="2">Multi-lane</td><td>Dual lane</td><td>3</td><td>• Slots 1, 2, 5, and 13 are used</td><td>4</td><td>N/A</td></tr>
<tr><td>Triple lane</td><td>4</td><td>• Slots 1, 2, 3, 5, 6, 13, and 14 are used</td><td>7</td><td>1</td></tr>
<tr><td colspan="2">Form 2 Lanes When Metered</td><td>3</td><td>• Slots 1, 2, 5, and 13 are used</td><td>4</td><td>N/A</td></tr>
<tr><td colspan="8">*Assumes the conventional cabinet pin-out assignment and wiring as illustrated in Appendix C.</td></tr>
</table>

Table 4-12 – Ramp Meter Cabinet Quantities

The current list of materials is available from the Office of Traffic Operations. The following statement should also be added to the list of materials plan sheet, “Note: Quantities are for information only. The contractor should field verify prior to bidding to reduce need for Supplemental Agreement.” Refer to sections 647 and 925 of the GDOT specifications for more information regarding cabinet equipment to be included in the list of materials.

Additionally, designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to the section 942 of the GDOT specifications for more information.

4.6 Communication Equipment

Each cabinet must connect either to the existing GDOT fiber communications network or through use of a wireless device. GDOT currently prefers cellular routers if no fiber is present in the area. Refer to **Chapter 15** for more information on communication.

For ramp meters installed on a freeway with existing GDOT fiber, the existing fiber pull boxes must be field located and checked for available space for new drop cables. Precise and accurate fiber allocations must be coordinated with GDOT staff. Ramp meters installed within a new ITS network should be included in the designer’s fiber count and cable routing plans. Refer to **section 16.4** for more information.

When a ramp meter is installed on a fiber optic network, each location may also need the following equipment to tie the ramp meter into the network:

- Pull Box, Type 7 – installed along the trunk line, contains the underground closure, trunk and drop cable storage, and splices
- Pull Box, Type 4s – installed along the drop cable line, at the base of the cabinet and ITS device poles, and contains drop cable storage
- Fiber Optic Closure, Underground, __ Splice
- Fiber Optic Splice, Fusion
- OSP Fiber Optic Cable, Loose Tube, Single Mode, No. Fiber (trunk and drop cable)

- Conduit

As previously mentioned, Type 4s pull boxes and conduit are included in the ramp meter installation lump sum pay item. However, designers should consult section 647 of the GDOT specifications to verify the equipment that should be included separately.

4.7 Conclusion & Key Points

When designing a ramp meter on a project, the following should be remembered:

- A minimum of 600 feet of acceleration distance for a 55 mph speed limit is required between the stop bar and the merge point, unless noted otherwise.
- The “Form Two Lanes When Metered” ramp meter can be used to retrofit an existing ramp without widening.
- Designers should consider the minimum and desired shoulder widths and lane widths when determining the type of ramp meter.
- Strain poles and cabinets must be outside of clear zone or protected by guardrail. Pedestal poles are considered break-away and do not need to be outside of clear zone.
- Inductance loops are the most commonly used for demand, passage, intermediate queue, and excessive queue loops. Microwave radar or video detection can be used in place of inductance loops when in-pavement loops aren’t feasible.
- Mainline detection for the ramp meter system shall be either microwave radar or video detection.
- A CCTV is needed to visually confirm all signal indications. If there is not an existing CCTV that can view the ramp meter signals, a new CCTV shall be proposed with the ramp meter system.
- Every ramp meter installation requires a separate plan sheet to illustrate the list of materials and non-standard cabinet input assignments.
- Refer to section 647 of the GDOT specifications to determine what equipment is included in the ramp meter installation lump sum pay item.
- Designers will need to include the Network Equipment Configuration and Integration pay item in all designs that tie an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information.
- Refer to **Chapter 16** for naming schemes regarding ITS devices.

Chapter 5. Dynamic Message Sign

5.1 Introduction

To provide safety, mobility, and efficiency on the roadway network, various information needs to be communicated to drivers. The best real-time method of informing drivers is through DMSs, which are message signs that allow TMCs to post various types of messages to provide information to drivers. These messages vary from travel times to AMBER (America's Missing: Broadcast Emergency Response) alerts in the area.

5.2 Types

There are seven different types of permanent DMSs defined in section 631 of the GDOT specifications, with the difference in type being the size of the sign. The specifications also require full color matrix for all DMS types. **Table 5-1** lists the number of lines each DMS can display, the amount of characters per line, the character height, and the maintenance access type.

DMS Type	Number of Lines	# of Characters Per Line	Character Height	Maintenance Access
Type 1	3	21	18 in.	Walk-in
Type 2	3	18	18 in.	Walk-in
Type 3	3	15	18 in.	Front access
Type 4	3	15	12 in.	Front access
Type 5	1	3	18 in.	Front access
Type 6	1	8	18 in.	Embedded or front access
Type 7	1	8	12 in.	Embedded or front access

Table 5-1 – DMS Type and Characteristics

The following pay items should be used for DMS installations:

631-010X DMS, Type ___

942-1000 Network Equipment Configuration and Integration

Additional pay items needed to complete the device installation may include:

638-1001 Structure Support for Overhead Sign, Type I, Station ___ (DMS over roadway)

638-1003 Structure Support for Overhead Sign, Type III, Station ___ (DMS on shoulder)

682-XXXX Pull Box, Type 4S

682-XXXX Pull Box, Type 7

926-210X Wireless System, Type ___

926-2220 Wireless System Survey

935-111X Outside Plant Fiber Optic Cable, Loose Tube, Single Mode, ___ Fiber (trunk and drop)

935-4010 Fiber Optic Splice, Fusion

935-410X Fiber Optic Closure, Underground, ___ Splice

935-420X	**Fiber Optic Closure, Aerial, ___ Splice**
935-450X	**Fiber Patch Panel, Wall Mount, ___ Port**
939-23XX	**Field Switch, Type ___**
939-239X	**SFP Fiber Module, Type___**
939-41XX	**Field Cabinet, Type ____**

5.3 Placement

Depending on the type of project, DMSs can be broken into two tiers. Tier 1 describes DMS placement for interstate applications, and Tier 2 describes DMS placement for arterial applications. DMS Types 1 and 3 are the most commonly used for interstate applications, and DMS Types 2 and 4 are the most commonly used for arterial applications. Refer to **section 5.3.1** for more guidelines on DMS support structures and **section 5.3.2** for CCTV requirements.

<u>Tier 1: DMS for Interstate Applications</u>

DMSs are one of the primary devices that should be placed after ramp meters but before considering detection and CCTV placement. The designer should consider the following when placing a DMS:

1. DMSs need to be placed far enough upstream to allow the driver to react to the message and make an informed decision. Consequently, the DMS should be located a minimum of 1,445 feet in advance of a major decision point. Major decision points, like freeway-to-freeway interchanges, alternative route access points, and managed lane entrances, are locations where the effect of taking a wrong ramp or missing the ramp cannot be easily corrected. (Based on the 2018, 7th edition AASHTO Green Book decision sight distance table.)
2. Existing static sign structures – DMSs should be placed a minimum of 800 feet from other signs based on the MUTCD (2009 version including revisions 1 and 2), but a preferred distance of one half mile.
3. The minimum letter height should be 18 inches for DMSs on roadways with speed limits of 45 mph or higher. The minimum letter height should be 12 inches for DMSs on roadways with speed limits of less than 45 mph. (Based on the MUTCD 2009 version including revisions 1 and 2.)
4. For speed limits of 55 mph or greater, DMSs should be visible from a half mile. (Based on the MUTCD 2009 version including revisions 1 and 2.)
5. For speed limits of 55 mph or greater, the message shall be designed to be legible from a minimum distance of 600 feet for nighttime conditions and 800 feet for normal daytime conditions. (Based on the MUTCD 2009 version including revisions 1 and 2.)
6. DMSs should not be placed along curves or where trees may potentially obscure them. While it is not preferred, DMSs may be placed in curves if they meet legibility requirements.
7. The grade of the road needs to be taken into consideration. In general, the approaching roadway to the DMS should be as flat as possible. Where this is unachievable, the designer should pick an up-grade location for placement, and down-grade locations are the least desirable option.
8. The designer should also consider ROW restraints, environmentally sensitive areas, and steep slopes when placing a DMS.

Designers should use the speed limit of the roadway to help determine the type of DMS. The designer should also factor in the type of message that will be displayed as the message length will help determine what type of DMS is needed. DMS Types 1 and 3 are the most commonly used on GDOT interstate projects. Designers should verify the DMS type to be used with the GDOT ITS group.

DMS Types 5, 6, and 7 will have limited applications since they are comprised of 1 line with 3 and 8 characters. In most cases, the applications are intended for VSL displays, toll-related messages, lane control signs, one-word alert messages to drivers, or one number (such as travel time or queue information) embedded on a static sign.

For express lane toll rate DMS signage, State Road and Tollway Authority requirements must be incorporated. Refer to the ELNIOM for more information.

Tier 2: DMS for Arterial Applications

The designer should consider the following when placing a DMS:

1. DMSs need to be placed at least 600 feet from adjacent signalized intersections on roadways with speed limits up to 50 mph. For higher speeds, refer to the MUTCD minimum sight distance for signal visibility requirements.
2. DMSs need to be continuously legible to motorists for at least 600 feet.
3. DMSs should not be placed along curves or where trees may potentially obscure them. While it is not preferred, DMSs may be placed in curves if they meet legibility requirements.
4. The minimum letter height should be 18 inches for DMSs on roadways with speed limits of 45 mph or higher. The minimum letter height should be 12 inches for DMSs on roadways with speed limits of less than 45 mph. (Based on the MUTCD 2009 version including revisions 1 and 2.)
5. The grade of the road needs to be taken into consideration. In general, the approaching roadway to the DMS should be as flat as possible. Where this is unachievable, the designer should pick an up-grade location for placement, and down-grade locations are the least desirable option.
6. The designer should also consider ROW restraints, environmentally sensitive areas, and steep slopes when placing a DMS.

As stated earlier, designers should use the speed limit of the roadway to help determine the type of DMS. The designer should also factor in the type of message that will be displayed as the message length will help determine what type of DMS is needed. DMS Types 2 and 4 are the most commonly used on GDOT arterial projects. However, Types 5, 6, and 7 can have limited applications on arterials as well. Designers should verify the DMS type to be used with the GDOT ITS group.

For express lane toll rate DMS signage, State Road and Tollway Authority requirements must be incorporated. Refer to the ELNIOM for more information.

Additionally, designers should consult the scoring criteria in **Table 5-2** below when considering DMS placement on arterial roadways. The most preferred site will have the highest score.

Arterial DMS Scoring Criteria: Traffic								
Scoring Index	0	1	2	3	4	Score	Multiplier	Subtotal
Alternative Route Availability	None	-	1 Parallel	-	Multiple Parallel		5	
Beneficial Hours per Day	None	1-4	5-8	9-13	14+		3	
Travel Time Data Availability	None	-	Part of Detour	-	Length of Detour		3	
Alternative Route Capacity	None / 2 Lanes	-	4+ Lanes	-	SigOps		2	
Special Event Traffic AND/OR Access to Managed Lanes	None	-	1 Applies	-	Both		1	
Existing CCTV Coverage Along Route	None	-	Major Intersections	-	Length of Detour		1	
Arterial DMS Scoring Criteria: Site Design								
Scoring Index	0	1	2	3	4	Score	Multiplier	Subtotal
Right of Way Needs	Privately Owned	-	Agency Owned	-	GDOT Owned		3	
Utility Conflicts	>1 Utilities Impacted	-	1 Utility Impacted	-	None		2.5	
Power Service Availability	2+ miles away	-	0.5-2 miles away	-	<0.5 miles away		2	
Structure Type	None	Gantry	-	-	Butterfly		1.5	
Posted Speed/Existing Signage	Cannot meet spacing needs	-	Relocate existing signage	-	No spacing issues		1	
Traffic Score:								
Site Design Score:								
Total Score:								

Table 5-2 – Arterial DMS Scoring Criteria

5.3.1 DMS Support Structures and Siting Guidelines

DMSs require structural supports as well. Structural supports need to be located outside of clear zone or be protected by guardrail or barrier wall. Supports that are installed behind guardrail shall be placed a minimum distance of 6 feet from the face of guardrail. Error! Reference source not found.**3** lists the two varieties of structural supports DMSs are mounted on as well as some defining attributes of the two types.

Structural Support Type	Attributes
Type I	• DMS is located over the roadway • Commonly used with a Type 1 and 2 DMS • Also known as an overhead structure • Requires a walkway to be called out on the plans • Has two supports that need to be outside of clear zone or protected by guardrail • More expensive than Type III
Type III	• DMS is located in the median or on the right shoulder • Commonly used with a Type 3 and 4 DMS • Also known as a butterfly structure • Has one support that needs to be outside of clear zone or protected by guardrail

Table 5-3 – Structural Supports for DMS

Type I structural supports should be considered for DMS applications when there are 3 or more lanes in a single direction. Alternatively, Type III structural supports should be considered when there are 1-2 lanes in a single direction. Designers should also consider which structural support type is fitting for the project budget. If the proposed DMS cannot be located outside of the clear zone, then guardrail will be needed to protect the supports. If there is existing guardrail that can be utilized to protect the supports, project costs can be reduced. Designers should talk with the maintaining agency to determine their preference of sign structure and the impact on the budget.

DMSs will be located over portions of the roadway with a Type I structural support. When the roadway is wider than two lanes, the DMS will not cover the entire roadway and lateral viewing needs to be considered. The intended use of the sign will dictate which lanes the DMS is mounted over. If the message is providing travel times on an up-coming corridor, the DMS should be mounted over the exiting lane. If the DMS is intended to display corridor travel time, the DMS should be mounted over the center of the roadway.

Designers should also verify proper line of sight for shoulder mounted DMSs. This is to ensure that minor tree trimming or clearing and grubbing is properly called out on the plans. For interstate applications, designers should check for a clear line of sight extending back 800 feet from the face of the sign for the width of the sign. For arterial applications, designers should check for a clear line of sight extending back 600 feet from the face of the sign for the width of the sign. This is to verify that the entire face of the DMS is legible to motorists. If the line of sight intersects with an adjacent tree line, then minor tree trimming or clearing and grubbing should be called out and illustrated on the plans. Designers should note that clearing and grubbing is not preferred, and care should be taken to select another viable DMS location if opportunity allows.

5.3.2 CCTV Requirements

All DMSs require a CCTV camera to be installed upstream of the DMS to visually confirm all messages. While 500 to 750 feet upstream is preferable, a maximum distance of 1500 feet can be used. Additionally, CCTV cameras may be installed on existing sign structures, provided they meet the distance requirement stated above. Designers should remember to take the additional CCTV camera placement into consideration when selecting a DMS location. Refer to **section 7.3** for more information.

5.4 Power

Power should be provided to the DMS cabinet. DMSs should not use solar power due to the potential for high power consumption. See **Chapter 14** for more on power design.

5.5 Cabinet and Network Equipment

Each DMS requires a Type 3 Field Cabinet that houses the DMS controller and additional network equipment. The cabinet should be located 100 to 150 feet in front of the sign to allow viewing of the sign from the cabinet, on the outside shoulder, and out of the clear zone or protected by guardrail. However, designers may opt for a pole-mounted field cabinet for installations on Type III support structures when there is limited ROW.

If the device is connected to the trunk line via a fiber optic drop cable then a Field Switch, Type A or B; FPP, Wall Mount; and SFP Fiber Modules shall also be labeled on the plans to be installed in the cabinet. When the device is connected via wireless or cellular, only the cabinet and wireless or cellular equipment shall be labeled on the plans.

Additionally, designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information.

5.6 Communication Equipment

It is preferred to operate DMSs over fiber optic cable; however, if the project will not allow the use of fiber, the DMS can also operate over cellular router or wireless radios. However, SRTA equipment must be on fiber optic cable. Refer to **Chapter 15** for more information on communication.

When a DMS is installed on a fiber optic network, each location will also need the following equipment to tie the device into the network:

- Pull Box, Type 7 – installed along the trunk line, contains the underground closure, trunk and drop cable storage, and splices
- Pull Box, Type 4s – installed along the drop cable line, at the base of the cabinet and ITS device poles, and contains drop cable storage
- Fiber Optic Closure, Underground, __ Splice
- Fiber Optic Splice, Fusion
- OSP Fiber Optic Cable, Loose Tube, Single Mode, No. Fiber (trunk and drop cable)
- Conduit

5.7 Conclusions and Key Points

When designing a DMS for a project, the following should be remembered:

- The minimum letter height should be 18 inches for DMSs on roadways with speed limits of 45 mph or higher. The minimum letter height should be 12 inches for DMSs on roadways with speed limits less than 45 mph.
- DMSs require a CCTV camera to be installed upstream of the DMS.
  - A 500 to 750-foot distance is preferred, but the maximum distance is 1500 feet.
  - Cameras may be installed on existing sign structures as long as they adhere to the 500 to 1500-foot requirement.
- A Type I structural support has the DMS over the roadway.
  - It is commonly used for Type 1 and 2 DMSs.
  - Designers must call out a walkway with all Type I structural supports. The walkway is included in the Type I structural support pay item, but it must be specified.
- A Type III structural support has the DMS on the shoulder.
  - It is commonly used for Type 3 and 4 DMSs.
- The field cabinet, support structure, communication equipment, and power equipment are not included in the DMS pay item per section 631 of the GDOT specifications.
- Designers will need to include the Network Equipment Configuration and Integration pay item in all designs that tie an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information.
- Refer to **Chapter 16** for naming schemes regarding ITS devices.

5.7.1 DMSs for Interstate Applications

- DMS Types 1 and 3 are the most commonly used.
- DMSs should be placed a minimum of 800 feet from any existing sign structures and from other DMSs along the freeway.
- DMSs need to be placed a minimum of 1,445 feet in advance of a major decision point along the freeway.
- DMSs need to be continuously legible to motorists for at least 800 feet.

5.7.2 DMSs for Arterial Applications

- DMS Types 2 and 4 are the most commonly used.
- DMSs need to be placed at least 600 feet from adjacent signalized intersections on roadways with speed limits up to 50 mph. For higher speeds, refer to the MUTCD minimum sight distance for signal visibility requirements.
- DMSs need to be continuously legible to motorists for at least 600 feet.

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Chapter 6. Vehicle Detection

6.1 Introduction

A key part of ITS is the ability to measure traffic volumes and speeds. Various methods and types of volume and speed detection devices exist, all with pros and cons. This chapter discusses various types of detection, placement, limitations, and design considerations for ITS applications. Refer to the GDOT Traffic Signal Design Guidelines for more information regarding detection at signalized intersections.

6.2 Types

There are many different vehicle detection methods in use today. The types discussed in this guide, and the most widely used in ITS applications, are microwave radar and video detection assemblies. The following pay items should be used for detection systems:

937-XXXX Video Detection System, No.

937-XXXX Microwave Vehicle Detection System, No.

942-1000 Network Equipment Configuration and Integration

Additional pay items needed to complete the device installation may include:

639-4004 Strain Pole, Type IV

681-5XXX Luminaire Bracket Arm, ___ ‘ Arm

682-XXXX Pull Box, Type 4S

682-XXXX Pull Box, Type 7

926-210X Wireless System, Type ___

926-2220 Wireless System Survey

935-111X Outside Plant Fiber Optic Cable, Loose Tube, Single Mode, ___ Fiber (trunk and drop)

935-4010 Fiber Optic Splice, Fusion

935-410X Fiber Optic Closure, Underground, ___ Splice

935-420X Fiber Optic Closure, Aerial, ___ Splice

935-440X Fiber Optic Closure, Rack Mount, ___ Port

935-450X Fiber Patch Panel, Wall Mount, ___ Port

936-490X CCTV Mounting Arm, Type ___

939-23XX Field Switch, Type ____

939-239X SFP Fiber Module, Type___

939-41XX Field Cabinet, Type ____

6.3 Placement

Depending on the type of project, detection can be broken into two tiers. Tier 1 describes detection placement at interchanges and conflict zones, and Tier 2 describes detection placement for express lane projects. Refer to **section 6.3.1** for more guidelines on detection support structures.

Tier 1: Detection at Interchanges and Conflict Zones

There is no longer a need to have regularly spaced detectors throughout the interstate as GDOT has done in the past. This is because speed maps, which previously sourced data from roadside detection devices, are now generated using vehicle probe data from third party providers. Detection units, however, should still be placed where traffic congestion is likely to occur so that real-time data can be obtained and any problems can be further investigated. In most cases, this is at interchanges and conflict zones.

The designer should look to capture mainline data, entrance ramps, and exit ramps at interchanges within the project boundaries. The designer should place the detection assembly to detect both the mainline and the entrance ramp or exit ramp when opportunity allows. The best placement is usually near the base of the ramp on the outside shoulder, which will allow detection of the ramp and mainline with one detection assembly. Designers should verify detection locations that fall outside of major metro areas with the GDOT ITS group.

Detection should also be provided at conflict zones along the project corridor. Conflict zones include major and minor bottlenecks along the corridor, as well as high crash areas and high congestion areas. Major and minor bottlenecks frequently occur at freeway-to-freeway interchanges as well as when there is a reduction in travel lanes. Designers should analyze the project corridor to determine high crash areas and high congestion areas, and subsequently coordinate with the GDOT ITS group to verify the conflict zone locations.

After detection locations have been identified, the designer should consider if AID should be used at the site. AID is a software overlay that can be installed on fixed CCTV cameras. AID uses computer vision to monitor traffic conditions, detect incidents and traffic queues, and detect any abnormal activity. After identifying detection locations that may benefit from AID, coordinate with the maintaining agency to determine if AID is desirable on the project.

Designers should factor in additional siting guidelines when considering AID on a project. The fixed CCTV cannot have foliage in the analyzed area of the camera view as the movement of leaves can produce false alarms. Additionally, the camera angle should be as steep as possible to limit occlusion concerns. Occlusion happens when taller vehicles, such as tractor trailers, hide smaller vehicles from the camera's field of view. As such, a fixed CCTV should be installed on the same side of the road as the area of concern and installed as close to the road as possible.

Additionally, designers should coordinate with the GDOT Office of Transportation Data to determine if the ITS project location corresponds with a prospective continuous count station site.

Tier 2: Detection for Express Lane Projects

Designers should note that express lane projects incorporate all of the placement criteria in Tier 1. However, express lane projects have an additional placement criterion regarding AID. All merge areas on express lane projects should be covered with AID. As previously noted, AID is a software overlay that can be installed on fixed CCTV cameras. A zone of at least 250 feet should be detected in the direction of travel on both sides of the merge area.

6.3.1 Detection Support Structures and Siting Guidelines

Tier 1 & Tier 2

Many limited-access roadway entrances and exits already have existing overhead sign structures that can be utilized for mounting detection assemblies to save on project costs. In locations where existing sign structures are not present or cannot support the detection assembly, the designer will need to place a strain pole. The designer should ensure the strain pole is out of the clear zone or protected by guardrail.

Strain poles that are installed behind guardrail shall be a minimum distance of 6 feet from the face of guardrail. In instances where a strain pole is being placed behind existing guardrail, the designer will need to verify the length of guardrail is adequate for the situation. Consequently, designers should consult the GDOT Construction Standards and Details to ensure guardrail standards are met. Otherwise, the designer should place the pole out of the clear zone based upon the most current edition of AASHTO's Green Book. AASHTO's Green Book uses the speed and traffic volume of the roadway, and the slope of the shoulder to determine the lateral offset distance required from the traveled way to a fixed object; in this case, a strain pole or cabinet.

In many cases, the designer does not have topography and may not have traffic volume data. The designer should, when available, use third-party roadway level photography or schedule a field visit to confirm the slope of the embankment. From there the designer should use the highest distance offset from the speed and slope, assuming the travel volume to be the highest that the AASHTO Green Book specifies.

In addition, if the designer does not have the topography surveyed, drainage structures may not be identified. Pole placements must avoid drainage structures. Thus, during the field visit or using roadway-level, third-party photography, the designer should mark drainage structure locations for reference. Next, the designer should consider environmentally sensitive areas, such as streams, wetlands, and historic resources. The designer should avoid placing equipment and conduit in environmentally sensitive areas as much as possible. Lastly, consideration must be given to the limit of ROW needs for placement. In most cases, there is more than enough ROW at interchanges to sufficiently install the necessary detection equipment. Designers should note that detection devices produce the most accurate results when mounted laterally as close to the road as possible.

In the event the designer cannot meet the necessary offsets, placement of the device on the opposing side of the roadway may be considered. If the designer has exhausted all other options of mounting on an existing sign structure or other existing structure and is limited by drainage structures and environmentally sensitive areas, the designer should speak with their respective ITS project manager about the need to purchase ROW. Again, most ITS projects avoid purchasing ROW because of the increased project cost.

6.3.2 Microwave Vehicle Detection System Design Requirements

When installing microwave radar detection on a project, there are two types from which to choose as illustrated in **Table 6-1**. Designers can use side-fire microwave radars or forward-fire microwave radars.

Type of Radar	Application	Mounting	Orientation
Type A (Side-fire)	• ITS mainline freeway installations	• On existing sign structures • On poles outside of clear zone or poles protected by guardrail	• Perpendicular to the lane of travel
Type B (Forward-fire)	• Traffic signals and ramp meters • When noise barriers and tall buildings prevent side-fire use	• On existing sign structures • On mast arms for arterial applications	• Facing frontward at approaching traffic

Table 6-1 – Types of Radars

Microwave radar can be installed on strain poles or on existing sign structures as discussed in **section 6.3.1**. Many limited-access entrances and exits already have existing sign structures on which MVDS can be installed. However, these detectors can have wave reflections off the sign sheeting; thus, the use of horizontal luminaire arms off the sign structure is recommended for side-fire applications. In addition, the designer needs to consider if the sign structure is a viable option based on the required mounting height of the detector. **Figure 6-1** is a general diagram to inform the designer of microwave radar mounting on existing sign structures. Refer to GDOT detail ITS-11 for more information regarding mounting microwave radars on existing sign structures.

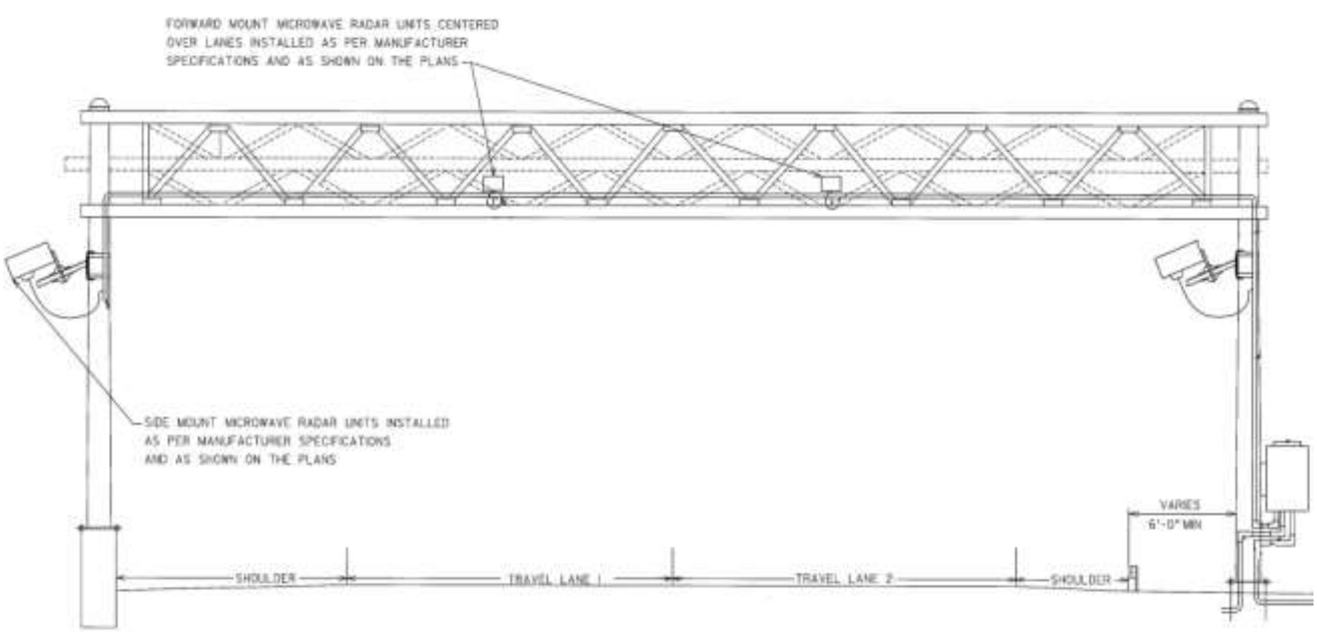

Figure 6-1: Microwave Radar Detection on Existing Sign Structures

While field placement is important, it is also crucial to know and design for the limitations of microwave radars. Forward-firing microwave radars can detect a minimum of 100 feet from the origination of the microwave beam. However, a forward-firing microwave radar is needed for each individual lane. Current side-fire microwave radar detectors have the limitation of being able to detect up to 200 feet from the origination of the microwave beam and can detect up to 16 lanes. Forward-fire microwave radars have a more limited window of detection than side-fire microwave radar, which is why side-fire microwave radars are more commonly used in interstate applications.

In addition, the 200 feet or 16 lanes limitation of side-fire microwave radar can become a potential problem when providing detection with extensive medians or locating bi-directional detection on one side of the road. Typically, the latter detector limitation will not be the limiting factor of a design due to occlusion concerns. However, the designer should specify the number of microwave radar detectors necessary if more than 16 lanes of detection is needed. Side-fire microwave radar also has difficulty in obtaining accurate results when vehicles are traveling at low speeds. However, this is not of much concern in interstate applications.

Designers should be cognizant of occlusion concerns during the design process. Occlusion occurs when the microwave radar beam is reflected prematurely due to tall vehicles, vertical concrete barriers walls, or roadway impact attenuators. To overcome this, side-fire microwave radars can be placed on both sides of the road to allow readings in both directions of travel. However, if this cannot be achieved, multiple side-fire microwave radars can be mounted on a single pole, but at differing heights to ensure the barrier is not an obstacle in producing accurate readings.

Noise barriers and large buildings have also been known to cause reflection of the microwave beam. When these limitations are present, the designer should consider the use of the forward-firing microwave radar. Forward-firing microwave radars are also used in situations where there is limited ROW on a project because of their ability to be used on existing sign structures.

6.3.3 Video Detection Design Requirements

When installing IVDS on a project, there are two types from which to choose. **Table 6-2** describes the two varieties. IVDS Type A is a standard, visual spectrum camera. IVDS Type B is a specialized infrared sensor and is only used where there is not sufficient standard highway lighting and for heavy fog conditions. As a result of these special circumstances, the Type B IVDS is typically a more expensive option and, thus, the less common option.

IVDS Type	Attributes
IVDS, Type A	• Visual spectrum camera • Most commonly used
IVDS, Type B	• Infrared sensor • Only used when there is not sufficient standard highway lighting and for heavy fog conditions

Table 6-2 – IVDS Types

IVDS can be installed on strain poles or existing sign structures as discussed in **section 6.3.1**. Video detection assemblies can be mounted on existing sign structures with the use of a tubular extension arm on top of the sign structure. Reference GDOT detail ITS-03, “Tubular Extension Detail,” for additional design information.

Designers should also be cognizant of occlusion concerns during the IVDS design process. Occlusion happens when taller vehicles or concrete barriers, hide smaller vehicles from the camera's field of view. To overcome this, the IVDS should be placed on the same side of the road as the detection area. Additionally, multiple IVDS can be mounted on a single pole, but at differing heights to ensure occlusion is not a concern.

6.4 Power

Power should be provided to every ITS device cabinet. With the exception of solar power locations, each device shall have power conduit provided to the cabinet that houses the controls for the detection assemblies. See **Chapter 14** for more on power design.

6.5 Cabinet and Network Equipment

Each device location requires a cabinet to house the additional detection assembly equipment and network equipment. A Type 1 Field Cabinet should be mounted on the strain pole or existing sign structure. If the device is connected to the trunk line via a fiber optic drop cable then a Field Switch, Type A or B; FPP, Wall Mount; and SFP Fiber Modules shall also be labeled on the plans to be installed in the cabinet. When the device is connected via wireless or cellular, only the cabinet and wireless or cellular equipment shall be labeled on the plans.

Additionally, designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information.

6.6 Communication Equipment

While communication has its own section in this document (**Chapter 15**), specific detection assembly communication requirements are briefly discussed here. Microwave radar and video detection can integrate with all forms of communication mediums (**Cellular (4G Router), Types, Design Considerations, and Fiber Optics**). However, the designer needs to consider the amount of connections necessary for the number of devices over a communication medium. The designer should consult **section 15.2**, which goes into detail about network switch equipment and the various communication mediums.

When a detection device is being installed on a fiber optic network, each location will also need the following equipment to tie the device into the network:

- Pull Box, Type 7 – installed along the trunk line and contains the underground closure, trunk and drop cable storage, and splices
- Pull Box, Type 4s – installed along the drop cable line, at the base of the cabinet and ITS device poles, and contains drop cable storage
- Fiber Optic Closure, Underground, __ Splice
- Fiber Optic Splice, Fusion
- OSP Fiber Optic Cable, Loose Tube, Single Mode, No. Fiber (trunk and drop cable)
- Conduit

6.7 Conclusion and Key Points

When choosing which detection assembly to install on a project, the following should be considered as well as consulting with the maintaining agency on their preference:

- IVDS is a better application for interstates in urban areas. Urban areas frequently have concrete barrier walls and noise barriers that can interfere with the microwave radar readings.
- Microwave radar is a better application for interstates in rural locations where both directions of travel can be captured by one unit from one side of the road. These locations frequently have guardrail dividing the directions of travel, as opposed to a concrete barrier, which does not interfere with the microwave beam.
- For AID applications, designers should consider fixed CCTV camera systems.
- The field cabinet, support structure, communication equipment, and power equipment are not included in the detection pay item per section 937 of the GDOT specifications.
- Designers will need to include the Network Equipment Configuration and Integration pay item in all designs that tie an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information.
- Refer to **Chapter 16** for naming schemes regarding ITS devices.

6.7.1 Video Detection Systems (IVDS)

- One assembly required for each direction of travel
- Mount on tubular extensions for use on existing sign structures
- Multiple IVDS devices can be mounted on the same pole
- The preferred installation of IVDS should be facing the headlights of vehicles

6.7.2 Microwave Radar

- One assembly required for each location, covering both directions of travel
- Mount on luminaire arms for use on existing sign structures
- Multiple microwave radar devices could be mounted on the same pole
- Side-fire microwave radar
  - 200-foot maximum distance
  - Single device can detect up to 16 lanes
  - Capturing bi-directional travel with side-fire microwave radar could be challenging if it is barrier-wall separated
  - Side-fire microwave radar has difficulty with low speeds and frequent congestion
- Front-fire microwave radar:
  - One device per lane is required

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Chapter 7. Closed-Circuit Television

7.1 Introduction

CCTV monitoring devices are used to visually confirm congestion, incidents, DMS messages, and toll rates, which are crucial for traffic management. Fixed CCTV cameras are also the most common type of device used for AID.

7.2 Types

GDOT currently supports various types of CCTV monitoring devices. Various cameras have different features and applications for which they are suited. **Table 7-1** indicates the six available cameras. Refer to section 936 of the GDOT specifications for legacy CCTV camera system pay items. The legacy pay items shall be used only when required and approved by the GDOT ITS group.

Type	Pressured vs. Non-pressurized	Operational features
Type 1	Non-pressurized	IP, PTZ, HD, Dome
Type 1 P	Pressurized	IP, PTZ, HD, Dome
Type 2	Non-pressurized	IP, PTZ, HD, Turret/positioning
Type 2 P	Pressurized	IP, PTZ, HD, Turret/positioning
Type 3	Non-pressurized	IP, Fixed, HD, Barrel
Type 3 P	Pressurized	IP, Fixed, HD, Barrel

Table 7-1 – CCTV Types

The following pay items should be used for CCTV assemblies:

936-4XXX CCTV Camera System, Type ___

936-490X CCTV Mounting Arm, Type ___

942-1000 Network Equipment Configuration and Integration

Additional pay items needed to complete the device installation may include:

639-4004 Strain Pole, Type IV

682-XXXX Pull Box, Type 4S

682-XXXX Pull Box, Type 7

926-210X Wireless System, Type ___

926-2220 Wireless System Survey

935-111X Outside Plant Fiber Optic Cable, Loose Tube, Single Mode, ____ Fiber (trunk and drop)

935-4010 Fiber Optic Splice, Fusion

935-410X Fiber Optic Closure, Underground, ___ Splice

935-420X Fiber Optic Closure, Aerial, ___ Splice

935-450X Fiber Patch Panel, Wall Mount, ___ Port

936-4950 Camera Lowering Device

939-23XX Field Switch, Type ____

939-239X SFP Fiber Module, Type ____

939-41XX Field Cabinet, Type ____

7.2.1 Pressurized versus Non-pressurized

Pressurized versus non-pressurized camera refers to the enclosed portion of the camera where the lens is located. The principle of pressurizing the camera with an inert gas is to prevent a variety of environmental factors from effecting the longevity and view of the camera. A pressurized camera can prevent condensation from forming on the enclosure and ensures a seal from rain, snow, ice, and/or salty air, resulting in less maintenance. Non-pressurized cameras are sealed but are more susceptible to environmental factors. Non-pressurized cameras should be the camera of choice unless otherwise requested by the maintaining agency.

7.2.2 Dome versus Turret

Both dome and turret cameras have a 360-degree horizontal view; however, the turret camera has a 360-degree vertical view. The most commonly used camera for ITS projects is the dome camera, and it should be the camera of choice unless specified by the maintaining agency. A turret camera should be installed in locations where a vertical view would be required. For example, underneath a bridge for security purposes.

7.2.3 PTZ versus Fixed

Camera Types 1 and 2 have PTZ capabilities, while the Type 3 camera is fixed. PTZ allows the camera to pan, tilt, and zoom for better and multiple views of the roadway with one camera. A DOT placard of 1 foot by 1 foot will be continuously legible at 500 feet for Types 1, 1P, 2, and 2P cameras. A fixed camera is restricted to the same view at all times. The view of a fixed camera will never change unless it is physically redirected in the field. A fixed camera would be preferred over PTZ if the agency wanted to view one specific location or use AID to monitor a conflict zone.

7.3 Placement

Depending on the type of project, CCTV installations can be broken into three tiers: Tier 1 details general CCTV placement for non-express lane projects; Tier 2 details CCTV placement for express lane projects; and Tier 3 details CCTV placement for arterial applications. Refer to **section 7.3.1** for more guidelines on CCTV support structures.

<u>Tier 1: CCTV Cameras for Non-express Lane Projects</u>

Once the type of camera has been determined, placement of the camera(s) is the next step. When possible, CCTVs should be co-located on poles with proposed detection equipment to reduce project costs. However, the designer should ensure the viewing goals of the CCTV are not compromised with co-location. There are five main CCTV viewing goals: interchange, message signs, ramp meter indications, ESS, and AID.

When designing a project, it is best to start by placing CCTV cameras at project interchanges. The camera should be located as close to the interchange as physically possible to allow viewing of the interstate, entrance ramps, and cross streets. Designers should also consider the use of CCTV cameras to monitor traffic under overpasses. For example, CCTV cameras are frequently installed under bridges along I-75/I-85 and I-285 because of the high accident rate in these areas. Designers should determine if this is a goal warranted for the project location. For this application, CCTV cameras would have to be offset from the bridge to have a clear view under it, which would consequently take away the view of the cross-street.

Note: Non-express lane projects may follow the 100 percent CCTV coverage goal illustrated in Tier 2, if it is requested by the maintaining agency.

Second, a CCTV camera must be placed upstream of all message signs, so the maintaining agency can visually confirm all messages displayed. It is preferable to install the CCTV camera 500 to 750 feet upstream of the message sign; however, the maximum allowable distance is 1500 feet. Existing CCTV cameras may be utilized as long as they meet the 500 to 1500-foot distance requirement stated above. Message signs include ITS devices such as DMS, DLCS, and VSLs. Once message signs are placed on the project, the designer may have to adjust the CCTV camera or message sign placement to ensure the requirement is met.

CCTV cameras are also used to monitor the operation of ramp meters on entrance ramps. The primary goal of the camera for a ramp meter is to view the signal indications. A camera installed at the interchange should be able to capture both ramps. However, in the event both ramp meters cannot be viewed from the camera at the interchange, another CCTV camera shall be installed to ensure viewing of all ramp meter signals.

CCTV cameras are used to monitor weather conditions at an ESS. For this application, a camera should be installed on the same pole as the proposed ESS or the ESS should be installed on an existing CCTV camera pole if adequate ESS conditions are met at that site.

Lastly, fixed CCTV cameras can be used for AID in conflict zones. Conflict zones include major and minor bottlenecks along the corridor, high crash areas, high congestion areas, and weaving areas. After identifying locations that may benefit from AID, coordinate with the maintaining agency to determine if AID is desirable on the project. Designers should factor in additional siting guidelines when considering AID on a project. The fixed CCTV should not have foliage in the immediate view of the camera as the movement of leaves can produce false alarms. Additionally, the camera angle should be as steep as possible to limit occlusion concerns. As such, a fixed CCTV should be installed on the same side of the road as the area of concern and should be installed as close to the road as possible.

Tier 2: CCTV Cameras for Express Lane Projects

Designers should note that express lane projects incorporate all of the CCTV viewing goals and placement criteria in Tier 1. However, express lane projects have two additional CCTV goals: 100 percent coverage of the corridor and electronically operated gates.

Once all the CCTV cameras are placed at the interchanges, the designer should start placing additional cameras along the corridor in between the interchanges until 100 percent coverage is achieved. Cameras should be placed 2,000 to 3,000 feet apart. However, cameras may need to be spaced closer together to meet all the viewing goals required for the project. Additionally, all merge areas on express lane projects should be covered with AID, which can be achieved on a fixed CCTV device. A zone of at least 250 feet should be detected in the direction of travel on both sides of the merge area. Refer to the ELNIOM for more information.

CCTV cameras are also used to visually confirm the position of electronically operated gates. Electronically operated gates include Emergency Access Gates (EAG) and Gate Lifting and Swinging Systems (GLSS). CCTV cameras must be placed within 500 to 750 feet of the gates, so the maintaining agency can verify the gate position. Refer to the ELNIOM for more information.

Tier 3: Arterial CCTV Applications

CCTV camera criteria that should be used when considering CCTV placement for arterials include:

- Complex intersections including but not limited to:
  - Single-point urban interchanges
  - Continuous-flow interchanges
  - Diverging diamond interchanges
  - ThrU-turn intersections
  - Flex lane intersections
  - Light-rail intersections
- Intersections overcapacity during peak hours that drive the cycle length for the corridor
- Intersections with a high crash history
- Intersections where the ADT is greater than:
  - 40,000 (urban)
  - 28,000 (rural)
- Arterials crossing arterials where the ADT is greater than the following for a single corridor:
  - 30,000 (urban)
  - 21,000 (rural)

- Intersections with approaches of 50 mph or higher with an ADT greater than the following for a single corridor:
  - 20,000 (urban)
  - 14,000 (rural)
- Intersections with complex signal phasing
- Intersections near special events
- Intersections with high pedestrian and/or bicycle traffic
- Large intersections
- Large roundabouts

Coordinate with the GDOT Traffic Signal group to determine if a CCTV camera should be installed at the location in question.

7.3.1 CCTV Support Structures and Siting Guidelines

Tier 1 & Tier 2

When considering CCTV placement, designers should first identify if there are existing CCTV cameras that can be used to meet the viewing goals stated above. If that is not the case, then new CCTV cameras may be located either on strain poles or on existing sign structures. When using strain poles, the following guidelines should be considered. The placement of the strain pole should be protected by guardrail if not out of the clear zone, away from heavy foliage, on the outside of horizontal curves, within existing ROW, and not in environmentally sensitive areas or on drainage structures. Strain poles that are installed behind guardrail shall be a minimum distance of 6 feet from the face of guardrail. In instances where a strain pole is being placed behind existing guardrail, the designer will need to verify the length of guardrail is adequate for the situation. Consequently, designers should consult the GDOT Construction Standards and Details to ensure guardrail standards are met. Clear zone is based upon the most current edition of AASHTO's Green Book. The Green Book uses the speed and traffic volume of the roadway, and the slope of the shoulder to determine the lateral offset distance required from the traveled way to a fixed object; in this case, a strain pole or cabinet. In many cases, the designer does not have topography and may not have traffic volume data. The designer should, when available, use third-party roadway level photography or schedule a field visit to confirm the slope of the embankment. From there the designer should use the highest distance offset from the speed and slope, assuming the travel volume to be the highest the AASHTO Green Book specifies. If additional ROW is needed, discuss with the project manager.

Designers should always consider the camera view and the viewing goals when considering CCTV placement. Care should be taken during the locating of cameras to consider horizontal and vertical curves, overpasses, signage, and any other existing or proposed infrastructure that might block the view of the camera. For example, a strain pole located in a sag vertical curve may not be able to achieve its viewing goals depending on the slope of the road. Consequently, designers should take advantage of vertical elevations to increase viewing capabilities when opportunity allows.

A curvature of the road will reduce the view of the CCTV camera and heavy tree foliage can block the view. However, CCTV mounting arms allow for better viewing of the roadway and should be included on all CCTV installations. **Table 7-2** illustrates the four available mounting arms.

Type	Extension	Length
Type 1	Horizontal	Short Arm: 1.5-2.5 ft
Type 2	Horizontal	Long Arm: 15-20 ft
Type 3	Vertical	Short Arm: 2-4 ft
Type 4	Vertical	Long Arm: 4-8 ft

Table 7-2 – CCTV Mounting Arms

A Type 2 mounting arm is helpful in instances where the proposed CCTV camera location is set outside the clear zone. The 15 to 20-foot horizontal extension allows the camera to be closer to the roadway and have a greater chance to reduce blind spots due to foliage. The vertical extension provided in both Type 3 and 4, is beneficial in instances where the CCTV camera is proposed on an existing sign structure. The vertical extension allows for better viewing capabilities as the CCTV camera is situated higher. Reference GDOT detail ITS-03, "Tubular Extension Detail," for additional design information. Additionally, lowering devices should only be utilized when a standalone CCTV is proposed on a new pole that is located on a steep grade.

Tier 3

When considering CCTV placement at a traffic signal, designers should first identify if there is an existing CCTV within sight of the intersection. If that is not the case, then designers should aim to utilize the existing traffic signal support structures to mount a new CCTV.

Mounting arms, as illustrated in **Table 7-2** above, can also provide better viewing opportunities for the camera by increasing the vertical or horizontal offset. When determining how to mount the CCTV, designers should always seek to maximize the line of sight of the camera. The CCTV should also be placed on the outside of curves, away from heavy foliage, and should consider the elevation of the CCTV relative to its viewing goals.

Additionally, designers should consider placing a CCTV on the same corner as the traffic signal cabinet in order to reduce cabling. CCTV cameras operate using CAT6 cabling, which have maximum cable lengths of 328 feet. However, to allow for slack, designers should ensure the CCTV is located a maximum distance of 300 feet from the field cabinet. It is preferred to use the existing traffic signal cabinet for CCTV installations when opportunity allows.

7.4 Power

Power should be provided to every ITS device cabinet. With the exception of solar locations, each device shall have power conduit provided to the cabinet that houses the controls for the CCTV assemblies. See **Chapter 14** for more on power design.

7.5 Cabinet and Network Equipment

Each device location requires a cabinet to house the additional CCTV system and network equipment. The designer shall call out a Type 1 Field Cabinet to be mounted on the strain pole or existing sign structure. If the device is connected to the trunk line via a fiber optic drop cable then a Field Switch, Type A or B; FPP, Wall Mount; and SFP Fiber Modules shall be labeled on the plans to be installed in the cabinet. In cases where CCTV cameras and detection systems are co-located, they will share the cabinet and network equipment. When the cabinet/camera is connected via cellular or radio, only the cabinet, CCTV camera (and any other ITS devices installed), and the wireless radio/ 4G router will be called out on the plans. If a CCTV camera is being installed at an existing traffic signal location, it is the designer's responsibility to ensure the existing cabinet can house the required network equipment or the existing equipment can support the addition of the CCTV camera.

As previously mentioned, it is important to note the maximum distance the category cable can be from the field cabinet. CCTV cameras operate using CAT6 cabling, which have maximum cable lengths of 328 feet. However, to allow for slack, designers should ensure the CCTV is located a maximum distance of 300 feet from the field cabinet.

Additionally, designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information.

7.6 Communication Equipment

CCTV cameras are one of the most bandwidth-consuming devices used in ITS. Today, compression formatting is bringing HD videos down to more manageable levels of data; however, the data volume remains high. This, coupled with the typical need for cameras in multiple locations, causes large data flow rates from areas. Therefore, when possible, it is recommended that cameras are backhauled with fiber optic communications. The other communication mediums are discussed in more detail in **Chapter 15** and should be consulted for decision beyond the use of fiber optic communication.

When a CCTV camera is being installed on a fiber optic network, each location will need the following equipment to tie the device into the network:

- Pull Box, Type 7 – installed along the trunk line and contains the underground closure, trunk and drop cable storage, and splices
- Pull Box, Type 4s – installed along the drop cable line, at the base of the cabinet and ITS device poles, and contains drop cable storage
- Fiber Optic Closure, Underground, __ Splice
- Fiber Optic Splice, Fusion
- OSP Fiber Optic Cable, Loose Tube, Single Mode, No. Fiber (trunk and drop cable)
- Conduit

7.7 Conclusion and Key Points

When designing CCTV cameras on a project, the following should be remembered:

- Start by placing interchange cameras first
- 500 to 750-foot viewing distance upstream from camera to message signs is preferable; however, a maximum distance of 1500 feet upstream can be used
- Ensure ramp meter signals on entrance ramps can be viewed by the CCTV camera
- Ensure every ESS has a CCTV camera co-located on the same pole
- A fixed CCTV should be used for AID applications
- Ensure 100 percent corridor coverage for express lane projects
- Ensure 500 to 750-foot viewing distance from camera to electronically operated gates
- CCTV cameras and detection assemblies can be co-located on a strain pole
- Strain poles shall be placed out of the clear zone or protected with guardrail
- The field cabinet, support structure, communication equipment, and power equipment are not included in the CCTV pay item per section 936 of the GDOT specifications
- Designers will need to include the Network Equipment Configuration and Integration pay item in all designs that tie an ITS device to the GDOT network; refer to section 942 of the GDOT specifications for more information
- Refer to **Chapter 16** for naming schemes regarding ITS devices

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Chapter 8. Environmental Sensor Station

8.1 Introduction

The State of Georgia spans a multitude of climate zones that can pose potential threats to drivers. In addition to alerting drivers of potentially hazardous weather or road conditions, it is important for GDOT and/or the local agency to monitor and better predict weather conditions.

ESSs currently offer the ability to collect air temperature, relative humidity, wind (direction and speed), barometric pressure, precipitation (all types), and visibility (fog and smoke). In addition, ESSs provide pavement surface data, including temperature, condition, and friction along with roadway precipitation data, type, percent of ice, and precipitation depth/amount. Lastly, ESSs can provide subsurface temperature.

8.2 Types

Table 8-1 identifies the types of ESSs, their mobility, and how they are powered and communicate.

Type	Mobile or Stationary	Power/ Communication Type
Type 1	Stationary	Utility power/Any
Type 2	Stationary	Solar power/Wireless
Type 3	Mobile	Vehicle mounted/Wireless

Table 8-1 – Environmental Sensor Station Types

This guide will only describe the design requirements for Types 1 and 2. Therefore, the only decision is the power and communication type. **Table 8-2** illustrates the sensors that are included with the ESS pay item. Designers should coordinate with the GDOT ITS group to inquire about sensors that are not included in section 694 of the GDOT specifications. Designers will also need to call out the strain pole which will support the ESS installation, as the support structure is not included in the ESS pay item.

ESS Sensors
Pavement Sensor, Non-invasive
Atmospheric Sensor, Visibility
Atmospheric Sensor, Air Temperature and Relative Humidity
Atmospheric Sensor, Ultrasonic Wind
Atmospheric Sensor, Barometric Pressure
Atmospheric Sensor, Precipitation
Subsoil Sensor

Table 8-2 – ESS Sensors

The following pay items should be used for ESS installations:

639-3001 Steel Strain Pole, Type I

694-00XX ESS, Type ___

694-0100 Remote Processing Unit (RPU)

942-1000 Network Equipment Configuration and Integration

Additional pay items needed to complete the device installation may include:

682-XXXX Pull Box, Type 4S

682-XXXX Pull Box, Type 7

694-0050 Pavement Sensor, Non-invasive

694-0055 Atmospheric Sensor, Visibility

694-0060 Atmospheric Sensor, Air Temperature and Relative Humidity

694-0065 Atmospheric Sensor, Ultrasonic Wind

694-0070 Atmospheric Sensor, Barometric Pressure

694-0075 Atmospheric Sensor, Precipitation

694-0080 Subsoil Sensor

926-210X Wireless System, Type ___

926-2220 Wireless System Survey

935-111X Outside Plant Fiber Optic Cable, Loose Tube, Single Mode, ___ Fiber (trunk and drop)

935-4010 Fiber Optic Splice, Fusion

935-410X Fiber Optic Closure, Underground, ___ Splice

935-420X Fiber Optic Closure, Aerial, ___Splice

935-450X Fiber Patch Panel, Wall Mount, ___ Port

936-4XXX CCTV Camera System, Type ___

936-490X CCTV Mounting Arm, Type ___

936-4950 Camera Lowering Device

939-23XX Field Switch, Type ___

939-239X SFP Fiber Module, Type ___

939-41XX Field Cabinet, Type ___

8.3 Placement

Placement of the ESS along the corridor should be considered based on historical data. The ESS should be placed in locations where, historically, there has been extensive fog, smoke, icing, rainfall, and high winds. Typically, ESSs are placed within 10 miles of each other in dense urban areas, and within 20 miles of each other in rural areas. ESSs should not be placed near stop bars, or where traffic is to be stopped for a prolonged period of time, as this could affect the sensors. When possible, ESSs should also be placed on flat shoulders to allow for better maintenance access. In addition, the designer should coordinate proposed ESS locations with the GDOT ITS group. The GDOT ITS group will oftentimes coordinate with the National Weather Service to get insight on valuable ESS locations.

In addition, all ESSs require a CCTV camera to be installed within view of all the sensors. A CCTV camera should be installed on the same pole as the proposed ESS or the ESS should be installed on an existing CCTV pole if adequate ESS conditions are met at that site. The CCTV camera simply allows the TMC to verify the current weather conditions at the ESS.

The lateral offset of the ESS is another consideration. It is important that the ESS is set back from the roadway sufficiently, so the data is not altered by vehicles traveling on the roadway. However, it is also important for the ESS to be close enough to accurately collect data that represents the conditions at the roadway. As a result, the ESS should be offset 30-50 feet from the outermost edge of the lane line. Designers should check clear zone distances to see if guardrail installation is warranted with these offset requirements. In addition, the system should be located a minimum of 30 feet away from large structures or dense foliage to ensure accurate readings can be produced from the wind sensor. Refer to the latest version of FHWA's Road Weather Information System Environmental Sensor Station Siting Guidelines for additional information.

8.4 Power

Power should be provided to every ITS device. With the exception of solar locations, each device shall have power conduit provided to the cabinet that houses the controls for the detection assemblies. See **Chapter 14** for more on power design.

8.5 Cabinet and Network Equipment

The designer should specify the use of a Type 3 Field Cabinet for the ESS. Cabling for equipment attachments operate on several cables with some distance limitations. The designer should keep the distance limitations of category cables, previously mentioned in this document, as a good rule of thumb. The designer should also specify the use of a RPU within the ESS field cabinet, which processes the ESS data.

Additionally, designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information.

8.6 Communication Equipment

The ESS communication can either be fiber optic or cellular. If no utility power is available, then typically no fiber optic communication will be available; therefore, cellular radio should be used. Refer to **Chapter 15** for more information on communication.

8.7 Conclusion and Key Points

When designing an ESS on a project, the following should be remembered:

- Coordinate with the GDOT ITS group to determine ESS locations
- ESS and CCTV cameras should be co-located on the same pole to ensure a view of all sensors
- Strain poles shall be placed out of the clear zone or protected with guardrail
- ESS should be offset 30 to 50 feet from the outermost lane line
- ESS should be located a minimum of 30 feet away from large structures or dense foliage
- The ESS pay item includes the 7 sensors listed in Table 8-2

- Separate pay items are required for the ESS support structure, power equipment, the field cabinet, RPU, and communication equipment per section 694 of the GDOT specifications
- Designers will need to include the Network Equipment Configuration and Integration pay item in all designs that tie an ITS device to the GDOT network; refer to section 942 of the GDOT specifications for more information
- Refer to **Chapter 16** for naming schemes regarding ITS devices

Chapter 9. Dynamic Lane Control Signs

9.1 Introduction

DLCS are time-of-day roadway expansion devices. DLCS are used to convert shoulders to travel lanes to ease congestion in an operation called hard shoulder running. Hard shoulder running is typically conducted during peak travel hours to expand capacity of the road beyond the general purpose lanes. For this operation, DMS are mounted on mast arms over the shoulder to indicate to drivers whether it is acceptable to travel on the shoulder or not. Typically, a green through arrow or a red “X” is illustrated on the DMS to convey this message.

The following pay items should be used for DLCS installations:

631-0105 DMS, Type 5

639-3004 Steel Strain Pole, Type IV W/ ___’ Mast Arm

942-1000 Network Equipment Configuration and Integration

Additional pay items needed to complete the device installation may include:

682-XXXX Pull Box, Type 4S

682-XXXX Pull Box, Type 7

926-210X Wireless System, Type ___

926-2220 Wireless System Survey

935-111X Outside Plant Fiber Optic Cable, Loose Tube, Single Mode, ___ Fiber (trunk and drop)

935-4010 Fiber Optic Splice, Fusion

935-410X Fiber Optic Closure, Underground, ___ Splice

935-420X Fiber Optic Closure, Aerial, ___Splice

935-450X Fiber Patch Panel, Wall Mount, ___ Port

939-23XX Field Switch, Type ___

939-239X SFP Fiber Module, Type ___

939-41XX Field Cabinet, Type ___

9.2 Placement

DLCS need to be placed at regular intervals so drivers entering or merging onto the shoulder can know whether the lane is open. Therefore, a DLCS must be placed at every corridor entrance, but should be at a location visible by corridor drivers as well. The designer must consider where existing sign structures, bridges, or other structures are located to not block any views of existing signage or the DLCS. From there, the designer should place DLCS assemblies every 1,000 feet along the corridor to the next exit.

Once placement along the corridor has been set, the strain pole foundations need to be protected by guardrail or outside the clear zone as specified in the AASHTO Green Book based upon average daily traffic, slopes, and speed of the corridor. Strain poles installed behind an existing guardrail shall be installed a minimum distance from the guardrail, and the designer should reference the guardrail detail to determine this distance. Based upon the offset, the mast arm length should be specified but shall not exceed 65 feet in length.

Refer to the latest version of FHWA's Use of Freeway Shoulders for Travel Guide for additional information.

9.3 Enclosure, Equipment, and Cabling

The enclosure utilized for DLCS assemblies should be a ground-mounted Type 3 Field Cabinet with a sealed base. The cabinet should be located 100 to 150 feet in front of the sign to allow viewing of the sign from the cabinet, on the outside shoulder, and out of the clear zone or protected by guardrail. If the device is connected to the trunk line via a fiber optic drop cable then a Field Switch, Type A or B; FPP, Wall Mount; and SFP Fiber Modules shall also be labeled on the plans to be installed in the cabinet. When the device is connected via wireless or cellular, only the cabinet and wireless or cellular equipment shall be labeled on the plans.

The DMS type mounted on the mast arm will be the Type 5 DMS. The DMS will be mounted over the center of the shoulder and be wired back to the DMS controller. For power options, reference **Chapter 14** of this document.

Additionally, designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information. Designers will also need to refer to **Chapter 16** for ITS device naming guidelines.

Chapter 10. Electronically Operated Gates

10.1 Introduction

While electronic gates have multiple applications in ITS, this section discusses the application of Emergency Access Gates (EAGs) and Gate Lifting and Swinging Systems (GLSSs) for express lane systems.

10.2 Placement

EAGs allow for concrete barrier-separated roadways to be accessed by emergency personnel. Oftentimes, there are limited entry points into the express lanes, which can be problematic when emergency personnel need to respond to incidents. To mitigate this, an EAG can be installed within the concrete barrier between access points to cut down response time to an incident. The number of EAGs will be project specific and will depend on the density of access points and the project budget. Designers should coordinate with GDOT and SRTA to determine EAG locations.

EAG placement should be coordinated with the roadway geometry design to ensure that all EAG's have at least one full-width (12') shoulder adjacent to the gate to allow for a responder to stop to open the gate without obstructing a travel lane. Additionally, this full-width shoulder provides access for routine maintenance checks without lane closures. When opened, EAG's create a blunt-end obstruction. The designer should make sure that all parties involved in an EAG design and installation are aware of this and that appropriate protection is made available when a gate is opened, such as a crash truck or lane closure.

Another type of gate deployed on express lanes includes GLSSs. GLSSs are life-safety systems that are commonly installed on reversible lane projects to prevent head on collisions at interstate speeds. Warning gates (WGs) and barrier gates (BGs) are the two types of GLSSs in use on express lane projects in Georgia. Both WGs and BGs are placed at entry points into the express lanes to indicate to drivers that the express lanes are closed for that direction of travel. These gates are installed with the purpose of stopping potential wrong-way drivers. WGs are breakaway style and there are typically several per express lane entrance that are encountered before coming across a single BG. The single BG is the final gate before entering traffic merges into the lane. Unlike the WG, the BG is designed to stop a vehicle and prevent the vehicle from entering the express lanes. Refer to the ELNIOM for more information.

10.3 Equipment, Enclosure, and Cabling

EAGs are turnkey systems that simply need power routed to the device for their operation. However, they can be operated with a hand-crank in the event of power outages.

There are two major components for the operation of GLSSs: the gate itself and the cabinet that contains all the equipment to control operation of the gate. GLSSs are life-safety systems and therefore should not use solar power. Refer to the ELNIOM for more information.

Additionally, designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information. Designers will also need to refer to **Chapter 16** for ITS device naming guidelines.

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Chapter 11. Variable Speed Limit Signs

11.1 Introduction

Within urban interstates and high-speed environments, drivers are typically not expecting to stop abruptly. Thus, the use of VSL signs will aid in lowering driver speed prior to congestion, whether it is recurring (typical) or non-recurring (an incident).

11.2 Placement

Placement of VSL signs is the key to the success of this ITS solution. If proper placement is not achieved, drivers cannot be properly informed of speeds, thus voiding the intent of the device. Therefore, it is important that the designer follows the guidelines detailed below as closely as possible.

The designer should follow the latest edition of the MUTCD and GDOT Signing and Marking Guidelines for speed limit sign location and spacing on a route. In addition to the standard speed limit sign placement, other VSL signs can be installed where recurring congestion has been identified along the route. In locations where it was identified to have decreased speeds at certain times of the day or large numbers of vehicular incidents, the addition of another speed limit sign should be included 750 feet beyond the original sign, where permitted. In locations that have other types of existing signage, the VSL sign should be adjusted to provide proper spacing for visibility.

It is not recommended to dual-indicate speed limits since installation and maintenance of the signs in urban medians requires a lane closure.

11.3 Enclosure, Equipment, and Cabling

Once the sign placement has been determined, the equipment, installation, and cabling must be considered. **Figure 11-1** is a detailed drawing showing the construction of the VSL sign assembly.

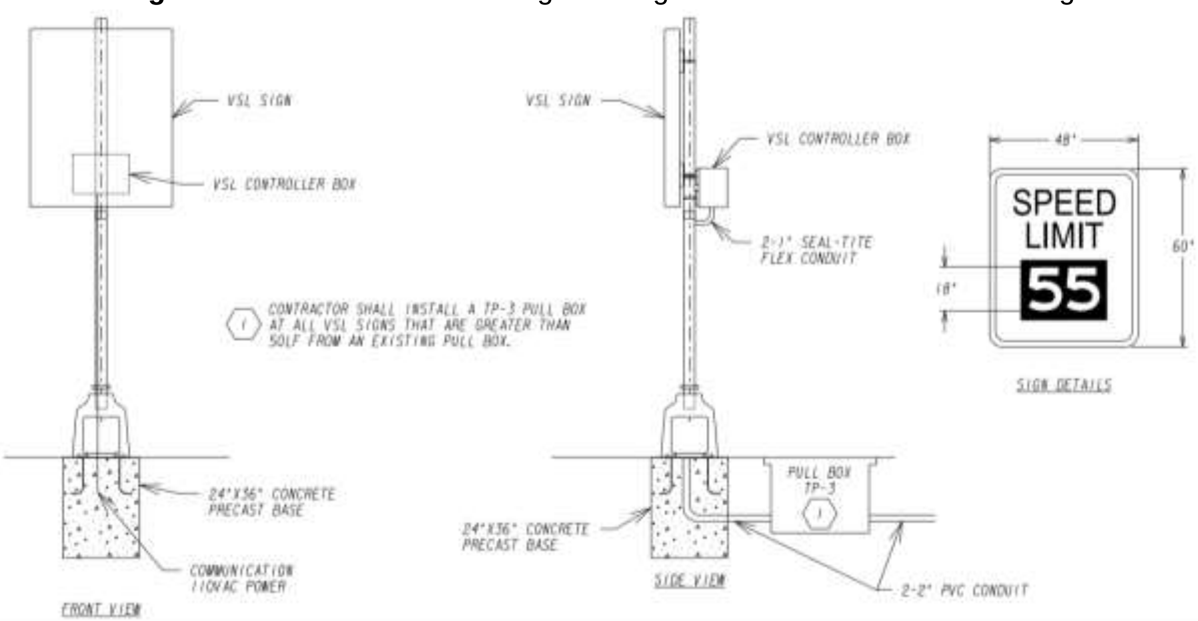

Figure 11-1: VSL Sign Construction Detail

When possible, communication should be taken from an existing ITS cabinet. Most VSL corridors will have existing ITS infrastructure; therefore, usage of communication within close vicinity should not be problematic. In addition, power should be readily available along the entire corridor. If a location does not have communication within the area, it is recommended for installation of a base-mounted, Type 3 cabinet to serve for the communication location. Additionally, designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information. Designers will also need to refer to **Chapter 16** for ITS device naming guidelines.

Chapter 12. ITS Safety Systems

12.1 Introduction

ITS solutions are being used more and more in safety-of-life applications. The safety-of-life applications discussed within this document are curve warning systems and intersection collision warning systems. These systems alert drivers based upon potential hazards to approaching drivers.

The following pay items should be used:

631-010X **DMS, Type ___**

639-3001 **Steel Strain Pole, Type I**

647-XXXX **Flashing Beacon Installation**

942-1000 **Network Equipment Configuration and Integration**

Additional pay items needed to complete the device installation may include:

636-10XX **Highway Signs, Type ___ Material, Reflective Sheeting, Type ___**

682-XXXX **Pull Box, Type 4S**

682-6223 **Conduit, Nonmetal, Type 3, 2 Inch**

926-210X **Wireless System, Type___**

937-XXXX **Inductance Loop Detection System, Type ____**

937-XXXX **Microwave Vehicle Detection System, Type ____**

939-41XX **Field Cabinet, Type ____**

12.2 Curve Warning System

A curve warning system is based upon detecting a vehicle's speed as it approaches a curve and displaying a flasher or blank-out message based upon the approaching vehicle's speed and the design curve speed to warn the driver to reduce their speed.

There are three key components for proper operation of curve warning. The first is detection, the second is warning the driver, and the last is equipment to make it all operational. Thus, the first component discussed will be the speed detection device. The preferred method for speed detection would be a front firing microwave radar detection assembly. A second, but less preferred option, would be a side-fire microwave radar detection assembly placed up-stream of the curve and a display to capture the speed while allowing for the proper amount of time for speed reduction.

There are two options for the designer to choose for the warning display. The warning display sign can be static sign with flashing beacons that will be activated based upon the oncoming vehicle. The second option is the use of a DMS to alert drivers with a message to "SLOW DOWN" using either a Type 6 or 7 DMS. The type of DMS decision will be based upon the roadway speed. In a lower speed application, the use of the Type 6 DMS will be sufficient. In higher speed areas, the use of the Type 7 DMS is recommended because of the larger size text for greater advanced readability. Refer to **Chapter 5** for more information on selecting the correct type of DMS.

12.2.1 Placement

Placement of devices is crucial to ensure proper warning to drivers, providing enough time for drivers to properly respond. Therefore, based upon AASHTO's deceleration guide and the posted speed limit versus the curve design speed, the warning distance can be calculated.

12.2.2 Equipment, Enclosure, and Cabling

The flashing beacon installation is considered a lump sum pay item, and therefore includes the pole mounted flashing beacon cabinet. Refer to section 647 of the GDOT specifications for more information regarding what is included in the lump sum pay item. Power and communication will be largely dependent on the location and placement of the system. Power can be supplied by utility or solar. For solar power options, consult the solar power subsection of **Chapter 14** within this document. Communication can either be fiber optic or cellular. For more information regarding communication, consult **Chapter 15** of this document.

The enclosure utilized for the DMS assemblies should be a ground-mounted Type 3 Field Cabinet with a sealed base. The cabinet should be located 100 to 150 feet in front of the sign to allow viewing of the sign from the cabinet, on the outside shoulder, and out of the clear zone or protected by guardrail. If the device is connected to the trunk line via a fiber optic drop cable then a Field Switch, Type A or B; FPP, Wall Mount; and SFP Fiber Modules shall also be labeled on the plans to be installed in the cabinet. When the device is connected via wireless or cellular, only the cabinet and wireless or cellular equipment shall be labeled on the plans. For power options, reference **Chapter 14** of this document.

Additionally, designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information. Designers will also need to refer to **Chapter 16** for ITS device naming guidelines.

Figure 12-1: Curve Warning System

Google®, Inc. (2018) *Curve Warning System from Google Street View™*. Available at https://goo.gl/maps/bWz5H8xYXoC2. Accessed July 9th, 2018

12.3 Intersection Collision Warning Systems

In typical rural intersections, the mainline will be free flow while the side streets are stop controlled. When vehicles are moving into the path of high-speed traffic from a stop, the potential for high-speed impacts increases; a way to mitigate this is using intersection collision warning systems (ICWS). ICWS operates by using detectors to identify the presence of vehicles on the mainline. When a vehicle crosses the detector, a flasher will signal drivers on the side streets of the mainline approaching traffic and to proceed with caution. Crash data should be reviewed to determine if detectors should also be installed on the side street and warning signs on the mainline to warn all drivers.

12.3.1 Placement

There are three key components for proper operation of ICWS. The first is detection; the second is warning the side street driver; the last is the equipment to make it all operational. The methods for vehicle detection would be traditional loops and microwave radar. If microwave radar is used, it should be installed so the unit is facing the oncoming traffic it is detecting. Detectors shall be placed up-stream of the intersection, which will allow for the proper amount of time to warn the driver on the side streets so they can make an informed decision to enter the intersection. Warning display signs shall be installed in a location that is in clear view of the driver on the side street and should be a static sign with flasher assemblies that will be activated by the detectors.

12.3.2 Equipment, Enclosure, and Cabling

A small cabinet mounted on the sign structure will control the flashing beacon assembly. As previously mentioned, the flashing beacon installation is considered a lump sum pay item, and therefore includes the pole mounted flashing beacon cabinet. Refer to section 647 of the GDOT specifications regarding what is included in the lump sum pay item. Power and communication will be largely dependent on the location and placement of the system. Power can be supplied by utility or solar. For solar power options, consult the solar power subsection of **Chapter 14** within this document. Communication can either be fiber optic or cellular. For more information regarding communication, consult **Chapter 15** of this document.

Additionally, designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information. Designers will also need to refer to **Chapter 16** for ITS device naming guidelines.

Figure 12-2: Intersection Collision Warning System

Google®, Inc. (2018) *Intersection Collision Warning System from Google Street View*™. Available at https://goo.gl/maps/Dq3iTnPAkV42. Accessed July 9th, 2018

Chapter 13. Connected Vehicle Equipment

13.1 Introduction

Connected Vehicle Roadside Units (RSU) have been identified as a communication medium for vehicles to communicate time critical information to other vehicles and infrastructure for safety and mobility applications. These communications are referred to as vehicle-to-infrastructure (V2I), or vehicle to everything (V2X). Currently, there are two connected vehicle protocols: Dedicated Short-Range Communication (DSRC) and Cellular Vehicle to Everything (C-V2X). RSUs currently operate in the radio frequency from 5.850 to 5.925 GHz range, however the band is being reduced to the 5.895 to 5.925 GHz range. This frequency band is regulated by the Federal Communication Commission and IEEE 802.11 governs the wireless protocol. C-V2X spectrum is governed by the FCC and the wireless protocol governed by 3GPP.

13.2 Placement

Whenever an RSU is going to be impacted by an ITS project, GDOT or the agency owning the RSU should be notified early in the design process and the removal and resetting of the radio should be noted in the design.

It is advantageous to utilize the existing traffic signal infrastructure for intersection placement of DSRC or C-V2X. The decision of which pole to use should be based on the following information. Poles that will provide the greatest line-of-sight for all intersection approaches are the most advantageous. Priority should be given to the major or highest speed approach. Second, designers should aim to limit potential electromagnetic interference (EMI) by selecting a pole with limited utility attachments. Additionally, the height of the RSU should maximize line-of-sight, limit EMI, and avoid attachment conflicts with other devices.

For freeway placement of DSRC or C-V2X, it is best to install on existing ITS infrastructure. DSRC has a standard operating range of 300 meters but real-world applications may provide longer operating ranges based on terrain, line-of-sight, antenna power, mount height, and many other factors. C-V2X leverages short- and long-range communications so operating distance is not a factor. If a DSRC radio is placed with the intent of a specific application, ensure the radio has coverage of the entire area surrounding the point of interest plus the distance for driver reaction.

For placement guidelines refer to GDOT's *CV Guidance Document.*

13.3 Enclosure, Equipment, and Cabling

RSUs are environmentally hardened and should be mounted on an existing signal or ITS pole. Existing cabinets will be used to store the surge protection equipment, CAT6 cables, POE injector, and any additional processing equipment needed. Additionally, the RSU needs to be patched into the GDOT network whether that be via fiber optic cable, radio backhaul, or 4G wireless system.

Additionally, designers will need to include the Network Equipment Configuration and Integration pay item in all designs that tie an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information. Designers will also need to refer to **Chapter 16** for ITS device naming guidelines.

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Chapter 14. Power

14.1 Introduction

This section briefly describes electrical power considerations that the designer needs to account for throughout the design process. The following pay items should be used for power installations:

682-6236 **Conduit, Nonmetal, Type 2 – Power Service, 2 Inch**

682-8500 **Electrical Power Service Assembly (Aerial Service Point)**

682-8525 **Electrical Power Service Assembly (Underground Service Point)**

939-420X **Solar Power System, Type ___**

14.2 Placement

Designers should first contact the GDOT ITS group to inquire about existing ITS power service points near the project area. If there are no existing power service points near a device site, then a designer should look for a power source nearest the project location for a new power service point. For example, if the project location is near an interchange, the designer may want to see if there is overhead power or underground power servicing the traffic signals at the entrance ramps. If there are overhead power lines, the designer should look for transformers from which the power companies can draw power. When overhead power lines are not visible it is possible that there is power underground. Whichever power service type is available, whether aerial or underground, should be called out on the plans as well as power service conduit to the device cabinet. Power service conduit simply connects the power service point to the device cabinet. Although there is not a defined maximum distance for power service conduit, designers should aim to keep the distance under 3,000 feet. Currently, the designer of ITS projects is not required to do any calculations for power installations, unless otherwise stated in project specific contract documents.

If an obvious power source cannot be determined, designers should coordinate with power companies that have existing service near the project location. Coordination of power service locations should start early in the design process so, if necessary, device locations can be repositioned to get the needed power service. The designer is responsible for placing the power service locations where they will interface with the ITS project. This can be achieved through the first utility submission to power companies with a request for power service location. At this stage, the plans should show all proposed devices and their locations.

Following the plan submittal, the power company will either return a set of mark ups showing their transformer locations or request a field visit with the designer to discuss each location and power conduit path. Once this information is provided, the designer should show power service locations and power conduit paths on the plans and send back for approval from the power company. Each device shall have power conduit provided to the cabinet on the plans as well. The designer should consider the placement of power conduit based upon environmentally sensitive areas, ROW, drainage structures, and railroads; all of which should be avoided. Additionally, conduit should be installed as close to the back of the ROW as feasible. This will allow protection from shoulder maintenance, future widening projects, and guardrail installations. In the event an existing service point is located just outside of existing ROW, designers should propose installing a new service within the existing ROW or propose procuring additional ROW. If power or fiber conduit must be placed under, over, or within a railroad property, the designer needs to complete and submit a railroad checklist to GDOT's railroad office. The current railroad checklist can be accessed online at:

http://www.dot.ga.gov/PartnerSmart/utilities/Documents/Railroad/RailroadPlanSubmittalChecklist.pdf#search=railroad%20checklist.

14.3 Grounding

Currently, the designer of ITS projects is not required to do any calculations or calling out for grounding to be installed, unless otherwise stated in project specific contract documents. The installation of proper grounding materials and testing is covered within GDOT specifications and details for the associated structures.

14.4 Solar Power

In locations where providing electrical service is not feasible, the use of alternate power solutions, such as solar power, should be considered. **Table 14-1** illustrates the types of solar power that can be used.

Solar Power Type	Power Capacity
Type 1	350W
Type 2	800W

Table 14-1 – Solar Power Types

Because of the high-power consumption for DMS devices, it is not recommended to utilize solar power for DMS installations. However, solar power can be used to support ITS devices like CCTV cameras and environmental sensor stations that do not consume a significant amount of power. Designers should note that all solar power installations require a Type 2 Field Cabinet regardless of the device type. This is to ensure the field cabinet is large enough to house the ITS device equipment and the batteries for the solar power system.

Placement of the solar power installation should be away from heavy foliage to avoid shade produced from adjacent tree lines. Solar power inherently relies on the sun's rays being able to reach the solar panels to produce energy. Thus, its placement away from potential shade is paramount.

The designer should ensure all other installation options have been pursued with placement of the device. Solar power is not a commonly used option on ITS projects; therefore, the designer should consult the GDOT Project Manager or ITS Manager about its use.

14.5 Conclusion and Key Points

When designing power service locations and conduit paths on a project, the following should be remembered:

- Coordinate with the GDOT ITS group to inquire about existing ITS power service points near the project
- Designers should aim to keep to power service conduit length under 3000 feet
- Coordinate with power companies in the early stages of the project
- Multiple devices can be serviced from one power service
- Power service conduit shall be shown on plans to all device cabinets
- Ensure conduit is avoiding ditches, environmentally sensitive areas, drainage, and railroads
- To identify aerial power, look for transformers in the project area
- To identify solar power on the plans, call-out a Solar Power System, Type _
- Solar power systems require a Type 2 Field Cabinet

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Chapter 15. Communication

15.1 Introduction

There are numerous communication methods. This chapter discusses various mediums to enable the designer to provide enough information to accurately design the communication network for any project. The mediums discussed in this document are fiber optics, radio, and cellular. Network topologies, field cabinets, and hubs are also discussed in the chapter. Designers should note to coordinate with the GDOT ITS group or the maintaining agency when designing the communication network or when adding devices to an existing network. Consequently, designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information.

15.2 Mediums

15.2.1 Fiber Optics

15.2.1.1 Introduction

Fiber optic cable uses glass or plastic strung into thin cables for transmittal of data using pulses of light to transmit machine language between devices. Underground fiber optic cable should be installed in conduit throughout the project while aerial fiber installations are lashed to steel strand wire. The fiber optic network is known as the “trunk line” or “back bone” of the network. Designers should contact the GDOT ITS group to obtain the latest NexusWorx information, before starting any fiber optic design.

Refer to sections 935 and 939 of the GDOT specifications for legacy communication pay items. The legacy pay items shall be used only when required and approved by the GDOT ITS group.

The following are pay items that should be used for fiber optic installations:

935-111X OSP Fiber Optic, Loose Tube, Single Mode, ___ Fiber (trunk and drop)

942-1000 Network Equipment Configuration and Integration

Additional pay items needed to complete the fiber optic design may include:

639-2001 Steel Wire Strand Cable, 1/4 Inch

682-XXXX Pull Box, Type 6

682-XXXX Pull Box, Type 7

682-XXXX Conduit, Nonmetal, Type 2, 2 Inch

682-XXXX Conduit, Nonmetal, Type 3, 2 Inch

682-XXXX Conduit, Fiberglass, 2 Inch

682-XXXX Conduit, Fiberglass, 4 Inch

682-XXXX Conduit, Duct Bank, Type 3

682-XXXX Electrical Communications Box, Type 5

682-XXXX Directional Bore, ___ Inch

935-4010 Fiber Optic Splice, Fusion

935-410X **Fiber Optic Closure, Underground, ___ Splice**

935-420X **Fiber Optic Closure, Aerial, ___ Splice**

935-440X **Fiber Patch Panel, Rack Mount, ___ Port**

935-440X **Fiber Distribution Unit, Rack Mount, ___ Port**

935-450X **Fiber Patch Panel, Wall Mount, ___ Port**

935-450X **Fiber Distribution Unit, Wall Mount, ___ Port**

939-23XX **Field Switch, Type ___**

939-239X **SFP Fiber Module, Type ___**

939-240X **Routing Switch, Hub, Type ___**

939-41XX **Field Cabinet, Type ___**

15.2.1.2 Fiber Optic Design Considerations

15.2.1.2.1 Fiber Optic Cable

To determine which size loose tube fiber to install for the trunk line on a project, reference **Table 15-1.** When designing a project for a local agency on a local road, coordinate with the agency on the fiber strand count they need. The fiber strand count may vary between agencies and even roadways throughout their areas. If the project is in an area where there is existing fiber that will need to be replaced, coordinate with GDOT to determine if the existing cable needs to be replaced in kind. For example, there is existing 288 fiber on some GDOT interstates that, if replaced, would be better in the form of 2-144 fiber optic cables. The designer should always have the maintaining agency sign off on the proposed fiber strand count.

Trunk Fiber Size	Urban Interstate (GDOT)	Rural Interstate (GDOT)	Arterial (GDOT)
72			X
96		X	X
144	X		

Table 15-1 – Trunk Line Fiber Size for Roadway Type

Drop cables connect device cabinets to the fiber optic trunk line. This allows the device's data to be transmitted through the fiber optic network back to a hub or the TMC. Typically, 12-fiber drop cables are used for ITS and traffic signal applications. **Table 15-2** illustrates common applications of the 12-fiber drop cable.

Drop Cable Size	Application
12-fiber	• Ramp meters • Traffic signal locations • All other device locations (CCTV, ESS, etc)

Table 15-2 – Drop Fiber Size for Device Type

Once the fiber size is determined for the project, the GDOT cable identifier should be requested. The designer shall request the cable name from the maintaining agency or GDOT. Once the cable name is received, the designer should add the complete cable ID to all fiber callouts on the plans. Refer to **Chapter 16** for more information on naming schemes.

15.2.1.2.2 Conduit Types

Fiber optic cable is installed in conduit to protect it from damage since it is the essential piece of the network. There are three types of conduit commonly used by GDOT: non-metal Type 2, non-metal Type 3, and fiberglass conduit. Their uses are illustrated in **Table 15-3**. Designers should note that a pull box or ECB is needed to transition between different conduit types.

Conduit Type	Application
Conduit, non-metal, Type 2, 2 inch (PVC)	• Conduit runs < 20 feet
Conduit, non-metal, Type 3, 2 inch (HDPE)	• Conduit runs > 20 feet • For all directional bores
Conduit, fiberglass	• For bridge attachment

Table 15-3 – Types of Conduit

15.2.1.2.3 Determining Conduit Counts

Typically, two or three 2-inch conduits or conduit duct bank, Type 3 should be installed on GDOT projects. Conduit duct bank, Type 3 is comprised of four 2-inch conduits and is used for fiber optic trunk lines on the interstate. Refer to GDOT detail ITS-07 for more information regarding conduit duct bank installation. Individual runs of conduit are used on arterials, along entrance ramps, and to house fiber optic drop cable.

To determine the number of conduits the project will require, the designer will need to determine how many fiber optic cables can be installed in one conduit. The nominal inside diameter of 2-inch conduit is 2.067 inches, which equates to 3.36 square inches. The designer should use **Table 15-4** to determine how many fiber optic cables can be installed in one conduit. Due to constructability, no more than three cables should be pulled through one conduit even if there is remaining room in the conduit. Once the decision on how many conduits are required to house the fiber optic cable, an additional conduit should be included for all runs of conduit. These additional conduit runs serve as spares and are commonly installed to provide for future expansion and to allow for easier maintenance.

Fiber Count	Estimated Cable Diameter (Inches)	Cross-Sectional Area (Sq. Inches)
12 to 60	0.52	0.21
72	0.54	0.23
96	0.64	0.32
144	0.76	0.45
288	0.91	0.65

Table 15-4 – Fiber Count to Cable Diameter

15.2.1.2.4 Conduit Installation

There are two methods of underground installation for conduit non-metal Type 2 and Type 3. **Table 15-5** describes the limitations for the two methods.

Type of Conduit Installation	Limitations
Trench	• For use with nonmetal Type 2 or 3 • Must follow topology of road • Use when there are extensive underground utilities
Bore	• For use with nonmetal Type 3 only • Requires 12x12 foot area to set up boring rig, and equivalent area for the receiving pit • Use when conduit is run in the paved shoulder, under ramps, or under travel lanes • Use when ROW is limited and conduit cannot follow topology of roadway

Table 15-5 – Conduit Installation Methods

When conduit is being trenched, the length and number of conduits should be called out on the plans. Bored conduit, however, requires a callout with the size and length of the directional bore, in addition to the length and number of conduits. Bore sizes are determined by the number of conduits that will need to fit inside and are in increments of odd inches. For example, one run of Type 3, 2-inch conduit would require a 3-inch bore, whereas, three runs of Type 3, 2-inch would require a 7-inch bore. Designers should remember that the nominal outer diameter of 2-inch conduit is 2.375

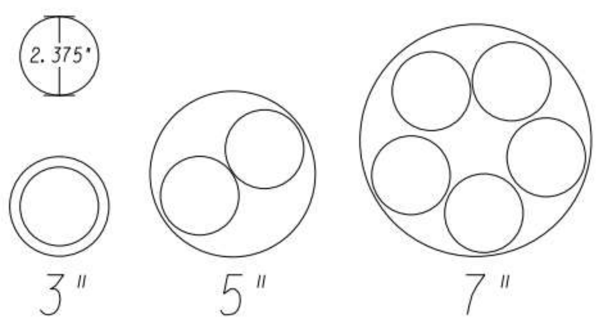


Figure 15-1: Number of Conduits per Bore Size

inches when considering what bore size is adequate. **Figure 15-1** illustrates how many 2-inch conduits can fit in different bore sizes.

Conduit should be installed as close to the back of the ROW as feasible. This will allow protection from shoulder maintenance, future widening projects, and guardrail installations. However, conduit should be installed in front of noise barriers, where possible, so that the conduit and corresponding pull boxes are more accessible from the roadway. This is helpful for maintenance purposes; it also allows for easier construction of future ITS devices along the trunk line. When considering conduit placement, the most favorable place for conduit installation is in the unpaved shoulder, and in front of noise barriers. If that cannot be achieved, designers should next consider conduit placement in the paved shoulder through the use of ECB's and boring. The least favorable option is to place conduit behind noise barriers as this requires additional coordination to ensure access doors are included in the noise barrier design. Coordinate with the GDOT ITS group if a project requires conduit placement behind noise barriers.

15.2.1.2.5 Underground Closures

Underground fiber optic closures shall be sized based on the size of the trunk cable. For example, if the project is installing a 144-fiber optic cable, then all splices to that cable shall be done in a "F/O splice closure, underground, 144 splice." Underground splice closures are housed inside Type 7 pull boxes or Type 5 electrical communication boxes. Additional cable length shall be included in the pull box for maintenance purposes as illustrated in **section 15.2.1.2.6.**

In addition to device locations, splice closures will need to be installed at reel-to-reel locations. Fiber optic cable comes in reels that are typically in lengths of 15,000 linear feet. At locations along the project where a reel will end, which includes the maintenance slack in all pull boxes, a reel-to-reel splice will occur. The designer should place a Type 7 pull box and a splice closure sized to the trunk cable fiber count. If at all possible, a reel-to-reel splice should be co-located with a device splice location.

15.2.1.2.6 Pull Boxes

Pull boxes shall be placed 1,000 to 1,500 feet apart along a consistent run of conduit, at each closure location for devices, the begin and end of each directional bore, and at reel-to-reel splice locations. Pull boxes are not traffic-rated and shall only be installed in unpaved shoulders. For locations where conduit is being installed in the paved shoulder, the designer shall call out an ECB, Type 5. ECBs are traffic-rated and should only be used in the paved shoulder due to costs. Refer to detail "Electrical Communication Box Type 5" ITS-02 for more information. **Table 15-6** shows the GDOT-approved pull boxes for fiber optic cable installations and their dimensions.

Pull Box Type	Length (Inches)	Width (Inches)	Height (Depth) (Inches)
Type 4	36	24	36
Type 4s	36	24	18
Type 5	48	30	36
Type 5s	48	30	18
Type 6	36	24	36
Type 7	48	30	36

Table 15-6 – Pull Box Sizes

These dimensions are based upon the traffic signal detail "Pull Box Assembly and Installation" TS-02. The designer should consult the latest version of this detail to confirm pull box types and sizes. The most commonly used pull boxes for interstate applications are Types 4s, 6, and 7. The Type 4s pull box is used near the cabinet, at the base of all ITS device poles, and for storage of drop cable. Type 4s pull box locations should be placed as close as possible to the cabinet that the drop is supporting and directly behind the Type 7 pull box. In some cases, the use of more than one drop pull box will be necessary to provide constructible conduit runs, and the designer should ensure all are labeled. Type 6 pull boxes should be used in locations for maintenance coils of the trunk line and without closures. Type 7 pull boxes should be used at locations with closures.

Each pull box and ECB will have fiber stored in it for maintenance purposes. The designer should call out the amount of stored trunk fiber or drop fiber that is required in each box. Storage requirements are detailed in section 935 of the GDOT specifications as follows:

Underground Storage Length Requirements:

1. Drop cable with no splice closure: 10 feet
2. One or more trunk cables with no splice closures: 110 feet of each cable
3. One trunk cable with one splice closure: 110 feet of trunk cable and 55 feet of drop cable
4. Two or more trunk cables with one splice closure: Store 55 feet of each trunk cable and 55 feet of each drop cable
5. One trunk cable with one splice closure and trunk cable ends: 95 feet of trunk cable and 55 feet of drop cable
6. Trunk cable ends with no closure: 95 feet
7. At a hub building location, 180 feet should be called out in the ECB
8. At TMC, transportation control center, or similar buildings, 180 feet should be called out

15.2.1.3 Aerial Fiber Optic Design Considerations

15.2.1.3.1 Aerial Fiber Optic Cable

Aerial fiber optic cable is lashed to steel strand wire and attached on utility poles. Installing fiber aerially requires coordination with utility companies to ensure there is room to install the fiber and provide the required utility clearances per the National Electrical Code®. The designer should start the coordination at the beginning of the project when the determination to install aerial fiber is made. With aerial fiber optic cabling, the entire cable is exposed to the elements and, therefore, is more vulnerable for degradation and damage causing communication losses. Thus, it is recommended that aerial fiber optics only be used in urban locations where boring or trenching is not an option and/or where boring or trenching is not economically feasible. Additionally, designers should note that steel strand wire will need to be included as a separate pay item for aerial fiber installations.

Aerial Storage Length Requirements:

1. A minimum of 150 feet of trunk cable slack halfway between devices
2. A minimum of 150 feet in locations where devices are greater than 1,000 feet apart
3. A minimum of 150 feet of trunk cable and 75 feet of drop cable at trunk cable to drop cable splice closures

A snowshoe, shown in **Figure 15-2**, allows aerial installation of fiber optic cable slack while maintaining the minimum bend radius of the cable. Snowshoes, however, are considered incidental to the cost of the loose tube fiber optic cable. Two fiber optic snowshoes together create a “figure eight or bow tie” configuration used for slack storage. Alternatively, splice locations only require one snowshoe.

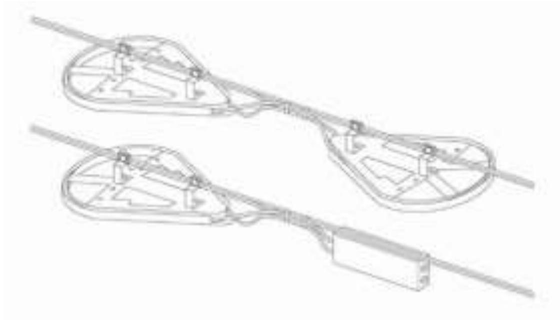


Figure 15-2: Aerial Snowshoe

15.2.1.3.2 Aerial Closures

Aerial splice closures should be specified for the largest number of splices that can occur at that point, which should be the size of the trunk cable. In addition to device locations, splice closures will need to be installed at reel-to-reel locations. Fiber optic cable comes in reels that are typically in lengths of 15,000 linear feet. At locations along the project where a reel will end, which includes the slack in all snowshoes, a reel-to-reel splice will occur. The designer should place an aerial closure and snowshoe sized to the trunk cable fiber count. If at all possible, a reel-to-reel splice should be co-located with a device splice location.

15.2.1.4 Splicing

Fusion splices are how the fiber optic cables are connected – the drop cable to trunk cable or one trunk cable reel to another. The following are the typical splices required per situation.

- Reel-to-reel – the number of splices will match the size of the trunk cable
- Ramp meters, traffic signals, and device locations with 12-fiber drop cable – 8 splices provide primary and redundant paths in each direction

The number of splices needed at each closure location listed above will need to be called out on the plans. Additionally, a fiber allocation table will be required to illustrate the splicing details on a project. Refer to **Chapter 16** for naming guidelines to be used in a fiber allocation table, and reference **Appendix D** for an example fiber allocation table.

15.2.1.5 Field Switch

Fiber optic networks require field switches in device cabinets to transmit data. There are two types of field switches, Layer 2 and Layer 3. Layer 2 switches are installed in all field cabinets, while Layer 3 switches are installed in hub cabinets, hub buildings, and TMCs.

Table 15-7 introduces each switch type currently supported by GDOT, including the type of switch, the level of logical operation (the OSI layer), and the interfaces or cables that can be plugged into the switch.

Network Switch Type	OSI Layer	Interfaces
TYPE A	Layer 2	Two Gigabit -Ethernet SFP ports Six 10/100 Mbps ports
TYPE B	Layer 2	Three Gigabit-Ethernet SFP ports Six 10/100 Mbps ports
TYPE C	Layer 2	Seven Gigabit-Ethernet SFP ports One 10/100 Mbps port
TYPE D	Layer 2 or Layer 3 upgradeable	Four dual purpose ports for 10/100/1000 Mbps port or 100/1000 Mbps SFP modules Four 10/100/1000 Mbps ports
TYPE E	Layer 2 or Layer 3 upgradeable	Four dual purpose ports for 10/100/1000 Mbps port or 100/1000 Mbps SFP modules Eight 10/100/1000 Mbps ports
TYPE A (HUB ONLY)	Layer 3	48 1/10/25 Gbps SFP ports Six 40/100 Gbps QSFP28 ports
TYPE B (HUB ONLY)	Layer 3	48 10/100/1000 Mbps ports Four 1 Gbps SFP ports

Table 15-7 – Network Switches

Currently, there are a variety of different types of SFPs. **Table 15-8** provides a list of SFP categories and data transmitting distances. SX will only be used when maintaining legacy systems.

GDOT Pay Item	Category Name	Wavelength	Distance*
N/A	SX	Multimode	550m
SFP, Fiber Module, Type 1	LX/LH	Single Mode, 1310 nm	10 kilometers
SFP, Fiber Module, Type 2	ZX	Single Mode, 1550 nm	70 kilometers

Table 15-8 – SFP Categories and Data Transmitting Distances

**Distances are based off ideal conditions.*

Out of the seven switches shown in **Table 15-7**, the most commonly used are Types A and B in field cabinets, and Type A (Hub Only), Layer 3 switch in hubs only.

The Type A network switch provides two SFP ports and six Ethernet ports. The Ethernet ports on the switch are for devices, such as CCTV cameras, DMS controllers, microwave radar systems, IVDS, and/or any other devices that need communication from a remote location. With the Type A switch, the number of devices must be less than or equal to six devices at that one cabinet location. The Type A switch can only support two SFP modules, meaning that the Type A switch can be wired (via the SFPs) to a maximum of two other network switches. The type of SFP modules that are used with the Type A field switch are determined by the distance to the network switch.

The Type B network switch provides three SFP ports and six Ethernet ports. Similar to the Type A switch, the Ethernet ports are available for device connections with the key difference being the number of available SFP ports. Type B switches should be installed in device cabinets that require three SFP ports. The three SFP ports are traditionally used for two SFP Fiber Modules, Type 1 and one SFP Fiber Module, Type 2. Two SFP ports will be occupied to make the ring and the third used to connect those to the rest of the network. Type A and Type B switches are connected to a Layer 3 switch located in a nearby hub building through the SFP Fiber Modules, which connects them to the overall network.

The Type C switch still falls in the first category of switches. The major difference of the Type C switch is that it has the largest amount of available SFP ports. The switch can support the same number of Ethernet ports; therefore, it can also be used to support local devices. However, with seven SFP ports it can be used to aggregate six sub-rings to connect to the network. This is similar to the Type B switch; however, Type C takes it further by its ability to support numerous sub-rings. With this configuration, there is a major point of failure within the network if the Type C switch is the only aggregation point of multiple sub-rings. For situations like this, it is recommended to have two geographically different locations where sub-rings can aggregate to the network, providing Layer 2 network redundancy in case one of the Type C switches fails.

Types A and B (hub only) are only for use within a hub building or mini-hub cabinet locations. The layer functionality of the hub switches is for combining all the Layer 2 rings or other topologies at a central location. The difference between the Type A and B (hub only) switch is the bandwidth. Type A (hub only) will support substantially higher bandwidths with links operating at 1, 10, and 25 Gbps and with special QSFPs designed to aggregate substantially large amounts of data supporting up to 100 Gbps. With the ability to transmit such large amounts of data, this switch should be in locations of large metro areas where major fiber networks are at intersecting or ending points. For comparison, the Type B (hub only) switch supports a maximum of a 1 Gigabit per second link, the minimum supported link of the Type A switch. Due to the limited bandwidth of the Type B (hub only) switch, it should only be considered when interfacing with legacy equipment on a project. With the ever-expanding demand for bandwidth, the use of the higher capacity Type A (hub only) switch should be the preferred switch in most hub applications. Types A and B (hub-only) switches should only be included in a project in coordination with GDOT IT or the local agency network administrator.

15.2.1.6 Fiber Patch Panel/Fiber Distribution Unit

FPP/FDUs are rack- or wall-mounted devices that provide an interface location where fiber can be distributed to various other devices. **Table 15-9** provides more information on when to use a FPP or FDU. FPPs are used to terminate drop cables onto a patch panel. Fiber jumpers are then used to connect the patch panel and the field switch. Within a hub, mini-hub, or TMC, FDUs are used to provide connection onto other fiber optic cables, network switches and/or routers, and devices inside the respective facilities.

Device	Number of Ports	Typical Application
FPP	6 - 36	• Trunk Lines ≤ 36 Fiber • Field Cabinets with 6 or 12 Fiber Drop Cables
FDU	48 - 288	• Trunk Lines ≥ 48 Fiber • Hub, Mini-hub, or TMC

Table 15-9 – Differentiating between FPP and FDU

The FPP/FDU size is determined by the amount of fibers in the fiber optic cable in which it is terminating. For example, if there is 144-fiber optic cable, a 144-port FDU must be provided. If there is 12-fiber optic drop cable, a 12-port FPP must be provided. Wall-mounted FPP/FDUs are installed in field cabinets and rack-mounted FPP/FDUs are installed in mini-hubs or hub buildings. Examples of the interconnections with FDUs and FPPs are provided below.

12 Fiber Drop Cable → FPP → Field Switch (Used within Device Field Cabinet)

96 Fiber Optic Trunk Line → FDU → Field Switch (Used within Hub/Mini-Hub/TMC)

15.2.2 Radio

15.2.2.1 Introduction

Wireless radios are a versatile communication method that provides relatively reliable communication without the cost of installing conduit and cabling. Radios are the less preferred communication option due to their bandwidth limitation and reliability. However, as a substitute based on cost, environmental factors, and/or location limitations, wireless communication can provide quality communications. Radios differ from cellular routers in that wireless radios must communicate to another wireless radio that has access to the rest of the network, whereas cellular does not. **Table 15-10** indicates the three available wireless radios. Designers should coordinate with the GDOT ITS group to verify the communication medium used on a project.

Radio Type	Frequency	Bandwidth
Type 1	900 MHz, 2.4 GHz, or 5 GHz	10 Mbps
Type 2	2.4 or 5 GHz	50 Mbps
Type 3	2.4 or 5 GHz	100 Mbps

Table 15-10 – Wireless Radio Characteristics

The following are pay items that should be used for radio installations:

926-2101 Wireless System, Type 1

926-2102 Wireless System, Type 2

926-2103 Wireless System, Type 3

926-2220 Wireless System Survey

942-1000 Network Equipment Configuration and Integration

15.2.2.2 Types

There is currently one model of 900MHz radio system. The Type 1 radio is not inherently a directional radio because radio frequency is broadcast in all directions; however, the limitations of radio technology limits the link of the radio to be a point-to-point radio. The 900MHz radio used for GDOT projects provides a bandwidth of 10 Mbps.

The Type 2 and Type 3 radios operate in the same frequency band and offer much more bandwidth than the 900 MHz radio. Therefore, they are more acceptable to be used as omni-directional radios. The bandwidth is larger; therefore, more devices can be run on these radios and multiple devices can connect to one radio for backhauling on another communication medium.

In general, a Type 2 radio is appropriate for point-to-point and potentially point-to-multipoint data transmission. The bandwidth can be a limiting factor based upon the 50 Mbps for augmenting multiple radios to one. The Type 2 radio should be used when the limitations of the 900 MHz radio cannot be met.

A Type 3 radio is appropriate for a trunk or backhauling device where multiple cabinets and devices in the area are augmented together at a single location. The Type 3 radio would then transmit all the data to another cabinet via a wireless connection. The cabinet receiving the trunk data may be connected to another Type 3 radio or to fiber optic cable. The preferred option would be to design the radios so the Type 3 radio would communicate to a cabinet that is tied to fiber optic cable; therefore, the data would be transferred via fiber to the TMC.

All radios require a line-of-sight wireless radio survey, which can be completed during the construction stage to confirm radio installation locations.

15.2.2.3 Design Considerations

When installing wireless radios on a project, the designer must ensure line-of-sight between radios. A line-of-sight survey can be completed during the construction stage to confirm radio installation locations. Line-of-sight means the two radio antennas must be in relative view of each other, meaning that there cannot be extensive foliage, building, structures, mountains, and/or terrain between the two radio antennas. The designer must consider the full wireless path including the possible attenuation in the Fresnel zone when designing wireless radios. It is not preferred, but a 900 MHz radio can be used to operate as a repeater in locations where environmental factors do not provide line-of-sight.

15.2.2.4 15Equipment/Cabling

Various equipment may be used to make the 900MHz and 2.4/5 GHz radio operational. That equipment includes, but is not limited to, the radio antenna, cabling, and power/data injection equipment. In general, the radio antenna should be mounted on a pole to provide clearance above low-level obstructions. The antenna receives and sends data to and from the radio via Cat 6 cables or coax cables. The data and power are provided to the antenna over the category cable using POE and a POE injector. Therefore, based upon the category cabling used, the cabling distance the antenna can be from the injector within the field cabinet cannot be greater than 328 feet, including slack.

The POE injector will fit into any ITS cabinet provided for the ITS device. Therefore, the POE injector will not be a limiting factor to the sizing of the cabinet.

From a device interconnection point, with the associated bandwidth limitation, the least number of devices should be used. However, a networking switch can be specified to interconnect to the radio antenna to provide more network interconnections for devices.

15.2.3 Cellular (4G Router)

15.2.3.1 Introduction

Cellular radio communication is one of the most prolific communication mediums of the 21st century. The ITS world, particularly GDOT, has adopted it as a viable communication medium. Present day cellular communication allows for large data transmission and has an extremely large percentage of the geographic United States covered. The following are pay items that should be used for 4G cellular radio installations:

926-2104 Wireless System, Type 4

942-1000 Network Equipment Configuration and Integration

15.2.3.2 Equipment/ Cabling

The Wireless System, Type 4 is a cellular radio, similar to the radio of a modern cellphone. The key difference of the two is the amount of power put through the antennas. Type 4 radios can achieve a much higher power and, therefore, provide signal capabilities that a cellphone may not.

Antenna cabling and connection is achieved in one of two ways: Cat. 6 cables or a coaxial cable. Usually radio antennas are mounted on top of the cabinet and run into the cabinet with a coaxial cable. Cat 6 cables are used to connect the cabinet and the devices.

In instances where more devices are needed to connect than cellular equipment can achieve, the designer should specify a network switch. This instance is where there are more than four devices that need to operate over cellular.

15.2.3.3 Limitations

Cellular radio has three main limitations. The first is avoidable and is locating the radio antenna within the limitation of the cabling. The second is that cellular radio is not as reliable because of intermittent communication loss and speed issues. Lastly, is the presence of cellular coverage. In most cases, cellular coverage will be present, but should be considered when deciding on a communication medium.

15.2.3.4 Monthly Fee

GDOT has a monthly fee for cellular radios and the acceptability of including more cellular routers into the existing infrastructure should be discussed with GDOT.

15.3 Networks

15.3.1 Topologies

There are several ways of interconnecting networking devices to create a network topology. Each topology has pros and cons, and all topologies should be considered when designing a communication network. The discussed topologies and diagrams show network devices in a series in relation to each other, but the devices can be geographically located not in a series. In addition, these topologies can all be used together where conditions permit. This document discusses three topologies with the most preferred topology being the physical ring. The decision for the type of topology used should be based on a few factors. The designer should ask themselves, the project manager, and/or the agency:

1. What does the maintaining agency or project scope desire in this ITS project?
2. What are the intentions of the devices within the project?
3. What topologies are in the surrounding area?
4. What is the level of redundancy needed at this location?
5. Is it extremely cost prohibitive to provide a certain topology?

These are questions the designer should ask themselves and, when necessary, discuss with the project manager or maintaining agency. The first and second questions may detail the communication requirements for the project. The third question tells the designer the surrounding topology and, when economically feasible, should match the surrounding network topologies. The fourth question relates to the first three questions, the maintaining agency or surrounding area will dictate the level of the communication reliability needed. The fourth question brings the project cost into the design process. When all topologies are economically unfeasible, the designer should consider wireless communication via cellular router, directional radios, and/or omni-directional radios, which are discussed in previous sections.

15.3.1.1 Daisy Chain

The first discussed topology is commonly referred to as a daisy chain topology or sometimes as a series topology. In this topology, all devices are connected by termination of the communication to the first in line, then the next device is wired on the same fiber, and this continues. To better understand this description, see **Figure 15-3,** which shows that each network device is wired in a series with the next one.

Figure 15-3: Daisy Chain Topology

When daisy chaining devices for ITS projects, a maximum of eight field switches should be in one series together on one fiber or connection medium. Daisy chains should also be designed in a leap frogging pattern when feasible. The leap frogging pattern simply means skipping field switches, so there are not 8 geographically sequential field switches on one fiber. This is to prevent losing all CCTV cameras and all device data in an area at the same time. Designers should note that the maximum of eight field switches rule applies to all topologies.

The benefit of this network topology approach is that the amount of cabling required with respect to the other topologies is less, thus reducing the price. However, the major downside of this topology is that if a break occurs somewhere in the connection medium, or if a network device fails, all other devices after that will not be able to communicate. Redundancy is not present in this topology, and thus is it an uncommon option.

15.3.1.2 Folded Ring

The next topology is a simple extension of the above daisy chain topology. This topology is called the “folded ring” topology. This topology keeps the daisy chain topology with the addition of a link from the last network device to the first network device. This link in fiber optic cabling is separated by being on a different pair of fibers but remains within the same cable. **Figure 15-4** is a diagram of a folded ring topology, which shows the “redundant link” being above the network devices with the daisy chain shown below the network devices. That is only to emphasize the redundant link directly from the first device to the last device.

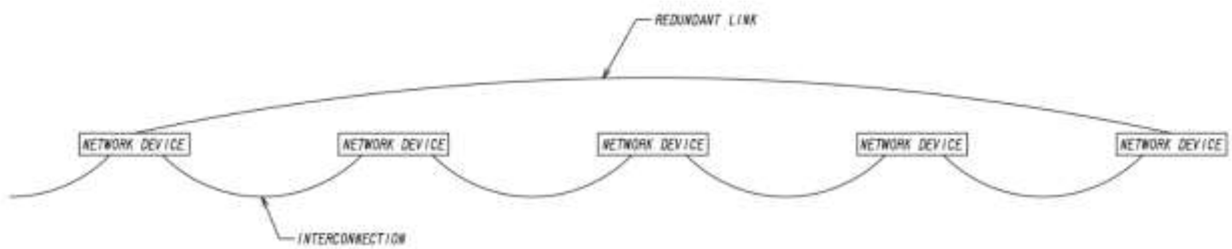


Figure 15-4: Folded Ring Topology

The benefit of this topology is the increased redundancy for communication of these devices. If a device in the series fails, all the devices can still communicate via the redundant link. However, there are two cons with this topology. The first is that if one of the interconnection cables is cut, it is extremely likely that both the daisy chain connection and redundant link will be cut. This is because the redundant link and interconnections are both located in the same cable. Secondly, the redundant link(s) can increase the cabling size needed, increasing the cost.

15.3.1.3 Physical Ring

The last topology discussed in this document is another extension of the daisy chain and folded ring topologies. This topology is called a physical ring. A physical ring operates by having a geographically diverse path for the interconnection. **Figure 15-5** is a diagram of the physical ring topology, which shows the network devices being interconnected in a series with the first and last device being connected.

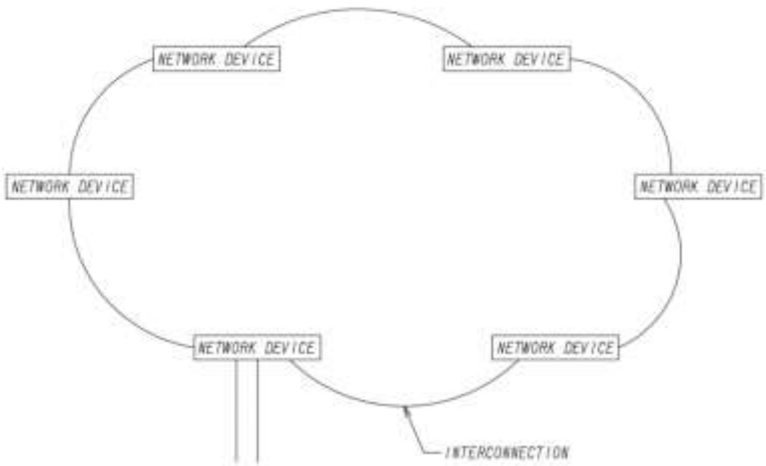


Figure 15-5: Physical Ring Topology

The difference between the folded ring and the physical ring topology is that the connection from the first device to the last device is on a geographically different cable, whereas the folded ring topology utilizes the same cable for the redundant link and interconnections. Physical ring topologies are commonly configured so that fiber is on both sides of the roadway, whereas folded ring topologies are often configured on a single side of the road. As a result, the physical ring is a better method for establishing redundancy. If a cut were to occur, the redundancy established by the geographically different path of the ring would allow for connectivity to remain with the network devices. **Figure 15-6** illustrates the difference between the folded ring and physical ring topologies when there is a cut in the cabling.

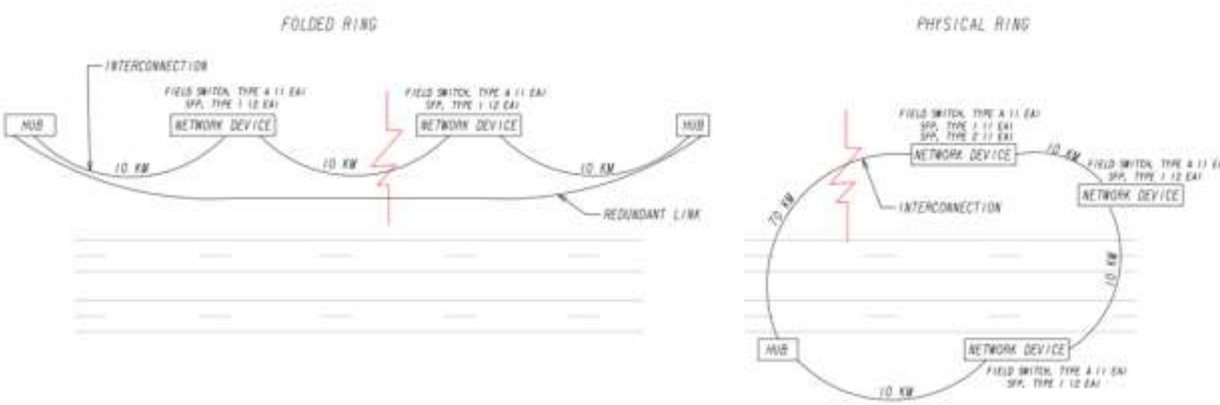


Figure 15-6: Folded Ring vs Physical Ring Topology

Again, the physical ring topology has pros and cons. The pro of this topology is that since the redundant link is on a physically different cable, it lessens the possibility of losing connectivity with network devices. If a break happens in one link, the redundant link should still be operational. The con of this topology is the increased cost, due to the amount of cable required to achieve the redundant link. Despite the increased cost, the redundancy of the physical ring topology makes it the more preferred option.

15.3.2 Rings and Subrings

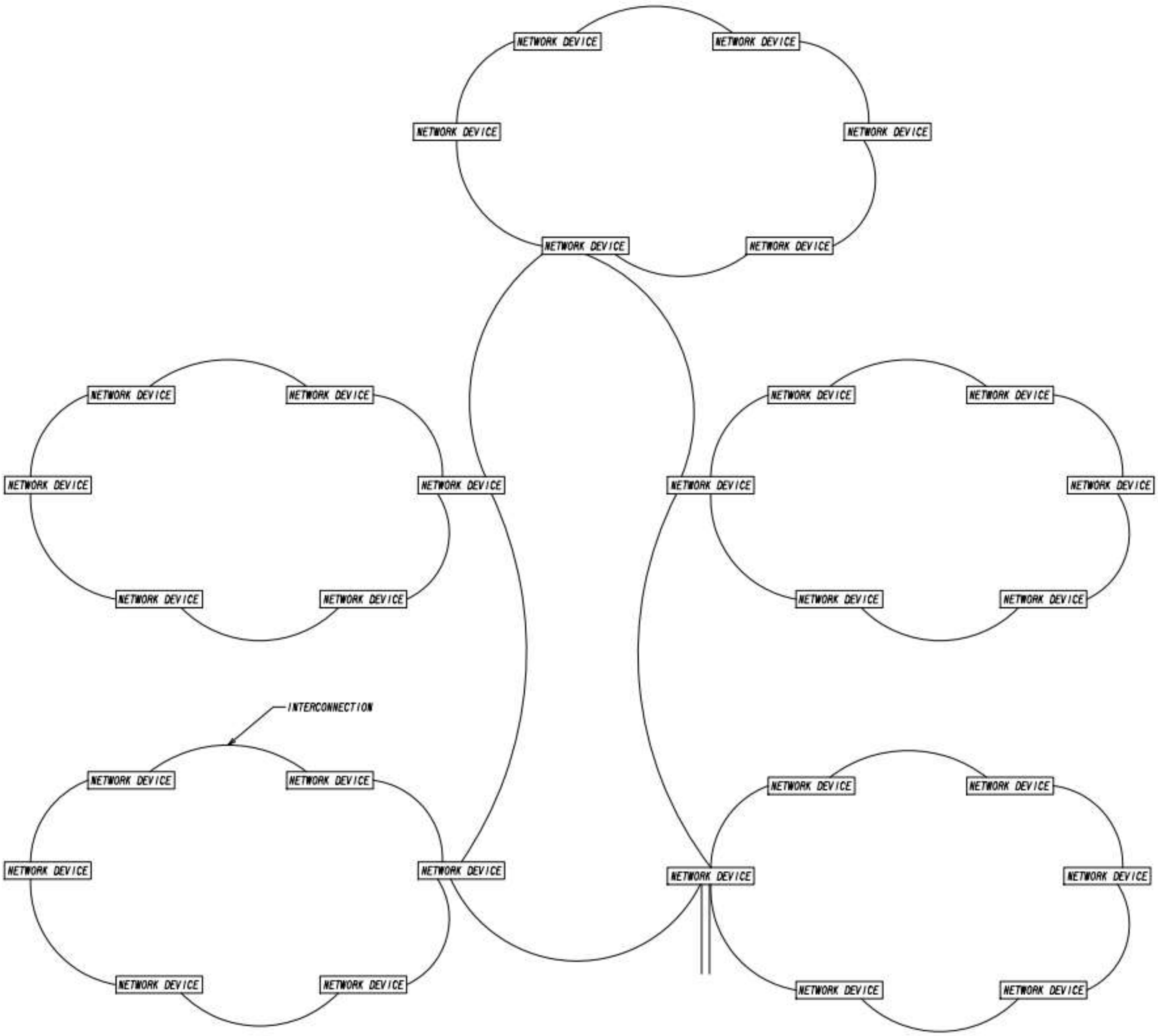


Figure 15-7: Rings and Sub-Rings Topology

Figure 15-7 shows the extension of the previously mentioned rings. With rings, you can create other rings within, called sub-rings. Depending on the direction given by the governing agency, the network could consist of all Layer 2 switches that can communication with each other; the networks can be virtually separated with VLANs running to a Layer 3 switch, or each sub-ring is connected via a Layer 3 switch. All of the options have pros and cons associated with them. The first option of all Layer 2 switches, which can communicate with each other, provides a network that can be choked with high amounts of data traveling to various switches and occupying processing power. The second option, a much better option to handle data, does not allow the network to become so choked up, but presents limitations of traveling through a Layer 3 switch to communicate with another Layer 2 switch. The third option, Layer 3 switches for each sub-ring, is a great option with the largest downfall being that the price of a Layer 3 switch is significantly higher than a Layer 2 switch. The designer should consult with the maintaining agency about their desired network setup for network switch decisions regarding rings and sub-rings.

15.4 Field Cabinets

Field cabinets are installed at each device location and contain all the network equipment, device equipment, power, lighting, grounding, fiber connection, etc. Field cabinets have been previously discussed in this document as it pertains to each device. Error! Reference source not found. details all the types of cabinets, sizes, and doors for comparison. The following are pay items that should be used for field cabinet installations:

939-XXXX Field Cabinet, Type__

GDOT Type	Minimum Dimension Ranges			Number of Doors	Type of Mounting
	Height	Width	Depth		
Type 1	30 to 36 in.	23 to 26 in.	18 to 24 in.	2	Pole-mounted
Type 2	44 to 47 in.	23 to 26 in.	18 to 24 in.	2	Pole-mounted
Type 3	64 to 67 in.	23 to 26 in.	24 to 30 in.	2	Ground-mounted
Type 4	64 to 67 in.	44 to 46 in.	24 to 30 in.	4	Ground-mounted

Table 15-11 – Field Cabinet Characteristics

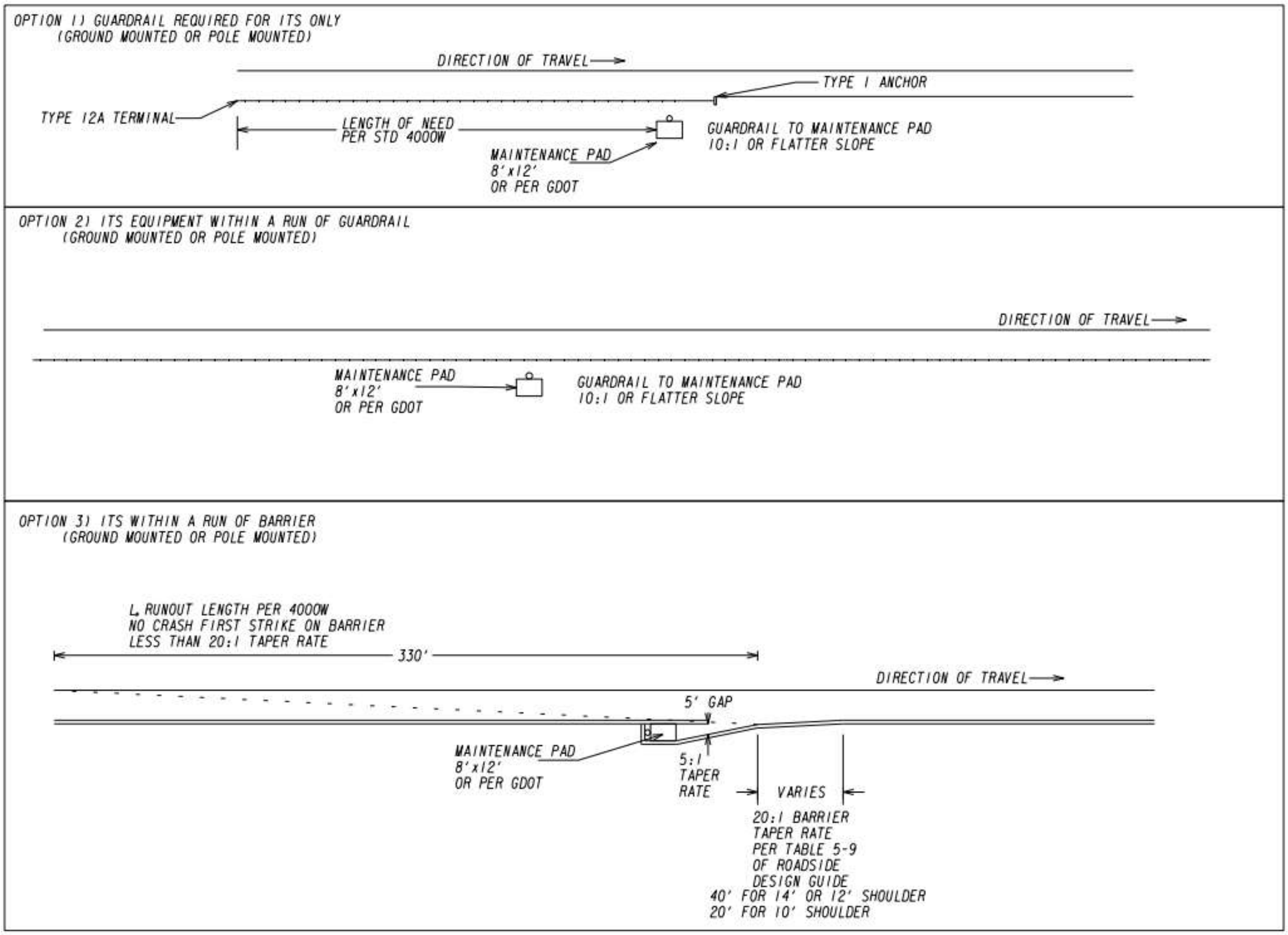
15.4.1 Mini-Hub

There are instances where ITS projects are in places that are not able to tie into a GDOT hub building. Hub buildings can be prohibitively expensive to install. In turn, a good, more cost-effective option is the use of a mini-hub where the functionality of a hub building can be supplied on a smaller scale. The mini-hub is a Type 4 Field Cabinet, with an HVAC cooling unit sized for the British Thermal Unit output of all the equipment. The Type 4 Field Cabinet pay item does not include an HVAC unit, so designers should call out the additional HVAC unit on the plans. Additionally, designers should include a general note that specifies the HVAC component is to be included in the overall bid price, since a designated pay item does not presently exist. Since the Type 4 Field Cabinet should have a HVAC cooling unit, it is acceptable to use a Type A and B (hub only) switch. The use of a mini-hub should be closely coordinated with the maintaining agency, GDOT, and all surrounding projects.

15.4.2 Maintenance Access

Cabinets may also require platforms depending on the slope of the terrain at the cabinet location. If a maintenance technician would have trouble standing on the steep slope to access the cabinet, designers should call for the use of a platform. This holds true for both pole-mounted cabinets as well as ground-mounted cabinets. All cabinets should be carefully examined to ensure they are easily accessible. Refer to GDOT detail ITS-05 for more information.

Additionally, maintenance pads are required on express lane projects. Maintenance pads are very similar to platforms in that they allow for safe access of the cabinet. Every GDOT ITS device cabinet should call for the use of a maintenance pad on express lane projects. **Figure 15-8** provides more information for the use of maintenance pads.



NOTES:
1) CONCRETE BARRIER IS NOT REQUIRED FOR ITS EQUIPMENT.
2) ITS POLE SHALL BE MINIMUM 6' BEHIND GUARDRAIL (FROM FACE OF GUARDRAIL TO FACE OF POLE)
3) 330' RUNOUT LENGTH IS BASED ON A 65 MPH DESIGN SPEED
4) NOISE BARRIER MAY BE MOUNTED DIRECTLY TO BARRIER WHICH IS MORE THAN 4' BEYOND THE 330' RUNOUT DASHED LINE (I.E. 5:1 TAPER AND BARRIER OVERLAP LOCATIONS)

Figure 15-8: Maintenance Pads for GDOT ITS Devices

15.5 Hubs

Hubs aggregate field device data and allow for communication with other hubs and the TMC. Depending on the size and scope of the project, hubs can range from small prefabricated brick buildings down to standard traffic cabinets. It is preferred for hubs to communicate directly to multiple hubs and their respective Layer 3 switches to ensure redundancy within the network. The following are pay items that should be used for hub installations:

797-2XXX **Hub Building, ___**

935-440X **Fiber Distribution Unit, Rack Mount, ___ Port**

935-XXXX **Fiber Patch Panel, Rack Mount, ___ Port**

939-XXXX **Field Switch, Type ___**

939-240X **Routing Switch, Hub, Type ___**

939-3010 **Equipment Rack**

939-XXXX **SFP Fiber Module, Type ___**

939-6040 **Hub UPS**

942-1000 **Network Equipment Configuration and Integration**

The typical outline of equipment needed in a hub is illustrated below:

Fiber Optic Trunk Line → FPP/FDU → Field Switch (Hub/Mini-Hub/TMC)

Upon entering the hub, trunk fiber is connected to the FPP or FDU. An FPP or FDU will be required for each trunk line entering the hub. The number of ports and the decision between FPP and FDU will depend on the fiber count of the trunk fiber. Refer to **15.2.1.6** for more information. FPP/FDUs are then connected to a Layer 3 switch. Designers should consult **15.2.1.5** to determine the appropriate Layer 3 switch, although the most commonly used in hubs is the Type A (Hub Only). Additionally, designers will need to call out SFPs so the Layer 3 switch can communicate with other Layer 3 switches at other hubs. For example, the Type A (Hub Only), switch has 48 slots available, meaning it could, in theory, use 48 SFPs to connect to 48 other Layer 3 switches. As mentioned in **Table 15-8**, the type of SFP modules that are used with the field switch are determined by the distance to that Layer 3 switch.

Designers should also call out a UPS on the plans and include the Network Equipment Configuration and Integration pay item in the cost estimate. The hub building type and number of equipment racks will be project specific, and thus designers should coordinate with the GDOT ITS group.

15.5.1 Hub Redundancy

Figure 15-9 illustrates the concept of redundancy for hubs. Just as a physical ring is the preferred topology for ITS field devices, the same holds true for hub design. Both network devices and hubs form a physical ring allowing for contingency if a switch fails or if there is a cut in the fiber optic cable. However, this is not always achievable due to the scope of the project or because of financial reasons. The preferred hub-to-hub communications are organized from most to least advantageous below:

- Hub Layer 3 switch communicates directly to multiple Layer 3 switches as illustrated in **Figure 15-9**
- Hub Layer 3 switch communicates directly to a single Layer 3 switch on 2 channels using two separate fiber optic cables in separate routes.
- Hub Layer 3 switch communicates directly to a single network layer 3 switch on 2 channels using the same fiber optic cable

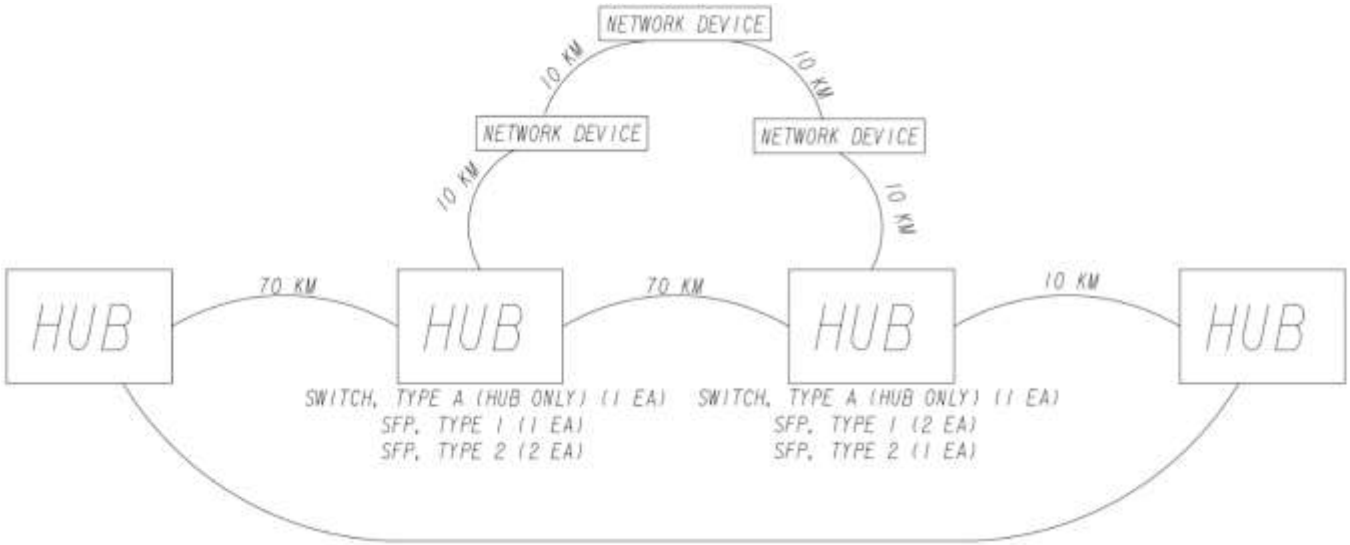


Figure 15-9: Hub Redundancy

15.6 Conclusion and Key Points

When designing the communications portion of the project, the following should be remembered:

- Designers will need to coordinate with the GDOT ITS group or the maintaining agency when designing the communication network or when adding devices to an existing network.
- Designers will need to include the Network Equipment Configuration and Integration pay item when connecting an ITS device to the GDOT network. Refer to section 942 of the GDOT specifications for more information.
- Refer to **Chapter 16** for naming schemes

15.6.1 Mediums

- Fiber optic cable is the preferred communication method
- Underground fiber optic cable is preferred to aerial
- Aerial fiber optic cable installation requires coordinating with utility companies
- Fiber optic cable reels are typically 15,000 feet
- Closures should be sized based on the size of the trunk fiber optic cable

- All devices that connect to fiber require a field switch, fiber patch panel/fiber distribution unit, and SFP fiber modules in all field cabinets
- Field switch Type A should be installed in all field cabinets, except for the cabinets at the beginning and end of the project, which should have a Type B field switch
- Wireless radios and cellular can be used when project cost is a concern
- Wireless radios require line-of-sight
- Cellular should be used when fiber optic cable and wireless radios are not feasible
- The communication method shall be approved by the maintaining agency
- On GDOT projects, consult with GDOT if they prefer to provide the 4G cellular radios for an ITS project
- On local agency projects, consult with the agency to ensure they can/want to use cellular communications to field devices

15.6.2 Networks

- Maximum of 8 field switches should be daisy chained in a series
- If feasible, daisy chains should be designed in a leap frogging pattern

15.6.3 Field Cabinets

- A mini-hub is a Type 4 field cabinet that requires an HVAC unit
- All cabinets should be carefully examined to determine if they require platforms
- GDOT ITS device cabinets require maintenance pads for express lane projects

15.6.4 Hubs

- Hub design should be closely coordinated with the GDOT ITS group

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Chapter 16. Naming Schemes

16.1 Introduction

There are distinct guidelines for the naming of sites, assets, and fiber optics which will be discussed in this chapter. These naming schemes allow GDOT to develop an organized approach for tracking the numerous devices deployed across the state.

16.2 Site Identification Naming Guidelines

A Site Identification Name (SIN) is required at any specific location or site that accommodates an asset. Assets are defined as ITS devices, hub equipment, related hardware, and infrastructure needed for ITS applications. These SINs provide an additional point of reference to distressed motorists if they need assistance identifying where they are located on the interstate. Designers should use the SIN guidelines when creating a fiber allocation table for ITS devices; refer to **section 16.4** for more information. The SIN is divided into the following seven sections:

1. Owner
2. Infrastructure Type
3. Roadway
4. County
5. Reference Location (Mile Marker, Address, Signal ID)
6. Nearest Travel Lane Direction
7. Unique Letter

Refer to section 16.2.8 for Site Identification Name examples.

16.2.1 Owner

The first SIN designator represents the Owner of the asset(s). Asset Owners shall be assigned a unique abbreviation of two (2) to four (4) letter(s). **Table 16-1** includes all the asset Owners for the State of Georgia.

Owner	Abbreviation
City of Alpharetta	ALPH
City of Atlanta	ATL
City of Augusta	AUG
Clayton County	CLAY
Cobb County	COBB
City of Columbus	COLU
Dekalb County	DEKA
Douglas County	DOUG
City of Dunwoody	DUNW
Georgia Department of Transportation	GDOT
Gwinnett County	GWIN

City of Johns Creek	JC
City of Marietta	MARI
Paulding County	PAUL
City of Roswell	ROSW
City of Sandy Springs	SSP
City of Smyrna	SMYR

Table 16-1 – Owner Abbreviations

16.2.2 Infrastructure Type

The second SIN designator represents the Infrastructure Type that houses an asset. Each Infrastructure Type shall be assigned a unique abbreviation for the SIN as displayed in **Table 16-2.**

Infrastructure Type	Abbreviation
Equipment Cabinet	CAB
Communication Network Hub	HUB
Pole Support Structure	POLE
Overhead Span or Support Structure	OSS

Table 16-2 – Infrastructure Type Abbreviations

16.2.3 Roadway

The third SIN designator represents the nearest Roadway (i.e., Interstate, United States (U.S) Routes, State Route, Local Road, Intersection, or Express Lane) to the site. The following rules apply to the use of the Roadway designator:

1. If the nearest roadway is an Interstate (I-75, I-85, I-20, etc.), the Interstate route number shall be used (e.g., I75, I85, I20).
2. If the nearest roadway is a U.S Route and not an Interstate, the U.S Route number shall be used (e.g., US41, US78).
3. If the nearest roadway is a State Route and not an Interstate or U.S Route, the State Route number shall be used (e.g., SR400, SR20, SR155).
4. If the nearest roadway is not an Interstate or State Route, the nearest Local Road name shall be used. The road name shall include the standard suffix abbreviation (2-4 digits) for streets, parkways, roads, avenues, etc. (e.g., RoswellSt, BarretPkwy, PowersFerryRd).
5. For traffic signal sites, the nearest roadway is typically a major intersection. In this case, the intersection name used on the permit for the traffic signal site shall be used (e.g., AkersMillRd_CumberlandBlvd).
6. For ramp meter system sites, the nearest arterial road name and freeway name shall be used (e.g.,I575_BellsFerryRd).
7. If the nearest roadway is an Express Lane, the abbreviated Express Lane Facility name shall be used. There are four (4) express lane facilities in operation in the State of Georgia and five (5) planned express lane facilities in the State of Georgia. Each facility shall be assigned a unique abbreviation for the SIN as displayed in **Table 16-3**.

Express Lane Facility	Abbreviation
I-75 South Metro Express Lanes	75A
I-85 Express Lanes	85A
I-75 Northwest Corridor Express Lanes	75B
I-85 Express Lanes Extension	85B
SR 400 Express Lanes	400A
I-285 Top End Express Lanes (East)	285A
I-285 Eastside Express Lanes	285B
I-285 Top End Express Lanes (West)	285C
I-285 Westside Express Lanes	285D

Table 16-3 – Express Lane Abbreviations

16.2.4 County

The fourth SIN designator represents the County in which the asset is located. **Table 16-4** includes all the counties and associated County Abbreviations for the state of Georgia.

COUNTY	ABBR
APPLING	AP
ATKINSON	AT
BACON	BC
BAKER	BX
BALDWIN	BL
BANKS	BA
BARROW	BW
BARTOW	BR
BENHILL	BH
BERRIEN	BE
BIBB	BI
BLECKLEY	BY
BRANTLEY	BT
BROOKS	BO
BRYAN	BN
BULLOCH	BU
BURKE	BK
BUTTS	BS
CALHOUN	CU
CAMDEN	CM
CANDLER	CZ

COUNTY	ABBR
CARRROLL	CL
CATOOSA	CT
CHARLTON	CR
CHATHAM	CH
CHATTAHOOCHEE	CE
CHATTOOGA	CG
CHEROKEE	CK
CLARKE	CA
CLAY	CY
CLAYTON	CN
CLINCH	CI
COBB	CO
COFFEE	CF
COLQUITT	CQ
COLUMBIA	CB
COOK	CX
COWETA	CW
CRAWFORD	CD
CRISP	CP
DADE	DD
DAWSON	DW

COUNTY	ABBR
DECATUR	DR
DEKALB	DA
DODGE	DG
DOOLY	DY
DOUGHERTY	DU
DOUGLAS	DO
EARLY	ER
ECHOLS	EC
EFFINGHAM	EF
ELBERT	EB
EMANUEL	EM
EVANS	EV
FANNIN	FN
FAYETTE	FY
FLOYD	FL
FORSYTH	FO
FRANKLIN	FK
FULTON	FU
GILMER	GI
GLASCOCK	GL
GLYNN	GN

COUNTY	ABBR	COUNTY	ABBR	COUNTY	ABBR
GORDON	GO	MACON	MA	STEWART	SW
GRADY	GR	MADISON	MD	SUMTER	SU
GREENE	GE	MARION	MR	TALBOT	TA
GWINNETT	GW	MERIWETHER	MW	TALIAFERRO	TL
HABERSHAM	HM	MILLER	MI	TATNALL	TT
HALL	HL	MITCHELL	ML	TAYLOR	TR
HANCOCK	HK	MONROE	MO	TELFAIR	TF
HARALSON	HR	MONTGOMERY	MY	TERRELL	TE
HARRIS	HS	MORGAN	MG	HOMAS	TH
HART	HA	MURRAY	MU	TIFT	TI
HEARD	HE	MUSCOGEE	ME	TOOMBS	TS
HENRY	HY	NEWTON	NE	TOWNS	TO
HOUSTON	HT	OCONEE	OC	TREUTLEN	TU
IRWIN	IR	OGLETHORPE	OG	TROUP	TP
JACKSON	JK	PAULDING	PA	TURNER	TN
JASPER	JA	PEACH	PE	TWIGGS	TW
JEFF DAVIS	JD	PICKENS	PI	UNION	UN
JEFFERSON	JF	PIERCE	PR	UPSON	UP
JENKINS	JS	PIKE	PK	WALKER	WA
JOHNSON	JH	POLK	PO	WALTON	WN
JONES	JO	PULASKI	PU	WARE	WE
LAMAR	LR	PUTNAM	PM	WARREN	WR
LANIER	LN	QUITMAN	QU	WASHINGTON	WG
LAURENS	LS	RABUN	RA	WAYNE	WY
LEE	LE	RANDOLPH	RH	WEBSTER	WB
LIBERTY	LI	RICHMOND	RI	WHEELER	WL
LINCOLN	LC	ROCKDALE	RO	WHITE	WH
LONG	LG	SCHLEY	SH	WHITFIELD	WD
LOWNDES	LW	SCREVEN	SN	WILCOX	WI
LUMPKIN	LU	SEMINOLE	SE	WILKES	WS
MCDUFFIE	MF	SPALDING	SP	WILKINSON	WK
MCINTOSH	MC	STEPHENS	ST	WORTH	WO

Table 16-4 – County Abbreviations

16.2.5 Reference Location

The fifth SIN designator represents the Reference Location. Depending on the asset and site location, different Reference Locations shall be used. The following rules apply to the use of the Reference Location designator:

1. For sites located along an interstate, U.S Route, State Route, or Express Lane, the mile marker to the nearest hundredth of a mile (0.01) shall be used.
2. Most local roads do not reference mile markers. For sites located along a local road, the known street address shall be used.
3. For traffic signal sites, the Signal ID shall be used in leu of a mile marker or street address. The Signal ID is a numeric identifier that can be referenced in the Department's Signal Central Software to view all the relevant location information.
4. For ramp meter sites, the mile marker to the nearest hundredth of a mile (0.01) shall be used.

16.2.6 Nearest Travel Lane Direction

The sixth SIN designator represents the nearest travel lane direction. The nearest travel lane direction shall be represented by one (1) letter or two (2) letter(s) to denote the direction of travel of the nearest lane (N, NE, NW, E, S, SE, SW, W). Routes with designated directions (i.e., U.S Routes, Interstates) shall be represented by one (1) letter direction of travel (N, E, S, W). For traffic signal sites and ramp meter sites, the direction of travel of the mainline shall be used.

16.2.7 Unique Letter

The seventh SIN designator represents a unique identifier used to differentiate between other sites that are present in the same hundredth (0.01) mile marker location and the same nearest travel lane direction. The Unique Letter designator will start with "A" and move sequentially through the alphabet.

16.2.8 Site Identification Name Examples

Example 1: COBB-OSS-MavellRd-CO-4680-E-A = Cobb County owned overhead sign structure located at 4680 Mavell Rd, Smyrna, GA 30082, USA in Cobb County with the nearest travel lane headed eastbound.

Example 2: GDOT-POLE-I85-FU-76.70-S-A = GDOT owned pole support structure located on I-85 at mile marker 76.70 in Fulton County with the nearest travel lane headed southbound.

Example 3: GDOT-CAB-75B-CO-20.15-S-A = GDOT owned equipment cabinet located on the Northwest Corridor Express Lane in Cobb County with the nearest travel lane headed southbound.

Example 4: SMYR-CAB-AkersMillRd_CumberlandBlvd-CO-1010-E-A = City of Smyrna owned traffic signal equipment cabinet located at the intersection of Akers Mill Rd and Cumberland Boulevard in Cobb County with the Signal ID of 1010 and the nearest mainline direction of travel headed eastbound.

16.3 Partial Asset Naming Guidelines

As previously noted, assets are defined as ITS devices, hub equipment, related hardware, and infrastructure needed for ITS applications. However, designers are only responsible for assigning names to ITS devices on plan sheets. Designers must callout the partial asset names of the ITS devices on the plan sheets, adjacent to the callout for the particular device. Similar to the SIN, the partial asset name is also used in fiber allocation tables as illustrated in **Figure 16-1**. The partial asset name follows a similar convention as the SIN, and is divided into the following six sections:

1. Owner
2. Asset Type/Component
3. Roadway
4. Reference Location
5. Nearest Travel Lane Direction
6. Unique Number

Refer to section 16.3.7 for Partial Asset Name examples.

16.3.1 Owner

Refer to section 16.2.1.

16.3.2 Asset Type/Component

<u>Asset Type:</u> The GDOT asset types include, but are not limited to, the following:

1. Acoustic Sensing Unit (ASU)
2. Automatic Incident Detection System (AID)
3. Barrier Gate (BG)
4. Blank-out Signs (BS)
5. Closed-Circuit Television Camera (CCTV)
6. Communication Network Hub (HUB)
7. Continuous Count Station (CCS)
8. Dynamic Message Sign (DMS)
9. Dynamic Lane Control Sign (DLCS)
10. Emergency Access Gate (EAG)
11. Environmental Sensor Station (ESS)
12. Infrared Detection System (IRDS)
13. Infrared Closed-Circuit Television Camera (IRCCTV)
14. Loop Detection System (LDS)
15. Magnetometer Detection System (MDS)
16. Pedestrian Hybrid Beacon (PHB)
17. Presence Detection System/Fixed CCTV Detection System (PDS)
18. Reversible Access Control System (RACS)
19. Radar/Microwave Detection System (RDS)
20. Roadside Unit (RSU)
21. Ramp Meter System (RMS)
22. School Zone Flashers (SZF)
23. Signal Phase and Timing Roadside Unit (SPaTRSU)

24. Traffic Signal (TS)
25. Travel-Time Reader (TTR)
26. Traffic Signal Detector or Detection System Interface (DET)
27. Video Detection System (VDS)
28. Variable Speed Limit Signs (VSLS)
29. Warning Gate (WG)

Asset Component: All related hardware, electronic components, auxiliary equipment, infrastructure, and firmware necessary for the operation of the asset types shall be listed as an asset component. Examples of managed asset components include, but are not limited to, the following:

1. Battery Back-up System/Uninterruptable Power Supply (BBS)
2. Cellular Router (CR)
3. Decoder (DEC)
4. Fiber Optic Transceiver (FOT)
5. Encoder (ENC)
6. Human Machine Interface (HMI)
7. Layer 2 Network Switch (L2SW)
8. Layer 3 Network Switch (L3SW)
9. Remote Lock Controller (REMLCK)
10. Terminal Server (TERMS)
11. Traffic Signal Controller (TSC)
12. Traffic Signal Conflict Monitor (MNTR)

16.3.3 Roadway

Refer to section 16.2.3.

16.3.4 Reference Location

Refer to section 16.2.5.

16.3.5 Nearest Travel Lane Direction

Refer to section 16.2.6.

16.3.6 Unique Number

The sixth designator is used to differentiate between the same asset types installed on or in the same infrastructure. Two characters shall be reserved (i.e., 01, 02, 03). For VSLs the primary VSL (typically mounted on the right-side of the roadway from the driver's perspective) shall use 01 and the mirror VSL (typically mounted on the left-side) shall use 02.

16.3.7 Partial Asset Name Examples

Example 1: COBB-DMS-MavellRd-4680-E-01 = Cobb County owned DMS on located at 4680 Mavell Rd, Smyrna, GA 30082, USA with the nearest travel lane headed eastbound.

Example 2: GDOT-CCTV-I85-76.70-S-01 = GDOT owned CCTV located on I-85 at mile marker 76.70 with the nearest travel lane headed southbound.

16.4 Fiber & Hub Naming Guidelines

Depending on the project scope, fiber allocation tables may need to be provided to illustrate how a device is connected to the trunk fiber backbone. Designers should note that SINs and partial asset names are also utilized as part of the fiber allocation table. Fiber and hub naming guidelines are illustrated below. **Figure 16-1** below contains an excerpt from a fiber allocation table and **Appendix D** provides a fiber design example with a corresponding fiber allocation table.

Trunk Cable Fiber ID or Drop Cable Fiber ID: NAVUU-YYYY.ZZZ or SOWW.ZZ (legacy fiber)

“UU” is the year the fiber is to be installed, “YYYY” is the unique trunk cable ID, and “Z” is the fiber number of the trunk cable. For example, on a 144-trunk fiber “Z” could be any value between 1 and 144. However, it is best to start with 001 with newly installed trunk fibers. On legacy fiber installations, the “WW” in “SOWW.ZZ” denotes the unique trunk cable ID. Coordinate with the GDOT ITS group to obtain trunk cable ID numbers.

Drop Cable ID: NAVUU-YYYY-XXX or SOWW-XXX (legacy fiber)

“UU” is the year the fiber is to be installed, “YYYY” is the ID of the trunk cable used in communications routing, and “XXX” is the three-digit number assigned to that drop cable for the given trunk cable. The drop cables are numbered for each trunk cable, starting with 001. On legacy fiber installations, the “WW” in “SOWW-XXX” denotes the unique trunk cable ID. If a project was tying into the existing trunk fiber, designers would need to coordinate with the GDOT ITS group to be able to identify the last drop cable ID number used, the unique trunk fiber ID, and which fibers of the trunk are available.

Fiber ID: SX

“X” is the fiber number used in the drop cable, and “S” denotes single mode. Since drop cables are typically 6 or 12 fibers, “X” values will be in that range. For example, “S2” would be the second fiber of a single mode drop cable.

Destination or FPP/FDU (previously FDC) Port ID: HUBXXFODISTRAABBCCDD

This is the next sequential destination of the device’s communications. Designers should either list the station of the next device connected on the same trunk fiber, or should include the HUB ID. “XX” is the hub’s letter designation, “AA” is the rack number within the hub/control center, “BB” is the FDU position in the rack, “CC” is the column within the FDU and “DD” is the row within the FDU.

DEVICE LOCATION (STATION #)	SIN	PARTIAL ASSET NAME			TRUNK CABLE FIBER # OR DROP CABLE ID : FIBER # (DROP TO DROP CABLE SPLICES)		DROP CABLE ID : FIBER # FIBER # = CABINET FPP/FDU PORT		DESTINATION OR FPP/FDU PORT	FUNCTION
		VDS #	CCTV ID #	DMS ID #			ID	FIBER #		
126+56	GDOT-POLE-I675-CN-7.16-S-A		GDOT-CCTV-I675-7.16-S-01		NAV15-001.01		NAV15-001	S1	HUBXXFODISTRAABBCCDD	RX1
RING 1					NAV15-001.02		NAV15-001	S2	HUBXXFODISTRAABBCCDD	TX1
					NAV15-001.03		NAV15-001	S3	HUBXXFODISTRAABBCCDD	RX1-SPARE (DAISY-CHAIN)
					NAV15-001.04		NAV15-001	S4	HUBXXFODISTRAABBCCDD	TX1-SPARE (DAISY-CHAIN)
					NAV15-001.05		NAV15-001	S5		
					NAV15-001.06		NAV15-001	S6		
					NAV15-001.01		NAV15-001	S7	164+64	TX2
					NAV15-001.02		NAV15-001	S8	164+64	RX2
					NAV15-001.03		NAV15-001	S9	164+64	TX2-SPARE (DAISY-CHAIN)
					NAV15-001.04		NAV15-001	S10	164+64	RX2-SPARE (DAISY-CHAIN)
					NAV15-001.05		NAV15-001	S11		
					NAV15-001.06		NAV15-001	S12		

Figure 16-1: Excerpt from a Fiber Allocation Table

16.5 Conclusion and Key Points

When applying naming schemes, the following should be remembered:

16.5.1 Site Identification Names

- Designers need to provide SINs in the fiber allocation table for all ITS devices installed on a project (if applicable)

16.5.2 Partial Asset Names

- Designers must callout the partial asset names of all ITS devices installed on the plan sheets
- Designers need to provide the partial asset names of all ITS devices installed in the fiber allocation table (if applicable)

16.5.3 Fiber and Hub Names

- Coordinate with the GDOT ITS group to obtain available trunk cable ID’s and available drop fiber ID’s
- All trunk cables should have an ID called out on the plans
- All ID’s for trunk cable, drop cable, fiber number, and destination/FPP/FDU should be identified in the fiber allocation table

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Appendix A. Design Checklist

Ramp Meter

General

- ☐ The updated ITS Legend is used in all plan sets to ensure compliance with the EDG
- ☐ One or both warrants have been met, or the GDOT ITS group has approved the proposed ramp meter location
- ☐ A separate sheet is included for each ramp meter detailing the list of materials and the non-standard pin-out diagram
- ☐ Partial asset names are provided on the plans for all ITS devices

Location and Placement

- ☐ There is adequate acceleration distance
- ☐ Stop bar is placed at the edge of the gore
- ☐ Single lane ramps call out two 12-inch signal heads, 1 backplate, and one enforcement light
- ☐ For single lane ramps, the pedestal pole is offset 6' from the middle of the stop bar
- ☐ Multi-lane ramps call out one signal head per lane, one backplate per lane, and one enforcement light per lane
- ☐ For multi-lane ramps, mast arms are set 60 feet upstream (40 feet minimum, 80 feet maximum)
- ☐ Mast arms are located outside of clear zone or protected by guardrail
- ☐ Cabinets are located a minimum of 18' from lane line or protected by guardrail
- ☐ The cabinet location has been investigated for the need of a maintenance pad or platform
- ☐ Each lane has a 6'x6' passage detector offset 4' from the middle of the stop bar
- ☐ Each lane has a 6'x20' demand detector offset 4' from the middle of the stop bar
- ☐ Each lane has a 6'x6' intermediate queue detector placed 40 percent of the distance between the stop bar and the upstream intersection.
- ☐ Each lane has a 6'x6' excessive queue detector placed 80 percent of the distance between the stop bar and the upstream intersection.
- ☐ If lanes are greater than 16' wide, 2 detectors are used
- ☐ Single lane ramps have an advance warning flasher that is placed adjacent to the excessive queue detector(s)
- ☐ Multi-lane ramps have two advance warning flashers that are placed on either side of the excessive queue detectors
- ☐ "Form Two Lanes When Metered" ramps have 6-inch skip (2-foot stripe with 6-foot gap) white striping between adjacent lanes extending 60 feet back from the stop bar
- ☐ The CCTV has an unobstructed view of the signal indications
- ☐ The mainline detection is aimed at the merge point and is within 500 feet of the ramp meter cabinet

Signs

- ☐ A R10-6R or R10-6L is located adjacent to the stop bar for a single lane ramp meter
- ☐ A R10-6R and R10-6L are located adjacent to the stop bar for multi-lane ramp meters
- ☐ A RM-2 is installed on the pedestal pole for single lane ramps

- A RM-1L, RM-2, and RM-1R are mounted on the mast arm of a dual lane ramp meter
- A RM-1L, RM-2, RM-1C, and RM-1R are mounted on the mast arm of a triple lane ramp meter
- A W4-2L or W4-2R is located downstream of the advanced warning flasher for multi-lane ramps
- Two pairs of “Form Two Lanes When Metered” signs are located adjacent to the beginning of the 2-foot stripe with 6-foot gap striping, and adjacent to the intermediate queues

Closure (If connected with fiber)

- Splice closure and splices have been identified
- A pull box, Type 7 is shown for the closure
- The closure matches the size of the trunk cable
- Drop fiber slack has been labeled in the Type 7 pull box
- A pull box, Type 4s is shown near the cabinet
- Drop fiber slack has been labeled in all Type 4s pull boxes from the cabinet to the trunk line

Power

- Power service locations are shown on the plans
- Power conduit is shown being installed from power service to cabinet
- Power conduit does not run through environmentally sensitive areas
- If applicable, the railroad checklist has been completed and submitted

Communication

- All communication mediums have been explored for potential usage and meet what is defined in the project contract
- The communication medium is clearly defined at the device location

DMS

General

- ☐ The updated ITS Legend is used in all plan sets to ensure compliance with the EDG
- ☐ Partial asset names are provided on the plans for all ITS devices

Location and Placement

- ☐ The spacing between existing sign gantries has been considered
- ☐ The face of the DMS will not be obstructed by trees
- ☐ The gantry uprights are placed 6' behind the face of guardrail
- ☐ The DMS is not placed within an environmentally sensitive area
- ☐ The DMS is placed within the right-of-way
- ☐ The DMS foundation is not placed over a drainage structure
- ☐ The DMS foundation is not placed over sub-surface utilities
- ☐ A CCTV is placed 500'-1500' upstream of the DMS
- ☐ Existing structures were considered for CCTV placement
- ☐ The CCTV has an unobstructed view of the face of the DMS
- ☐ The DMS cabinet is placed 100-150' from the front of the DMS
- ☐ The cabinet location has been investigated for the need of a maintenance pad or platform

Type

- ☐ The typical message length has been determined
- ☐ The speed and respective letter size has been determined
- ☐ The proper DMS type has been confirmed with the maintaining agency
- ☐ The CCTV meets what is outlined within the contract
- ☐ The CCTV meets the operational requirements for the location

Closure (If connected with fiber)

- ☐ Splice closure and splices have been identified
- ☐ A pull box, Type 7 is shown for the closure
- ☐ The closure matches the size of the trunk cable
- ☐ Drop fiber slack has been labeled in the Type 7 pull box
- ☐ A pull box, Type 4s is shown near the cabinet
- ☐ Drop fiber slack has been labeled in all Type 4s pull boxes from the cabinet to the trunk line

Power

- ☐ Power service locations are shown on the plans
- ☐ Power conduit is shown being installed from power service to cabinet
- ☐ Power conduit does not run through environmentally sensitive areas
- ☐ If applicable, the railroad checklist has been completed and submitted

Communication

- ☐ All communication mediums have been explored for potential usage and meet what is defined in the project contract
- ☐ The communication medium is clearly defined at the device location

Vehicle Detection

General

- ☐ The updated ITS Legend is used in all plan sets to ensure compliance with the EDG
- ☐ Partial asset names are provided on the plans for all ITS devices

Location and Placement

- ☐ The detector was placed to accurately capture the mainline and entrance or exit ramp
- ☐ Existing structures were considered for co-location
- ☐ The strain pole is located within ROW
- ☐ The strain pole is not located within an environmentally sensitive area
- ☐ The strain pole is not located on a drainage structure
- ☐ The strain pole is not located on subsurface utility
- ☐ The strain pole is not located near an overhead utility
- ☐ The strain pole is located where it can be easily accessed for maintenance
- ☐ The strain pole has been placed behind guardrail or outside the clear zone
- ☐ If microwave radar, the detector is mounted to overcome barrier wall reflection, if applicable
- ☐ The cabinet location has been investigated for the need of a maintenance pad or platform

Type

- ☐ The type of detector is the best for the situation and type of detection needed

Closure (If connected with fiber)

- ☐ Splice closure and splices have been identified
- ☐ A pull box, Type 7 is shown for the closure
- ☐ The closure matches the size of the trunk cable
- ☐ Drop fiber slack has been labeled in the Type 7 pull box
- ☐ A pull box, Type 4s is shown near the cabinet
- ☐ Drop fiber slack has been labeled in all Type 4s pull boxes from the cabinet to the trunk line

Power

- ☐ Power service locations are shown on the plans
- ☐ Power conduit is shown being installed from power service to cabinet
- ☐ Power conduit does not run through environmentally sensitive areas
- ☐ If applicable, the railroad checklist has been completed and submitted
- ☐ Solar power has been shown on the plan sheet
- ☐ The maintaining agency has accepted the use of solar power
- ☐ The solar assembly has been properly placed for solar exposure

Communication

- ☐ All communication mediums have been explored for potential usage and meet what is defined in the project contract
- ☐ The communication medium is clearly defined at device location

CCTV

General

- ☐ The updated ITS Legend is used in all plan sets to ensure compliance with the EDG
- ☐ Partial asset names are provided on the plans for all ITS devices

Location and Placement

- ☐ Existing structures were considered for co-location
- ☐ The camera viewing coverage has been determined
- ☐ The project meets the camera coverage required
- ☐ The CCTV pole is not placed within an environmentally sensitive area
- ☐ The CCTV pole is placed within the ROW
- ☐ The CCTV pole is not placed on top of a drainage structure
- ☐ The CCTV pole is not placed on top of sub-surface utilities
- ☐ The CCTV pole is not placed within the vicinity of overhead utilities
- ☐ The CCTV pole is placed 6' behind face of guardrail or outside clear zone
- ☐ The CCTV pole will not be obstructed by trees or other existing structures
- ☐ The cabinet location has been investigated for the need of a maintenance pad or platform

Type

- ☐ The CCTV meets what is outlined within the contract
- ☐ The CCTV meets the operational requirements for the location

Closure (If connected with fiber)

- ☐ Splice closure and splices have been identified
- ☐ A pull box, Type 7 is shown for the closure
- ☐ The closure matches the size of the trunk cable
- ☐ Drop fiber slack has been labeled in the Type 7 pull box
- ☐ A pull box, Type 4s is shown near the cabinet
- ☐ Drop fiber slack has been labeled in all Type 4s pull boxes from the cabinet to the trunk line

Power

- ☐ Power service locations are shown on the plans
- ☐ Power conduit is shown being installed from power service to cabinet
- ☐ Power conduit does not run through environmentally sensitive areas
- ☐ If applicable, the railroad checklist has been completed and submitted
- ☐ Solar power has been shown on the plan sheet
- ☐ The maintaining agency has accepted the use of solar power
- ☐ The solar assembly has been properly placed for solar exposure

Communication

- ☐ All communication mediums have been explored for potential usage and meet what is defined in the project contract
- ☐ The communication medium is clearly defined at device location

ESS

General

- ☐ The updated ITS Legend is used in all plan sets to ensure compliance with the EDG
- ☐ Partial asset names are provided on the plans for all ITS devices

Location and Placement

- ☐ Existing structures were considered for co-location
- ☐ The GDOT ITS group has signed off on the ESS locations
- ☐ A CCTV is installed on the same pole as an ESS
- ☐ The strain pole is not placed within an environmentally sensitive area
- ☐ The strain pole is placed within the ROW
- ☐ The strain pole is not placed on top of a drainage structure
- ☐ The strain pole is not placed on top of sub-surface utilities
- ☐ The strain pole is not placed within the vicinity of overhead utilities
- ☐ The strain pole is placed 6' behind face of guardrail or outside clear zone
- ☐ The ESS is offset 30-50 feet from outermost lane line
- ☐ The ESS is located a minimum of 30' away from large structures or dense foliage
- ☐ The cabinet location has been investigated for the need of a maintenance pad or platform

Type

- ☐ The CCTV meets what is outlined within the contract
- ☐ The CCTV meets the operational requirements for the location
- ☐ The ESS meets the operational requirements for the location

Closure (If connected with fiber)

- ☐ Splice closure and splices have been identified
- ☐ A pull box, Type 7 is shown for the closure
- ☐ The closure matches the size of the trunk cable
- ☐ Drop fiber slack has been labeled in the Type 7 pull box
- ☐ A pull box, Type 4s is shown near the cabinet
- ☐ Drop fiber slack has been labeled in all Type 4s pull boxes from the cabinet to the trunk line

Power

- ☐ Power service locations are shown on the plans
- ☐ Power conduit is shown being installed from power service to cabinet
- ☐ Power conduit does not run through environmentally sensitive areas
- ☐ If applicable, the railroad checklist has been completed and submitted
- ☐ Solar power has been shown on the plan sheet
- ☐ The maintaining agency has accepted the use of solar power
- ☐ The solar assembly has been properly placed for solar exposure

Communication

- ☐ All communication mediums have been explored for potential usage and meet what is defined in the project contract
- ☐ The communication medium is clearly defined at device location

Power

- ☐ Power locations have been coordinated with and approved by Utility Companies
- ☐ Power conduit is shown on the plans
- ☐ Power service locations are shown on the plans
- ☐ Power conduit does not run through environmentally sensitive areas
- ☐ If applicable, the railroad checklist has been completed and submitted
- ☐ Type of power (solar or utility) is identified on the plans
- ☐ Where applicable, solar power has been properly located for solar exposure

Communication

Fiber

- ☐ Aerial versus underground fiber installation has been determined
- ☐ The fiber count provides for future growth and conforms to the contract documents

Aerial (where applicable)

- ☐ Fiber is called out for aerial fiber attachments
- ☐ Fiber has proper support wire called out, where necessary
- ☐ Fiber does not have extensively large spans between poles
- ☐ Poles, where applicable, are identified for installation
- ☐ Aerial splice closures are identified
- ☐ Aerial splice closures are sized for the largest cable
- ☐ Proper amounts of slack have been identified on the plans
- ☐ Snowshoes and proper quantities are identified on the plans
- ☐ Transition from aerial to underground, if applicable, has been identified

Underground (where applicable)

- ☐ The fill calculations have been performed and utilized for sizing of conduit
- ☐ Conduit provides space for future cabling
- ☐ Conduit does not run through environmentally sensitive areas
- ☐ Pull boxes have been properly sized on trunk and drop cables
- ☐ Underground splice closures have been identified
- ☐ Underground splice closures have been sized based upon on the largest cable
- ☐ Proper lengths of slack have been identified at the respective pull boxes and ECBs
- ☐ Reel to reel splice locations have been identified
- ☐ Reel to reel splice closures and splices have been identified

General

- ☐ SFPs have been identified and properly selected
- ☐ The trunk cable(s) have been properly identified
- ☐ The drop cable(s) have been properly identified
- ☐ SFP type has been properly shown on the plans at the respective locations
- ☐ SFP type has been properly selected for distance and bandwidth and network switch termination
- ☐ FPP/FDU have been identified on the plans
- ☐ FPP/FDU have been properly sized for the termination at the respective locations
- ☐ FPP/FDU type has been identified
- ☐ Splicing diagram details properly identify the buffer tube and fiber strand being spliced, trunk cable, and drop cable

Network Switch

- ☐ At each location, the type of switch has been identified
- ☐ The respective switch has the amount of termination ports required
- ☐ The SFPs required for switch location have been identified

4G Router

- ☐ Fiber optic communication is not a viable option
- ☐ 2.4/5 GHz radios are not a viable option
- ☐ 900 MHz radio is not a viable option
- ☐ Maintaining agency has agreed with installation and associated monthly cost
- ☐ Cellular coverage has been confirmed at each respective location

900 MHz

- ☐ Fiber optic communication has been deemed to not be acceptable
- ☐ The data transfer rate is below the maximum supported
- ☐ Line-of-sight between the two-radio transceivers has been confirmed
- ☐ The radio can be mounted above low-level obstructions

2.4/5 GHz Radio

- ☐ Fiber optic communication has been deemed to not be acceptable
- ☐ The data transfer rate is below the maximum supported.
- ☐ Line-of-sight between the two-radio transceivers has been confirmed
- ☐ The radio can be mounted above low-level obstructions
- ☐ The type of radio has been properly identified
- ☐ Radios have been identified on the plan sheets

Naming Schemes

Site Identification Names

- ☐ SINs have been assigned in the fiber allocation table for all ITS devices installed on the project (if applicable)
- ☐ All SINs have the following seven sections: Owner, Infrastructure Type, Roadway, County Abbreviation, Reference Location, Nearest Travel Lane Direction, and Unique Letter

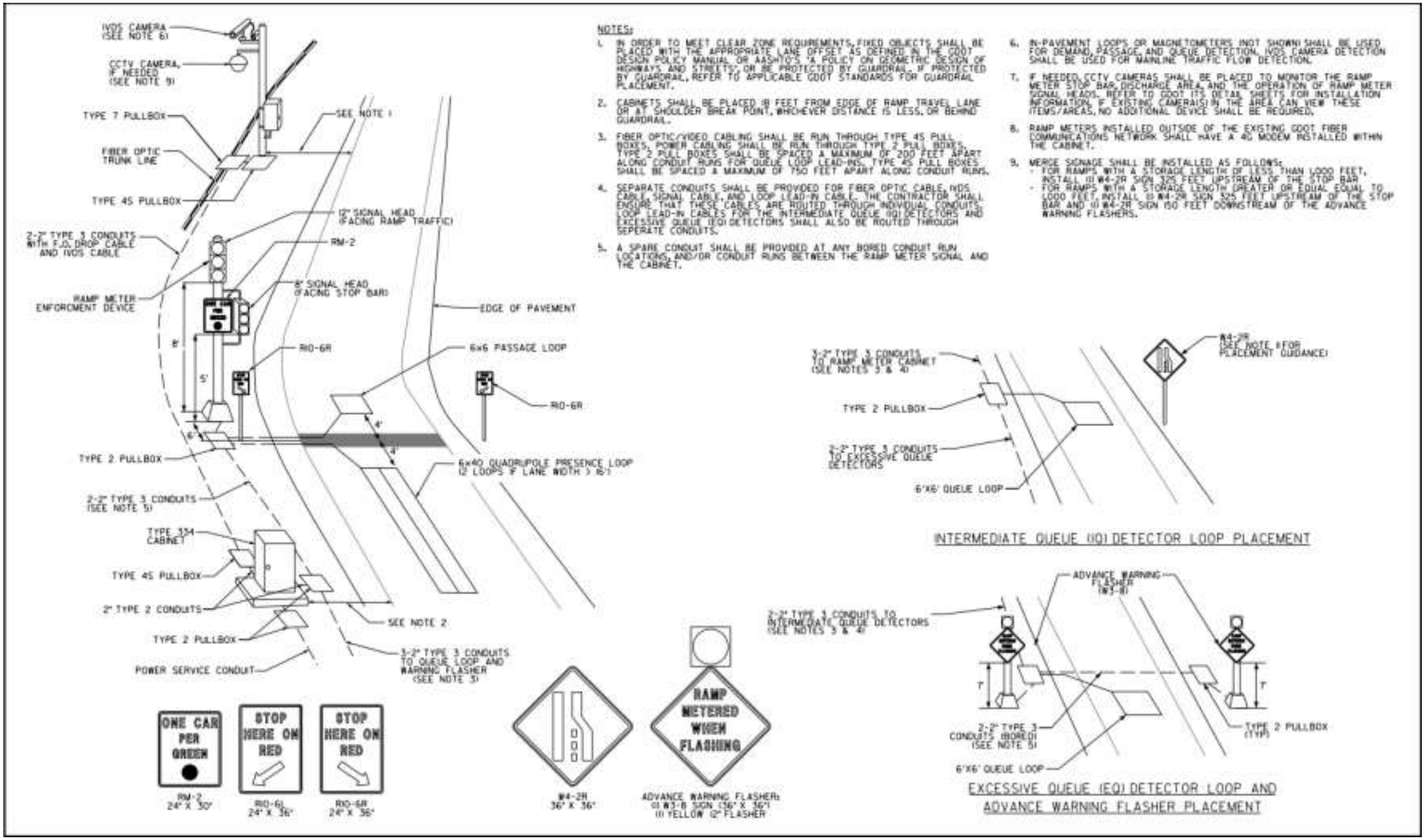
Partial Asset Names

- ☐ All proposed ITS devices have a partial asset name called out on the plans
- ☐ Asset names include the following six components: Owner, Asset Type/Component, Roadway, Reference Location, Nearest Travel Lane Direction, and Unique Number
- ☐ All partial asset names for the proposed ITS devices are included in the fiber allocation table (if applicable)

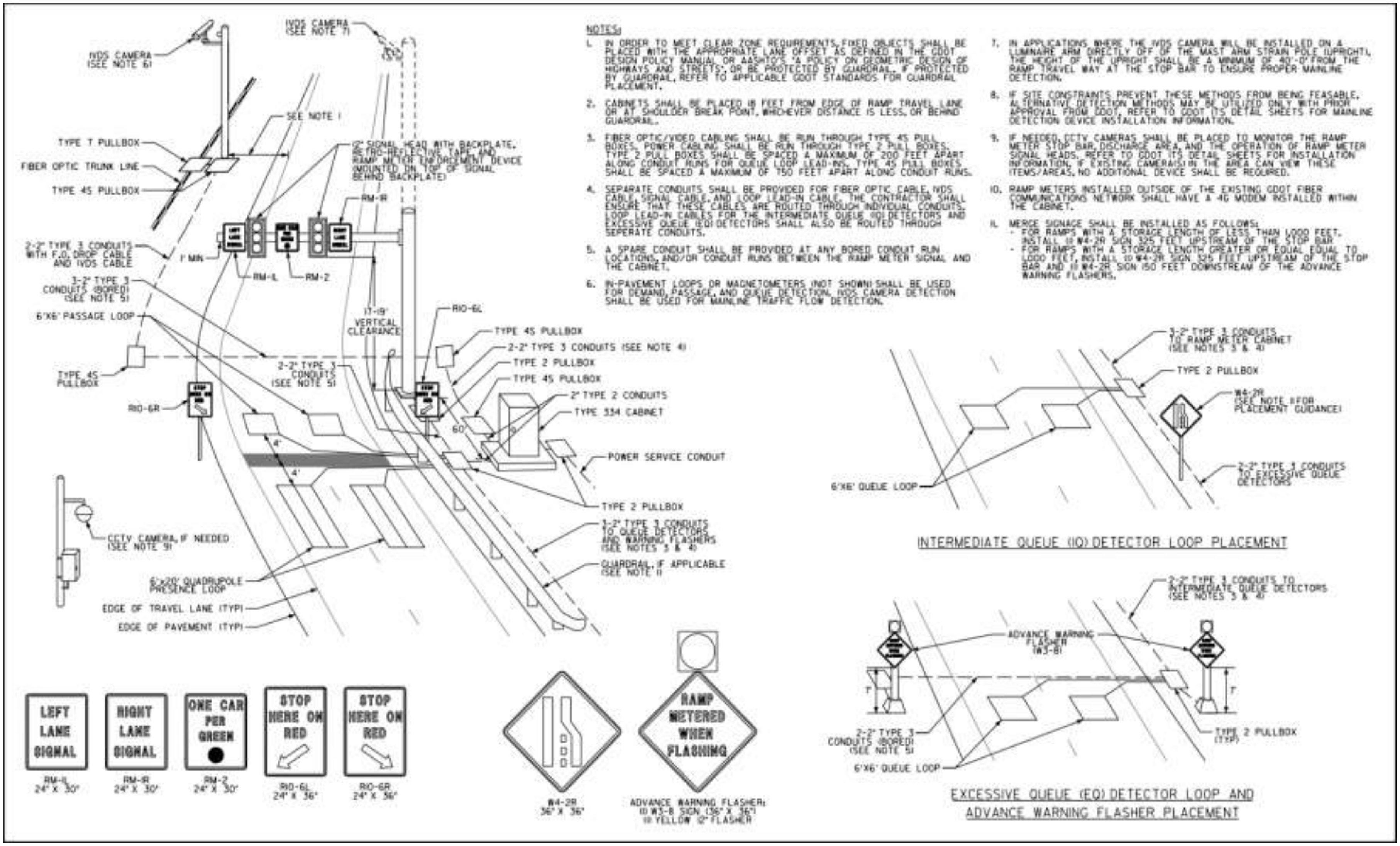
Fiber and Hub Names

- ☐ All trunk cables have an ID called out on the plans
- ☐ The GDOT ITS group has provided available trunk cable ID’s and available drop fiber ID’s
- ☐ All ID’s for trunk cable, drop cable, fiber number, and Destination/FPP/FDU are identified in the fiber allocation table

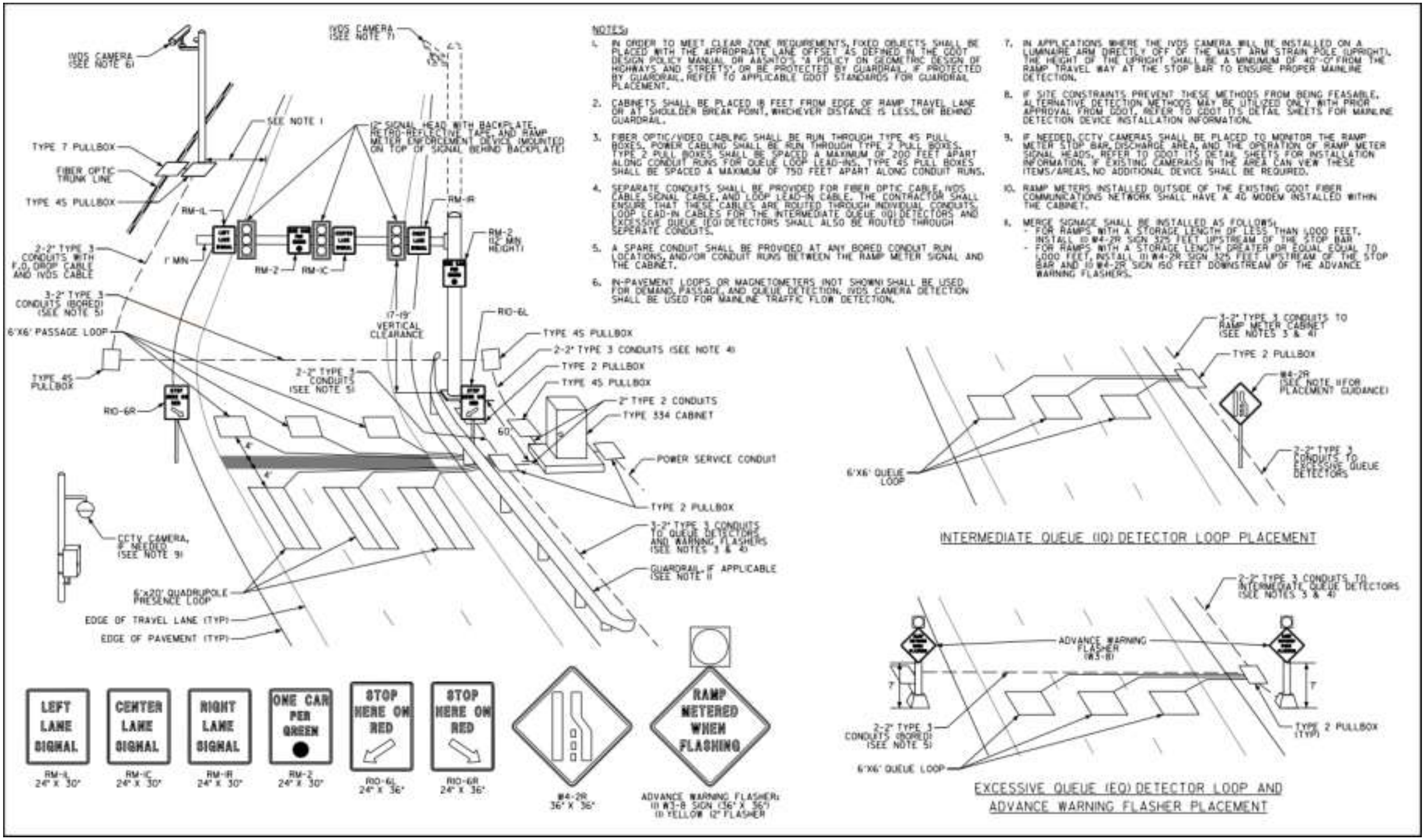
Appendix B. Ramp Meter Installation Details



ITS-51A Ramp Meter Installation – Single Lane Meter Details



ITS-51B Ramp Meter Installation – Dual Lane Meter Details



ITS-51C Ramp Meter Installation – Triple Lane Meter Details

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Appendix C. Standard Ramp Meter Cabinet Pin-out and Wiring Diagram

Standard Cabinet Pin-out

Model 334 Default Input File Assignment Detail															
Slot		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Type		**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**	**Det**
Channel 1	**C1 Pin**	46	50	49	55	51	57	59	61	81	79	53	41	43	45
	Function	L1 D1	L2 D2	L3 D3	L4 D4	L1 EQ1	L3 EQ3	L5 EQ5	L1 MLA	L2 MLA	L3 MLA	L4 MLA	L5 MLA	L1 IQ1	L3 IQ3
	Field Term	TB-2 1,2	TB-2 5,6	TB-2 9,10	TB-3 1,2	TB-3 5,6	TB-3 9,10	TB-4 1,2	TB-4 5,6	TB-4 9,10	TB-5 1,2	TB-5 5,6	TB-5 9,10	TB-6 1,2	TB-6 5,6
Channel 2	**C1 Pin**	39	47	48	56	52	58	60	62	80	82	54	40	42	44
	Function	L1 P1	L2 P2	L3 P3	L4 P4	L2 EQ2	L4 EQ4	L6 EQ6	L1 MLB	L2 MLB	L3 MLB	L4 MLB	L5 MLB	L2 IQ2	L4 IQ4
	Field Term	TB-2 3,4	TB-2 7,8	TB-2 11,12	TB-3 3,4	TB-3 7,8	TB-3 11,12	TB-4 3,4	TB-4 7,8	TB-4 11,12	TB-5 3,4	TB-5 7,8	TB-5 11,12	TB-6 3,4	TB-6 7,8

Standard Cabinet Pin-out

Model 334 PDA Type 3 Ramp Meter Output File

	Switchpack 1					Switchpack 2					Switchpack 3				
	C1 Pin	Out #	Connector	Function	Field Terminal	C1 Pin	Out #	Connector	Function	Field Terminal	C1 Pin	Out #	Connector	Function	Field Terminal
RED	2	0	C6-1	Warn 1	T4-7	4	2	C6-3	Lane 1 Red	T4-4	7	5	C6-6	Lane 2 Red	T4-1
YELLOW	37	34	C6-9	Not used	T4-8	5	3	C6-4	Lane 1 Yel	T4-5	8	6	C6-7	Lane 2 Yel	T4-2
GREEN	3	1	C6-2	Warn 2	T4-9	6	4	C6-5	Lane 1 Grn	T4-6	9	7	C6-8	Lane 2 Grn	T4-3

Model 334 Ramp Meter Auxiliary Output File

	Switchpack 9					Switchpack 10					Switchpack 11				
	C1 Pin	Out #	Connector	Function	Field Terminal	C1 Pin	Out #	Connector	Function	Field Terminal	C1 Pin	Out #	Connector	Function	Field Terminal
RED	97	53	C5-14	Lane 3 R	A1-24	94	50	C5-11	Not used	A121	91	48	C5-9	Not used	A114
YELLOW	98	54	C5-15	Lane 3 Y	A1-25	95	51	C5-12	Not used	A122	101	37	C5-18	Not used	A115

Standard Cabinet Pin-out																	
	GREEN	99	55	C5-16	Lane 3 G	A1-26	96	52	C5-13	Not used	A123	93	49	C5-10	Not used	A116	

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Appendix D. ITS Plan Sheet Examples

List of Examples:

D-2:

- Ramp Meter Design
- CCTV Design
- Fiber Optic Communication
- Proposed Aerial Power Service

D-4:

- DMS Design
- CCTV Design
- 4G Router Communication
- Type 3 Cabinet
- Proposed Aerial Power Service

D-5:

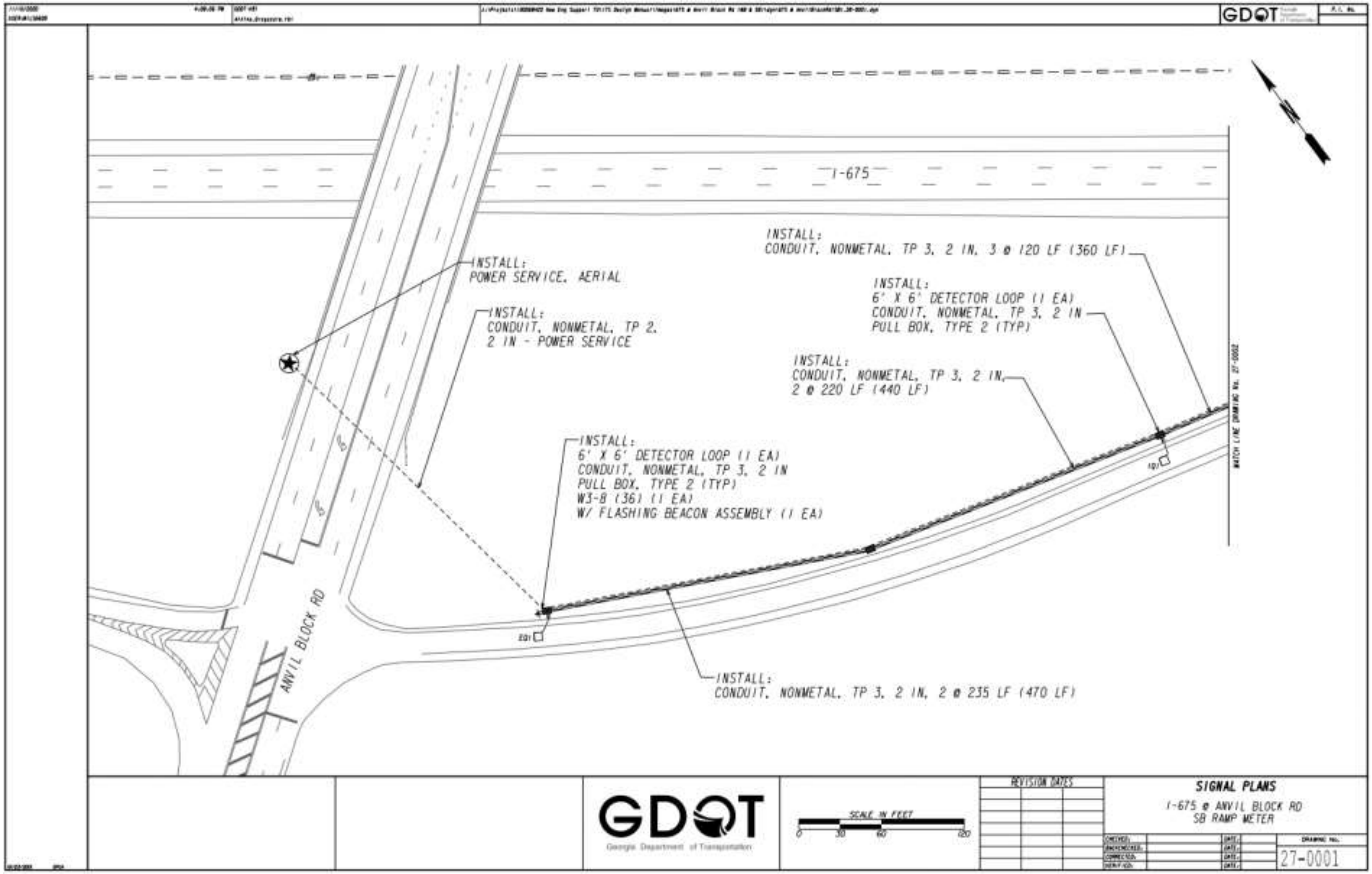
- Microwave Radar Design
- CCTV Design
- Fiber Optic Trunk Design
- Type 1 Cabinet
- Existing Aerial Power Service

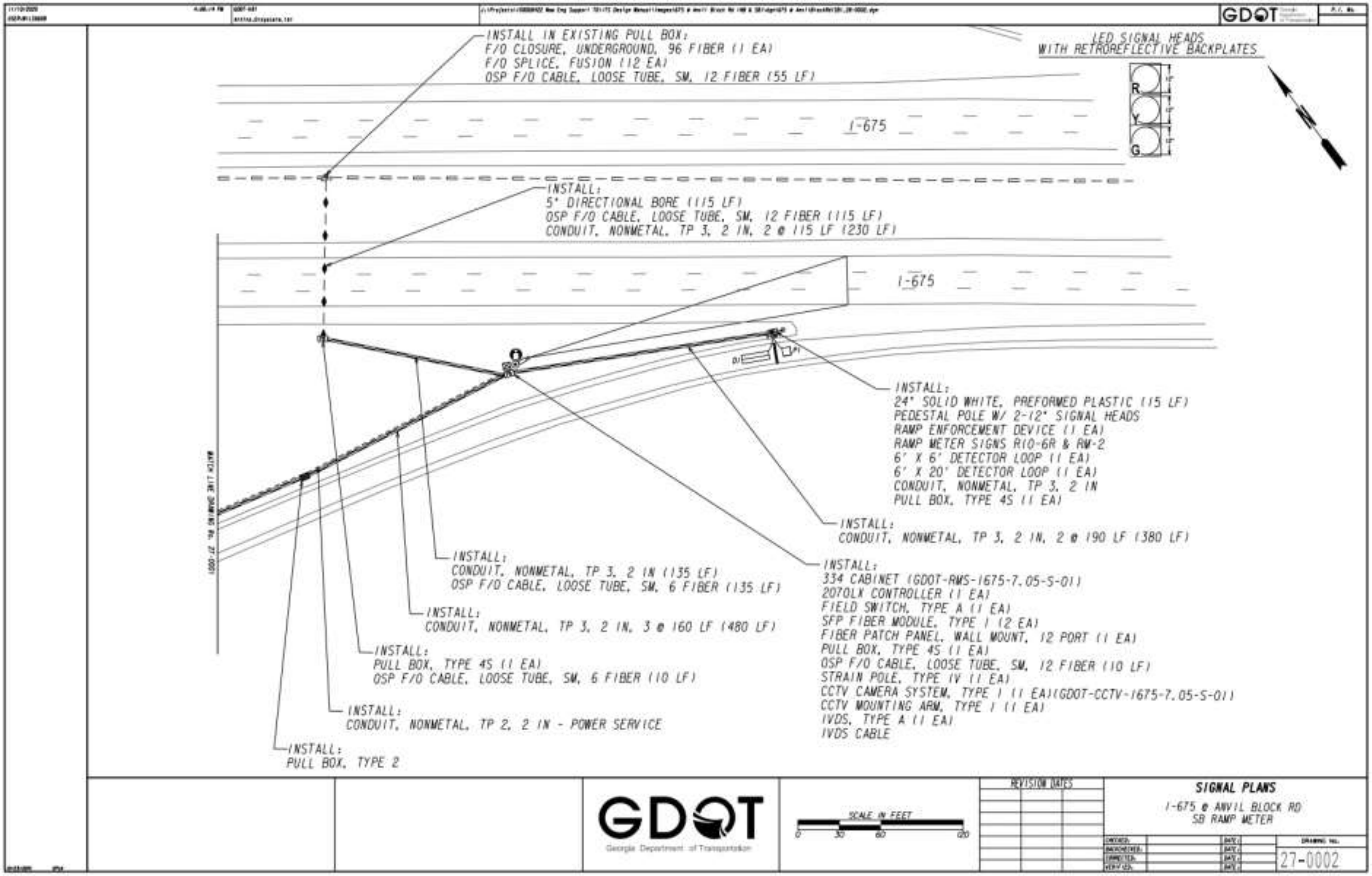
D-11:

- Fiber Allocation Table (corresponds with D-5 example)

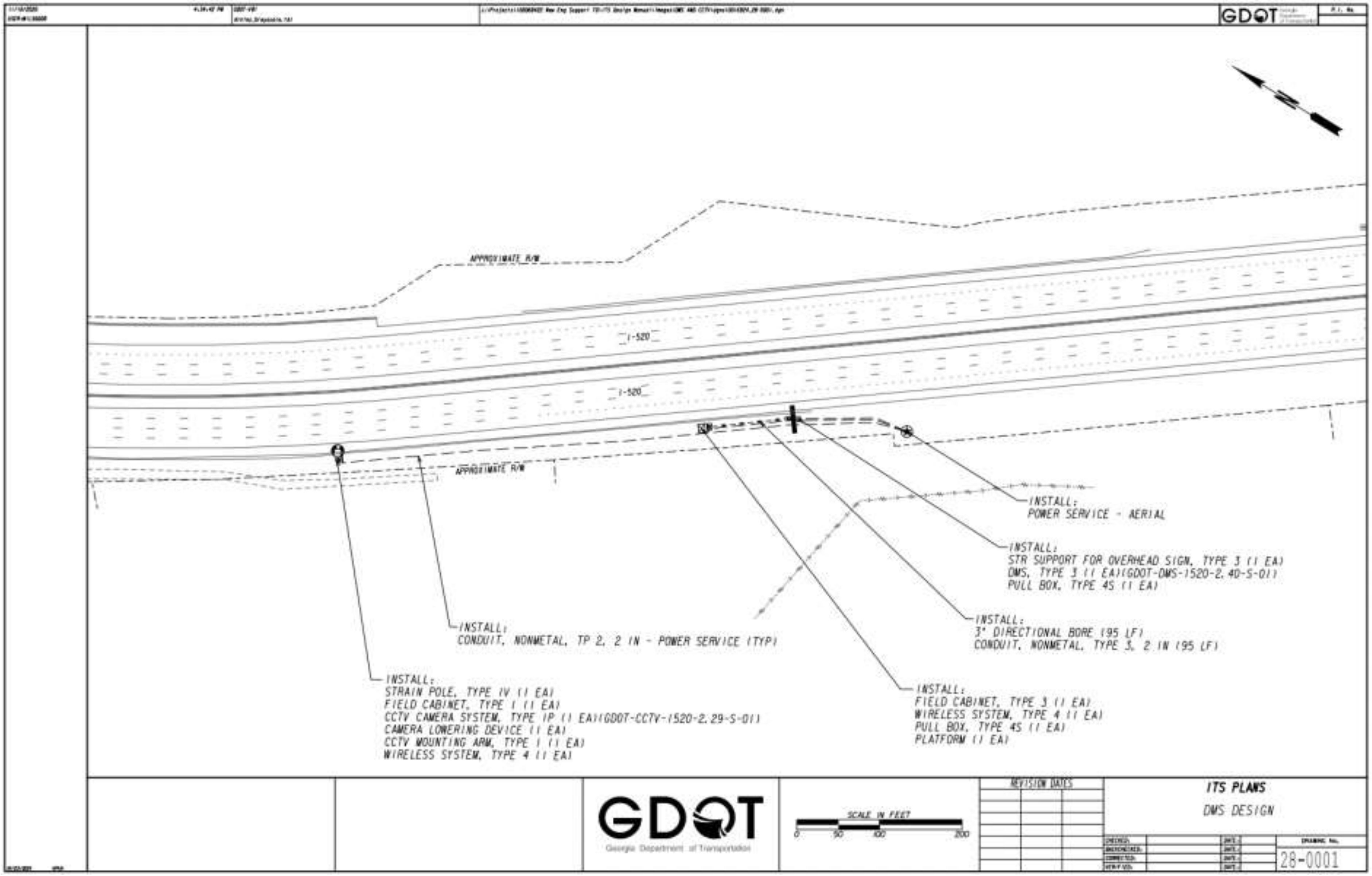
D-13:

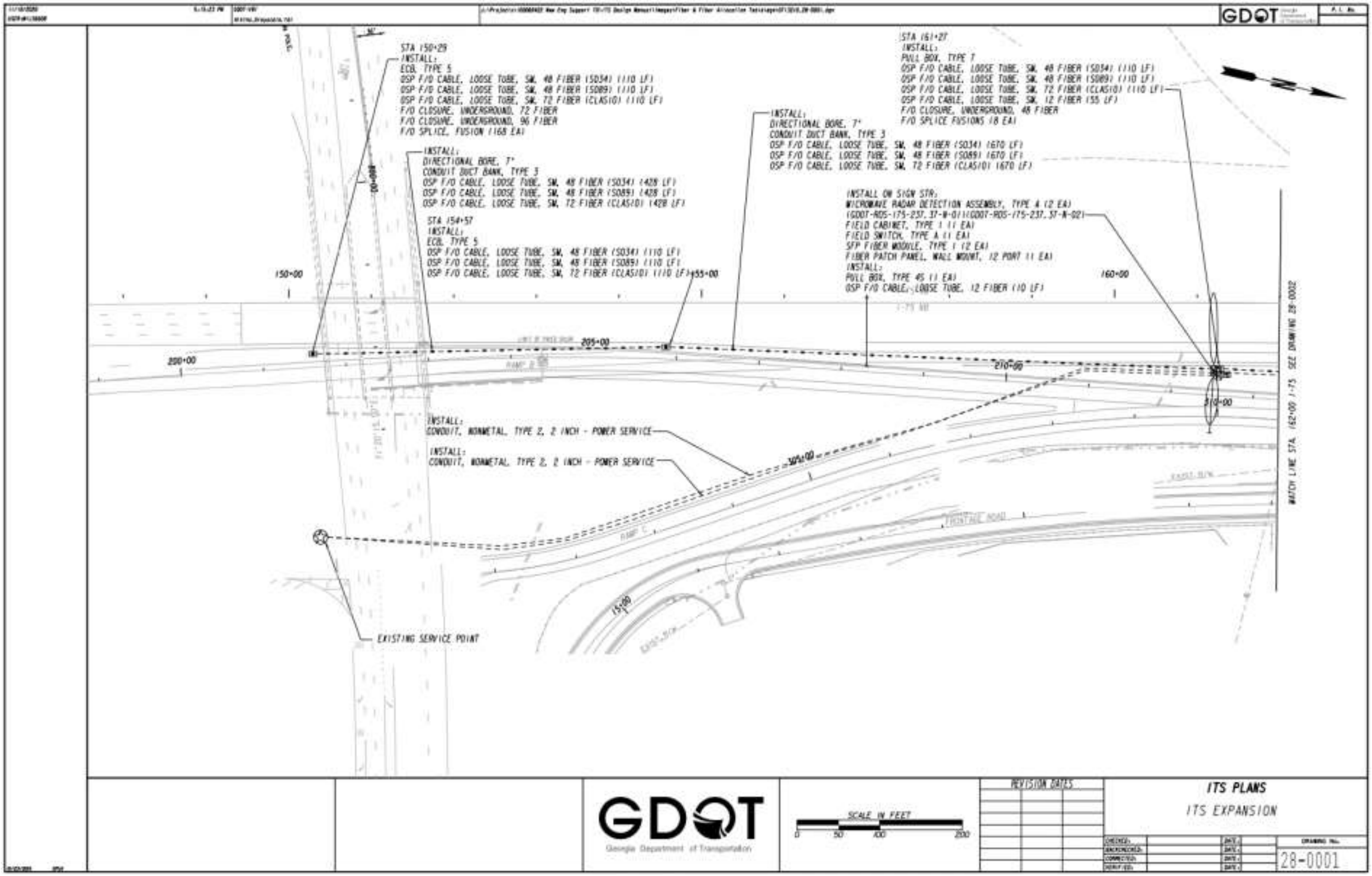
- Wiring Diagram (corresponds with D-5 & D-11)

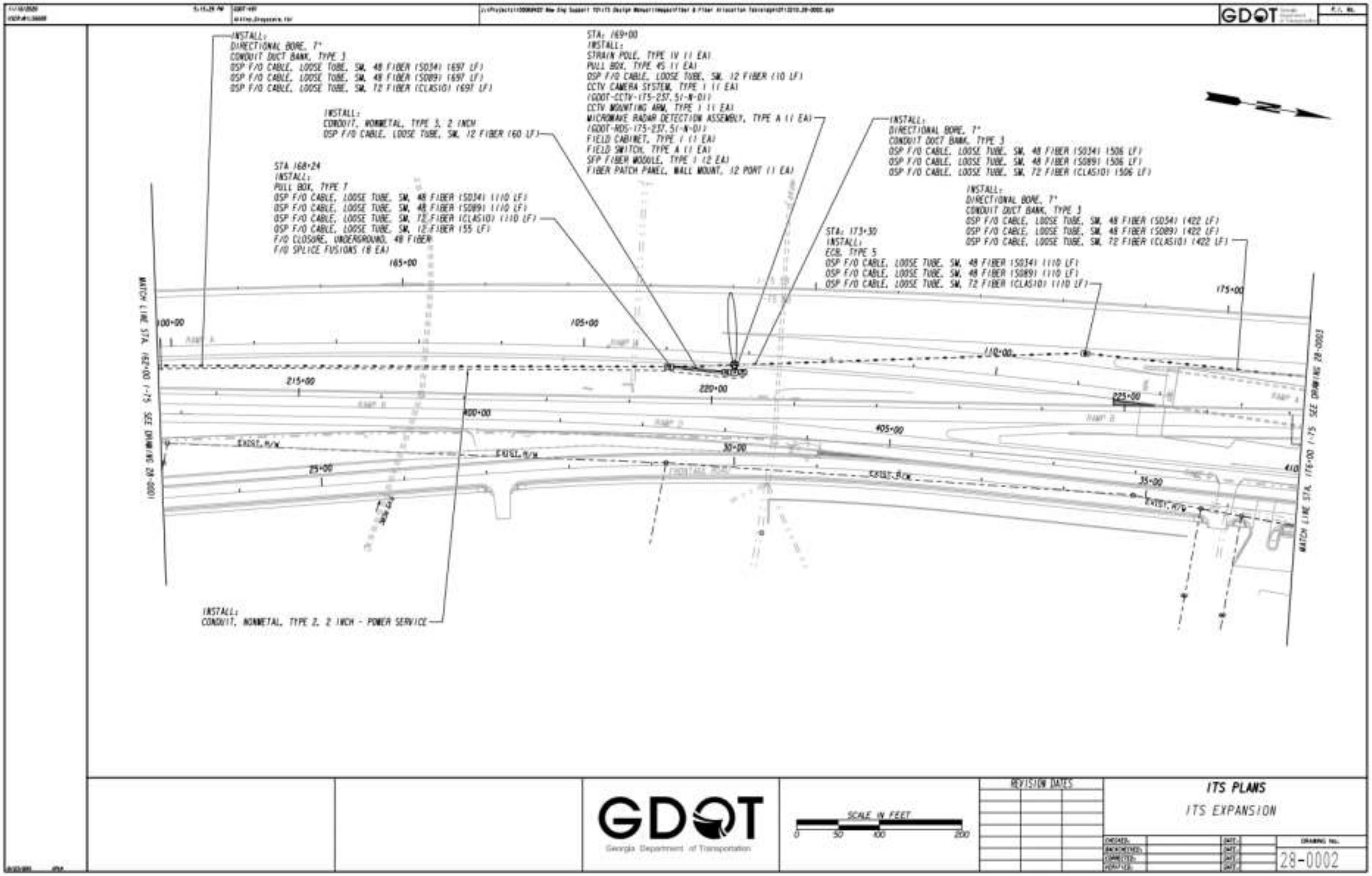

I-675
INSTALL:
POWER SERVICE, AERIAL
INSTALL:
CONDUIT, NONMETAL, TP 2,
2 IN - POWER SERVICE
INSTALL:
CONDUIT, NONMETAL, TP 3, 2 IN, 3 @ 120 LF (360 LF)
INSTALL:
6' X 6' DETECTOR LOOP (1 EA)
CONDUIT, NONMETAL, TP 3, 2 IN
PULL BOX, TYPE 2 (TYP)
INSTALL:
CONDUIT, NONMETAL, TP 3, 2 IN,
2 @ 220 LF (440 LF)
INSTALL:
6' X 6' DETECTOR LOOP (1 EA)
CONDUIT, NONMETAL, TP 3, 2 IN
PULL BOX, TYPE 2 (TYP)
W3-8 (36) (1 EA)
W/ FLASHING BEACON ASSEMBLY (1 EA)
ANVIL BLOCK RD
INSTALL:
CONDUIT, NONMETAL, TP 3, 2 IN, 2 @ 235 LF (470 LF)
GDOT
REVISION DATES
SCALE IN FEET
0
30
60
120
SIGNAL PLANS
I-675 @ ANVIL BLOCK RD
SB RAMP METER
27-0001

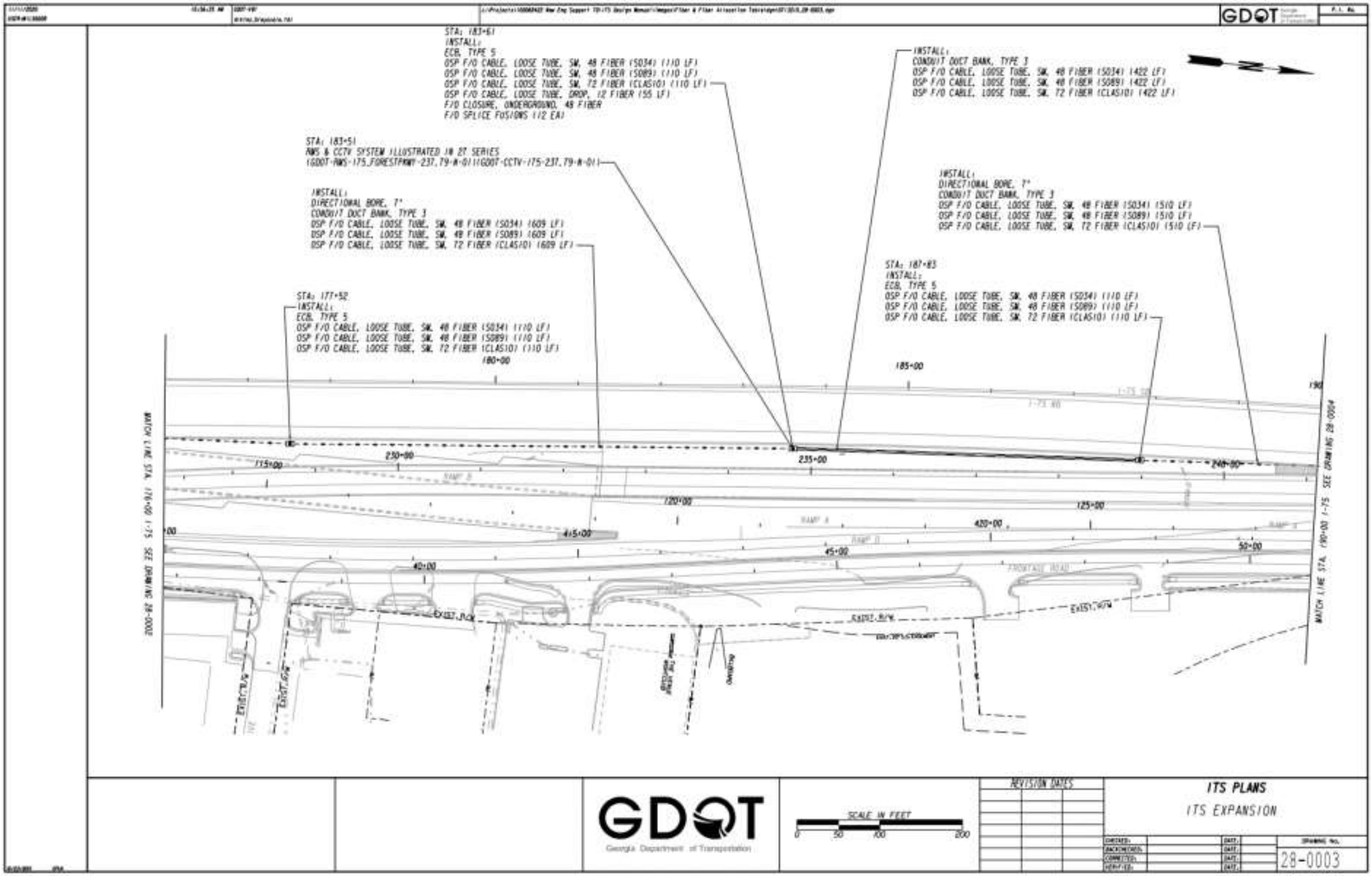


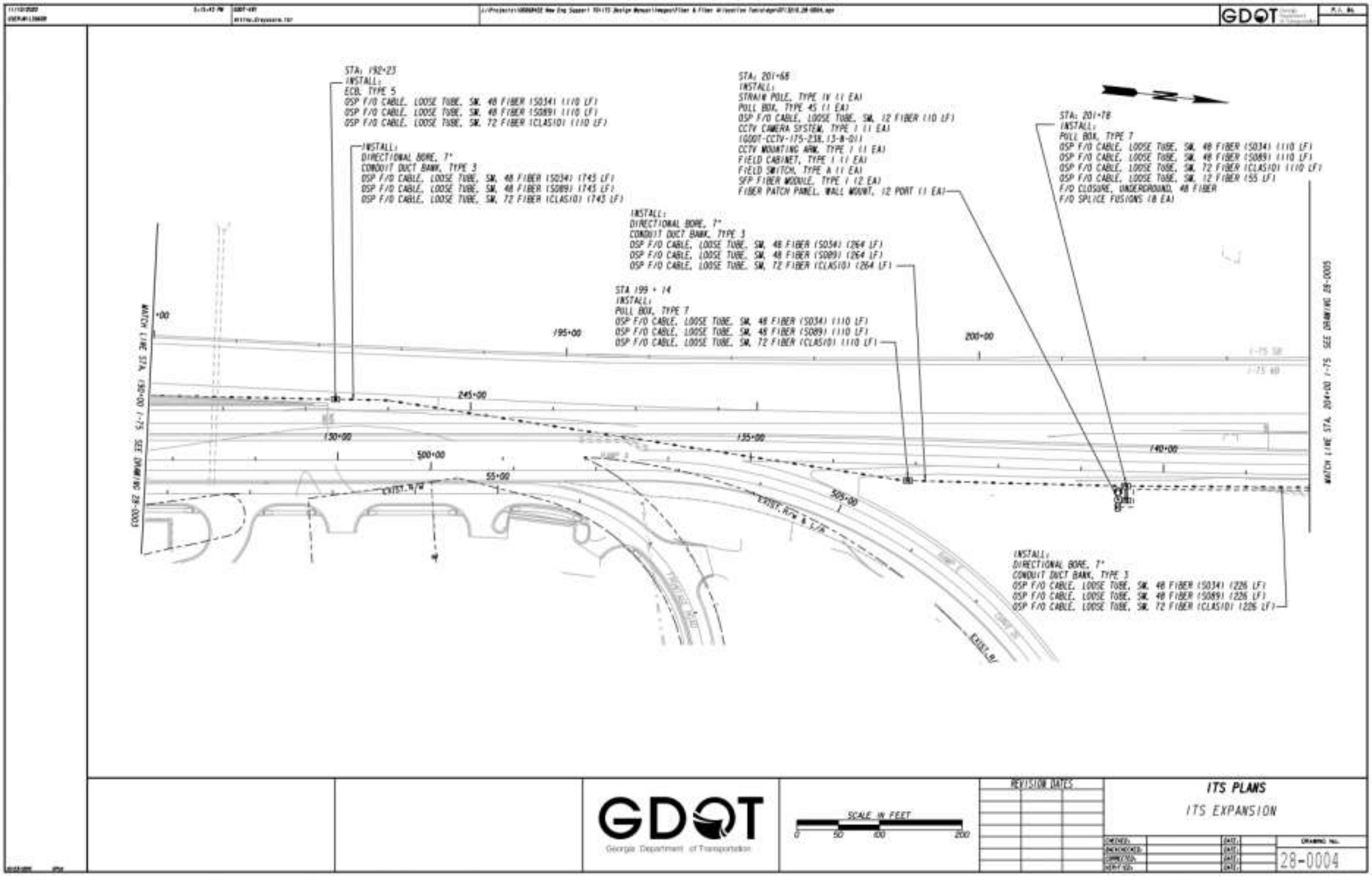
INSTALL IN EXISTING PULL BOX:
F/O CLOSURE, UNDERGROUND, 96 FIBER (1 EA)
F/O SPLICE, FUSION (12 EA)
OSP F/O CABLE, LOOSE TUBE, SM, 12 FIBER (55 LF)
LED SIGNAL HEADS WITH RETROREFLECTIVE BACKPLATES
R
Y
G
I-675
INSTALL:
5" DIRECTIONAL BORE (115 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 12 FIBER (115 LF)
CONDUIT, NONMETAL, TP 3, 2 IN, 2 @ 115 LF (230 LF)
I-675
INSTALL:
24" SOLID WHITE, PREFORMED PLASTIC (15 LF)
PEDESTAL POLE W/ 2-12" SIGNAL HEADS
RAMP ENFORCEMENT DEVICE (1 EA)
RAMP METER SIGNS R10-6R & RM-2
6' X 6' DETECTOR LOOP (1 EA)
6' X 20' DETECTOR LOOP (1 EA)
CONDUIT, NONMETAL, TP 3, 2 IN
PULL BOX, TYPE 4S (1 EA)
INSTALL:
CONDUIT, NONMETAL, TP 3, 2 IN, 2 @ 190 LF (380 LF)
INSTALL:
CONDUIT, NONMETAL, TP 3, 2 IN (135 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 6 FIBER (135 LF)
INSTALL:
CONDUIT, NONMETAL, TP 3, 2 IN, 3 @ 160 LF (480 LF)
INSTALL:
PULL BOX, TYPE 4S (1 EA)
OSP F/O CABLE, LOOSE TUBE, SM, 6 FIBER (10 LF)
INSTALL:
CONDUIT, NONMETAL, TP 2, 2 IN - POWER SERVICE
INSTALL:
PULL BOX, TYPE 2
INSTALL:
334 CABINET (GDOT-RMS-I675-7.05-S-01)
2070LX CONTROLLER (1 EA)
FIELD SWITCH, TYPE A (1 EA)
SFP FIBER MODULE, TYPE I (2 EA)
FIBER PATCH PANEL, WALL MOUNT, 12 PORT (1 EA)
PULL BOX, TYPE 4S (1 EA)
OSP F/O CABLE, LOOSE TUBE, SM, 12 FIBER (10 LF)
STRAIN POLE, TYPE IV (1 EA)
CCTV CAMERA SYSTEM, TYPE I (1 EA)(GDOT-CCTV-I675-7.05-S-01)
CCTV MOUNTING ARM, TYPE I (1 EA)
IVDS, TYPE A (1 EA)
IVDS CABLE
MATCH LINE DRAWING No. 27-0001
GDOT
Georgia Department of Transportation
SCALE IN FEET
0 30 60 120
REVISION DATES
SIGNAL PLANS
I-675 @ ANVIL BLOCK RD
SB RAMP METER
27-0002


APPROXIMATE R/W
I-520
I-520
APPROXIMATE R/W
INSTALL:
POWER SERVICE - AERIAL
INSTALL:
STR SUPPORT FOR OVERHEAD SIGN, TYPE 3 (1 EA)
DMS, TYPE 3 (1 EA)(GDOT-DMS-I520-2, 40-S-01)
PULL BOX, TYPE 4S (1 EA)
INSTALL:
3" DIRECTIONAL BORE (95 LF)
CONDUIT, NONMETAL, TYPE 3, 2 IN (95 LF)
INSTALL:
CONDUIT, NONMETAL, TP 2, 2 IN - POWER SERVICE (TYP)
INSTALL:
STRAIN POLE, TYPE IV (1 EA)
FIELD CABINET, TYPE 1 (1 EA)
CCTV CAMERA SYSTEM, TYPE IP (1 EA)(GDOT-CCTV-I520-2, 29-S-01)
CAMERA LOWERING DEVICE (1 EA)
CCTV MOUNTING ARM, TYPE 1 (1 EA)
WIRELESS SYSTEM, TYPE 4 (1 EA)
INSTALL:
FIELD CABINET, TYPE 3 (1 EA)
WIRELESS SYSTEM, TYPE 4 (1 EA)
PULL BOX, TYPE 4S (1 EA)
PLATFORM (1 EA)
GDOT
Georgia Department of Transportation
SCALE IN FEET
0 50 100 200
REVISION DATES
ITS PLANS
DMS DESIGN
28-0001

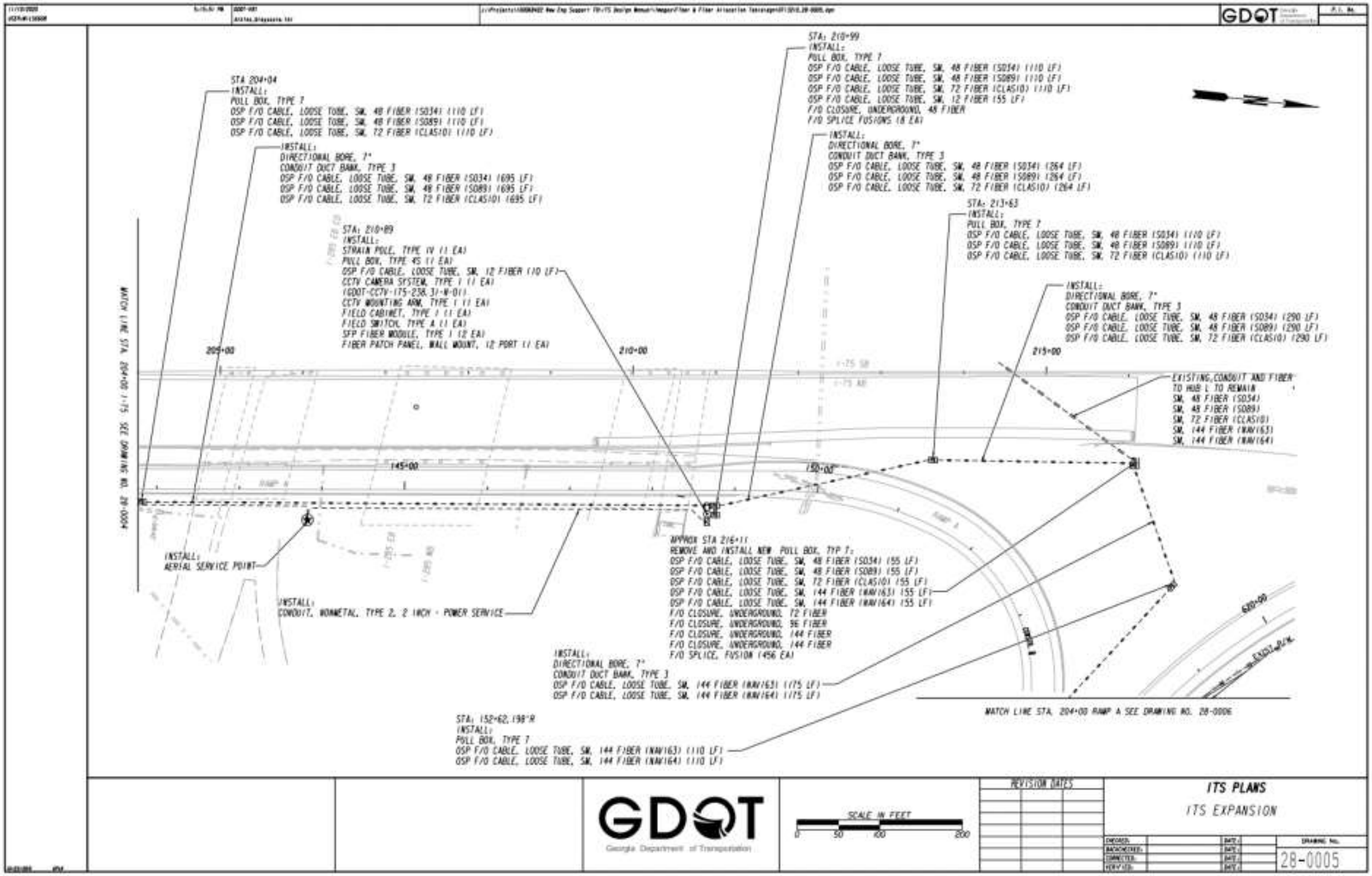

STA 150+29
INSTALL:
ECB, TYPE 5
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (SO34) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (SO89) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLASIO) (110 LF)
F/O CLOSURE, UNDERGROUND, 72 FIBER
F/O CLOSURE, UNDERGROUND, 96 FIBER
F/O SPLICE, FUSION (168 EA)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (SO34) (428 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (SO89) (428 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLASIO) (428 LF)
STA 154+57
INSTALL:
ECB, TYPE 5
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (SO34) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (SO89) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLASIO) (110 LF)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (SO34) (670 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (SO89) (670 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLASIO) (670 LF)
STA 161+27
INSTALL:
PULL BOX, TYPE 7
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (SO34) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (SO89) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLASIO) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 12 FIBER (55 LF)
F/O CLOSURE, UNDERGROUND, 48 FIBER
F/O SPLICE FUSIONS (8 EA)
INSTALL ON SIGN STR:
MICROWAVE RADAR DETECTION ASSEMBLY, TYPE A (2 EA)
FIELD CABINET, TYPE 1 (1 EA)
FIELD SWITCH, TYPE A (1 EA)
SFP FIBER MODULE, TYPE 1 (2 EA)
FIBER PATCH PANEL, WALL MOUNT, 12 PORT (1 EA)
INSTALL:
PULL BOX, TYPE 4S (1 EA)
OSP F/O CABLE, LOOSE TUBE, 12 FIBER (10 LF)
150+00
155+00
160+00
200+00
205+00
210+00
INSTALL:
CONDUIT, NONMETAL, TYPE 2, 2 INCH - POWER SERVICE
INSTALL:
CONDUIT, NONMETAL, TYPE 2, 2 INCH - POWER SERVICE
EXISTING SERVICE POINT
RAMP C
FRONTAGE ROAD
WATCH LINE STA. 162+00 I-75 SEE DRAWING 28-0002
GDOT
Georgia Department of Transportation
SCALE IN FEET
0 50 100 200
REVISION DATES
ITS PLANS
ITS EXPANSION
DRAWING No.
28-0001

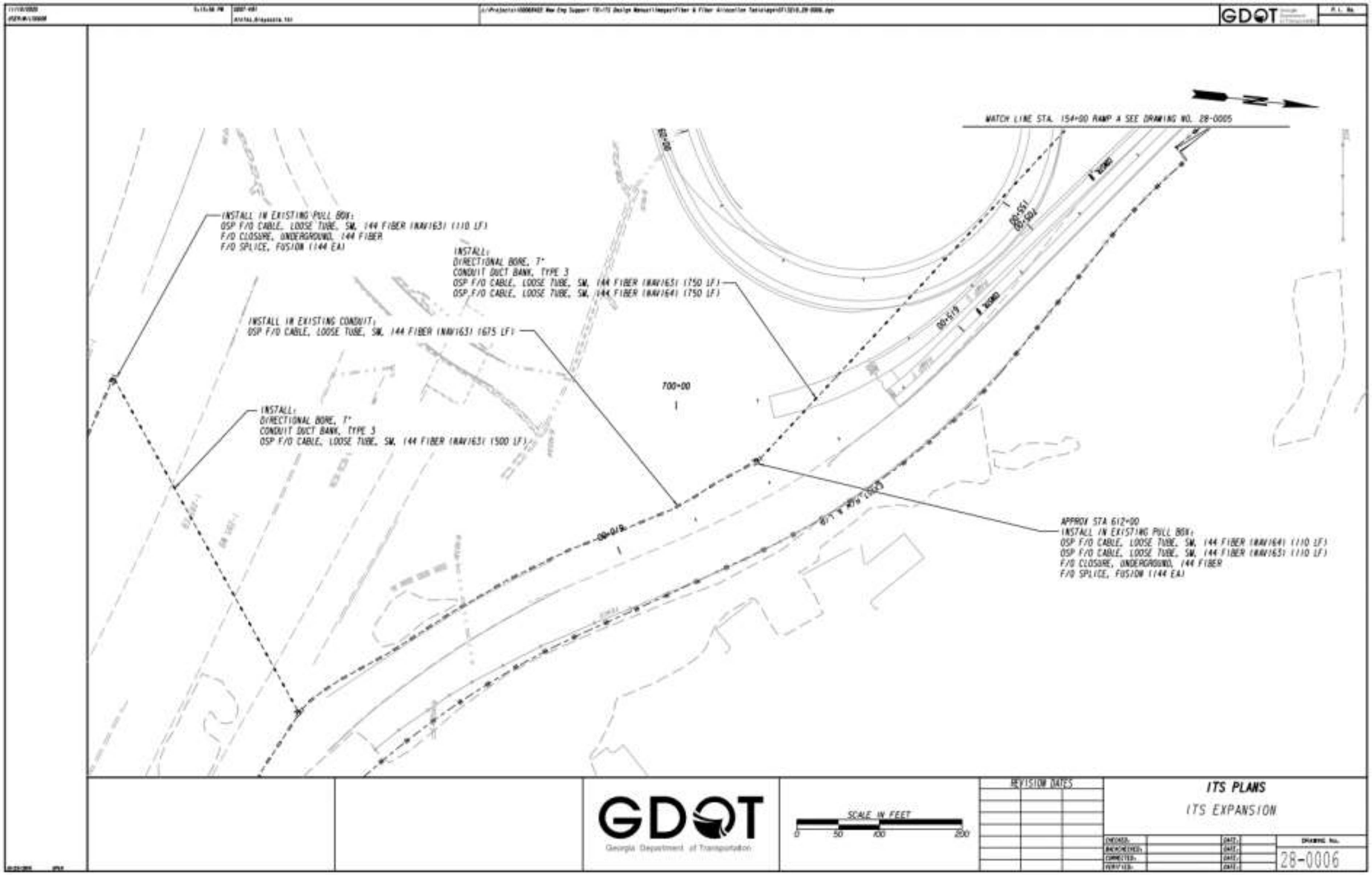

INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (697 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (697 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (697 LF)
INSTALL:
CONDUIT, NONMETAL, TYPE 3, 2 INCH
OSP F/O CABLE, LOOSE TUBE, SM, 12 FIBER (60 LF)
STA 168+24
INSTALL:
PULL BOX, TYPE 7
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 12 FIBER (55 LF)
F/O CLOSURE, UNDERGROUND, 48 FIBER
F/O SPLICE FUSIONS (8 EA)
STA: 169+00
INSTALL:
STRAIN POLE, TYPE IV (1 EA)
PULL BOX, TYPE 45 (1 EA)
OSP F/O CABLE, LOOSE TUBE, SM, 12 FIBER (10 LF)
CCTV CAMERA SYSTEM, TYPE 1 (1 EA)
(GDOT-CCTV-I75-237.5(-N-01)
CCTV MOUNTING ARM, TYPE 1 (1 EA)
MICROWAVE RADAR DETECTION ASSEMBLY, TYPE A (1 EA)
(GDOT-RDS-I75-237.5(-N-01)
FIELD CABINET, TYPE I (1 EA)
FIELD SWITCH, TYPE A (1 EA)
SFP FIBER MODULE, TYPE I (2 EA)
FIBER PATCH PANEL, WALL MOUNT, 12 PORT (1 EA)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (506 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (506 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (506 LF)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (422 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (422 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (422 LF)
STA: 173+30
INSTALL:
ECB, TYPE 5
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (110 LF)
INSTALL:
CONDUIT, NONMETAL, TYPE 2, 2 INCH - POWER SERVICE
MATCH LINE STA. 162+00 I-75 SEE DRAWING 28-0001
MATCH LINE STA. 176+00 I-75 SEE DRAWING 28-0003
165+00
175+00
105+00
110+00
215+00
220+00
225+00
400+00
405+00
25+00
30+00
35+00
EXIST. R/W
REVISION DATES
ITS PLANS
ITS EXPANSION
SCALE IN FEET
0
50
100
200
GDOT
Georgia Department of Transportation
DRAWING NO.
28-0002


STA: 183+61
INSTALL:
ECB, TYPE 5
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (110 LF)
OSP F/O CABLE, LOOSE TUBE, DROP, 12 FIBER (55 LF)
F/O CLOSURE, UNDERGROUND, 48 FIBER
F/O SPLICE FUSIONS (12 EA)
STA: 183+51
RWS & CCTV SYSTEM ILLUSTRATED IN 2T SERIES
(GDOT-RWS-I75_FORESTPKWY-237.79-N-01)(GDOT-CCTV-I75-237.79-N-01)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (609 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (609 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (609 LF)
STA: 177+52
INSTALL:
ECB, TYPE 5
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (110 LF)
INSTALL:
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (422 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (422 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (422 LF)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (510 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (510 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (510 LF)
STA: 187+83
INSTALL:
ECB, TYPE 5
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (110 LF)
180+00
185+00
230+00
235+00
240+00
115+00
120+00
125+00
420+00
45+00
50+00
40+00
MATCH LINE STA. 176+00 I-75 SEE DRAWING 28-0002
MATCH LINE STA. 190+00 I-75 SEE DRAWING 28-0004
EXIST. R/W
GDOT
Georgia Department of Transportation
SCALE IN FEET
0 50 100 200
REVISION DATES
ITS PLANS
ITS EXPANSION
CHECKED:
BACKCHECKED:
CORRECTED:
VERIFIED:
DATE:
DRAWING No.
28-0003



STA: 192+23
INSTALL:
ECB, TYPE 5
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5034) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5089) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (110 LF)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5034) (745 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5089) (745 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (745 LF)
STA: 201+68
INSTALL:
STRAIN POLE, TYPE IV (1 EA)
PULL BOX, TYPE 45 (1 EA)
OSP F/O CABLE, LOOSE TUBE, SM, 12 FIBER (10 LF)
CCTV CAMERA SYSTEM, TYPE 1 (1 EA)
(GDOT-CCTV-175-238, 13-N-01)
CCTV MOUNTING ARM, TYPE 1 (1 EA)
FIELD CABINET, TYPE 1 (1 EA)
FIELD SWITCH, TYPE A (1 EA)
SFP FIBER MODULE, TYPE 1 (2 EA)
FIBER PATCH PANEL, WALL MOUNT, 12 PORT (1 EA)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5034) (264 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5089) (264 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (264 LF)
STA 199 + 14
INSTALL:
PULL BOX, TYPE 7
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5034) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5089) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (110 LF)
STA: 201+78
INSTALL:
PULL BOX, TYPE 7
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5034) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5089) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 12 FIBER (55 LF)
F/O CLOSURE, UNDERGROUND, 48 FIBER
F/O SPLICE FUSIONS (8 EA)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5034) (226 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (5089) (226 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (226 LF)
195+00
200+00
245+00
130+00
135+00
140+00
500+00
55+00
505+00
EXIST. R/W
MATCH LINE STA. 190+00 I-75 SEE DRAWING 28-0003
MATCH LINE STA. 204+00 I-75 SEE DRAWING 28-0005
REVISION DATES
ITS PLANS
ITS EXPANSION
SCALE IN FEET
0 50 100 200
GDOT
Georgia Department of Transportation
28-0004


STA 204+04
INSTALL:
PULL BOX, TYPE 7
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (110 LF)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (695 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (695 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (695 LF)
STA: 210+89
INSTALL:
STRAIN POLE, TYPE IV (1 EA)
PULL BOX, TYPE 45 (1 EA)
OSP F/O CABLE, LOOSE TUBE, SM, 12 FIBER (10 LF)
CCTV CAMERA SYSTEM, TYPE 1 (1 EA)
(GDOT-CCTV-175-238.31-N-01)
CCTV MOUNTING ARM, TYPE 1 (1 EA)
FIELD CABINET, TYPE 1 (1 EA)
FIELD SWITCH, TYPE A (1 EA)
SFP FIBER MODULE, TYPE 1 (2 EA)
FIBER PATCH PANEL, WALL MOUNT, 12 PORT (1 EA)
STA: 210+99
INSTALL:
PULL BOX, TYPE 7
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 12 FIBER (55 LF)
F/O CLOSURE, UNDERGROUND, 48 FIBER
F/O SPLICE FUSIONS (8 EA)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (264 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (264 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (264 LF)
STA: 213+63
INSTALL:
PULL BOX, TYPE 7
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (110 LF)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (290 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (290 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (290 LF)
205+00
210+00
215+00
145+00
150+00
MATCH LINE STA. 204+00 I-75 SEE DRAWING NO. 28-0004
EXISTING CONDUIT AND FIBER TO HUB L TO REMAIN
SM, 48 FIBER (S034)
SM, 48 FIBER (S089)
SM, 72 FIBER (CLAS10)
SM, 144 FIBER (NAV163)
SM, 144 FIBER (NAV164)
INSTALL:
AERIAL SERVICE POINT
INSTALL:
CONDUIT, NONMETAL, TYPE 2, 2 INCH - POWER SERVICE
APPROX STA 216+11
REMOVE AND INSTALL NEW PULL BOX, TYP 7:
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S034) (55 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 48 FIBER (S089) (55 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 72 FIBER (CLAS10) (55 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV163) (55 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV164) (55 LF)
F/O CLOSURE, UNDERGROUND, 72 FIBER
F/O CLOSURE, UNDERGROUND, 96 FIBER
F/O CLOSURE, UNDERGROUND, 144 FIBER
F/O CLOSURE, UNDERGROUND, 144 FIBER
F/O SPLICE, FUSION (456 EA)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV163) (175 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV164) (175 LF)
STA: 152+62, 198'R
INSTALL:
PULL BOX, TYPE 7
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV163) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV164) (110 LF)
MATCH LINE STA. 204+00 RAMP A SEE DRAWING NO. 28-0006
630+00
REVISION DATES
SCALE IN FEET
0 50 100 200
GDOT
Georgia Department of Transportation
ITS PLANS
ITS EXPANSION
DRAWING No.
28-0005


WATCH LINE STA. 154+00 RAMP A SEE DRAWING NO. 28-0005
INSTALL IN EXISTING PULL BOX:
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV163) (110 LF)
F/O CLOSURE, UNDERGROUND, 144 FIBER
F/O SPLICE, FUSION (144 EA)
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV165) (750 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV164) (750 LF)
INSTALL IN EXISTING CONDUIT:
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV163) (675 LF)
700+00
INSTALL:
DIRECTIONAL BORE, 7"
CONDUIT DUCT BANK, TYPE 3
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV163) (500 LF)
APPROX STA 612+00
INSTALL IN EXISTING PULL BOX:
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV164) (110 LF)
OSP F/O CABLE, LOOSE TUBE, SM, 144 FIBER (NAV163) (110 LF)
F/O CLOSURE, UNDERGROUND, 144 FIBER
F/O SPLICE, FUSION (144 EA)
GDOT
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SCALE IN FEET
0
50
100
200
REVISION DATES
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28-0006

FIBER ALLOCATION TABLE 1 OF 2

DEVICE LOCATION (STATION #)	SIN	PARTIAL ASSET NAME: RDS ID #	PARTIAL ASSET NAME: CCTV ID #	PARTIAL ASSET NAME: RMS ID #	TRUNK CABLE.FIBER # OR DROP CABLE ID : FIBER # (DROP TO DROP CABLE		DROP CABLE ID: ID	DROP CABLE ID: FIBER #	DESTINATION OR FPP/FDU PORT	FUNCTION
161+27	GDOT-OSS-I75-CN-237.37-N-A	GDOT-RDS-I75-237.37-N-01			5034.19		5034-001	51	HUBNFODISTR07030903	RX1
		GDOT-RDS-I75-237.37-N-02			5034.20		5034-001	52	HUBNFODISTR07030904	TX1
					5034.21		5034-001	53	HUBNFODISTR07030905	RX1-SPARE
					5034.22		5034-001	54	HUBNFODISTR07030906	TX1-SPARE
					5034.23		5034-001	55		
					5034.24		5034-001	56		
					5034.19		5034-001	57	169+00	TX2
					5034.20		5034-001	58	169+00	RX2
					5034.21		5034-001	59	169+00	TX2-SPARE
					5034.22		5034-001	510	169+00	RX2-SPARE
					5034.23		5034-001	511		
					5034.24		5034-001	512		
169+00	GDOT-POLE-I75-CN-237.51-N-A	GDOT-RDS-I75-237.51-N-01	GDOT-CCTV-I75-237.51-N-01		5034.19		5034-002	51	161+27	RX1
					5034.20		5034-002	52	161+27	TX1
					5034.21		5034-002	53	161+27	RX1-SPARE
					5034.22		5034-002	54	161+27	TX1-SPARE
					5034.23		5034-002	55		
					5034.24		5034-002	56		
					5034.19		5034-002	57	183+51	TX2
					5034.20		5034-002	58	183+51	RX2
					5034.21		5034-002	59	183+51	TX2-SPARE
					5034.22		5034-002	510	183+51	RX2-SPARE
					5034.23		5034-002	511		
					5034.24		5034-002	512		
183+51	GDOT-CAB-I75-CN-237.79-N-A		GDOT-CCTV-I75-237.79-N-01	GDOT-RMS-I75_FORESTPKWY-237.79-N-01	5034.19		5034-003	51	169+00	RX1
					5034.20		5034-003	52	169+00	TX1
					5034.21		5034-003	53	169+00	RX1-SPARE
					5034.22		5034-003	54	169+00	TX1-SPARE
					5034.23		5034-003	55		
					5034.24		5034-003	56		
					5034.19		5034-003	57	201+68	TX2
					5034.20		5034-003	58	201+68	RX2
					5034.21		5034-003	59	201+68	TX2-SPARE
					5034.22		5034-003	510	201+68	RX2-SPARE
					5034.23		5034-003	511		
					5034.24		5034-003	512		

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SCALE IN FEET 0 50 100 200

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FIBER ALLOCATION TABLE 2 OF 2

DEVICE LOCATION (STATION #)	SIN	PARTIAL ASSET NAME: RDS ID #	PARTIAL ASSET NAME: CCTV ID #	PARTIAL ASSET NAME: RMS ID #	TRUNK CABLE.FIBER # OR DROP CABLE ID : FIBER # (DROP TO DROP CABLE	DROP CABLE ID : ID	DROP CABLE ID : FIBER #	DESTINATION OR FPP/FDU PORT	FUNCTION
201+68	GDOT- POLE-I75-CN-238.13-N-A		GDOT-CCTV-I75-238.13-N-01		S034.19	S034-004	S1	183+51	RX1
					S034.20	S034-004	S2	183+51	TX1
					S034.21	S034-004	S3	183+51	RX1-SPARE
					S034.22	S034-004	S4	183+51	TX1-SPARE
					S034.23	S034-004	S5		
					S034.24	S034-004	S6		
					S034.19	S034-004	S7	210+89	TX2
					S034.20	S034-004	S8	210+89	RX2
					S034.21	S034-004	S9	210+89	TX2-SPARE
					S034.22	S034-004	S10	210+89	RX2-SPARE
					S034.23	S034-004	S11		
					S034.24	S034-004	S12		
210+89	GDOT-POLE-I75-CN-238.31-N-A		GDOT-CCTV-I75-238.31-N-01		S034.19	S034-005	S1	201+68	RX1
					S034.20	S034-005	S2	201+68	TX1
					S034.21	S034-005	S3	201+68	RX1-SPARE
					S034.22	S034-005	S4	201+68	TX1-SPARE
					S034.23	S034-005	S5		
					S034.24	S034-005	S6		
					S034.19	S034-005	S7	HUBLFOJISTR07060401	TX2
					S034.20	S034-005	S8	HUBLFOJISTR07060402	RX2
					S034.21	S034-005	S9	HUBLFOJISTR07060403	TX2-SPARE
					S034.22	S034-005	S10	HUBLFOJISTR07060404	RX2-SPARE
					S034.23	S034-005	S11		
					S034.24	S034-005	S12		

GDOT Georgia Department of Transportation

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REVISION DATES

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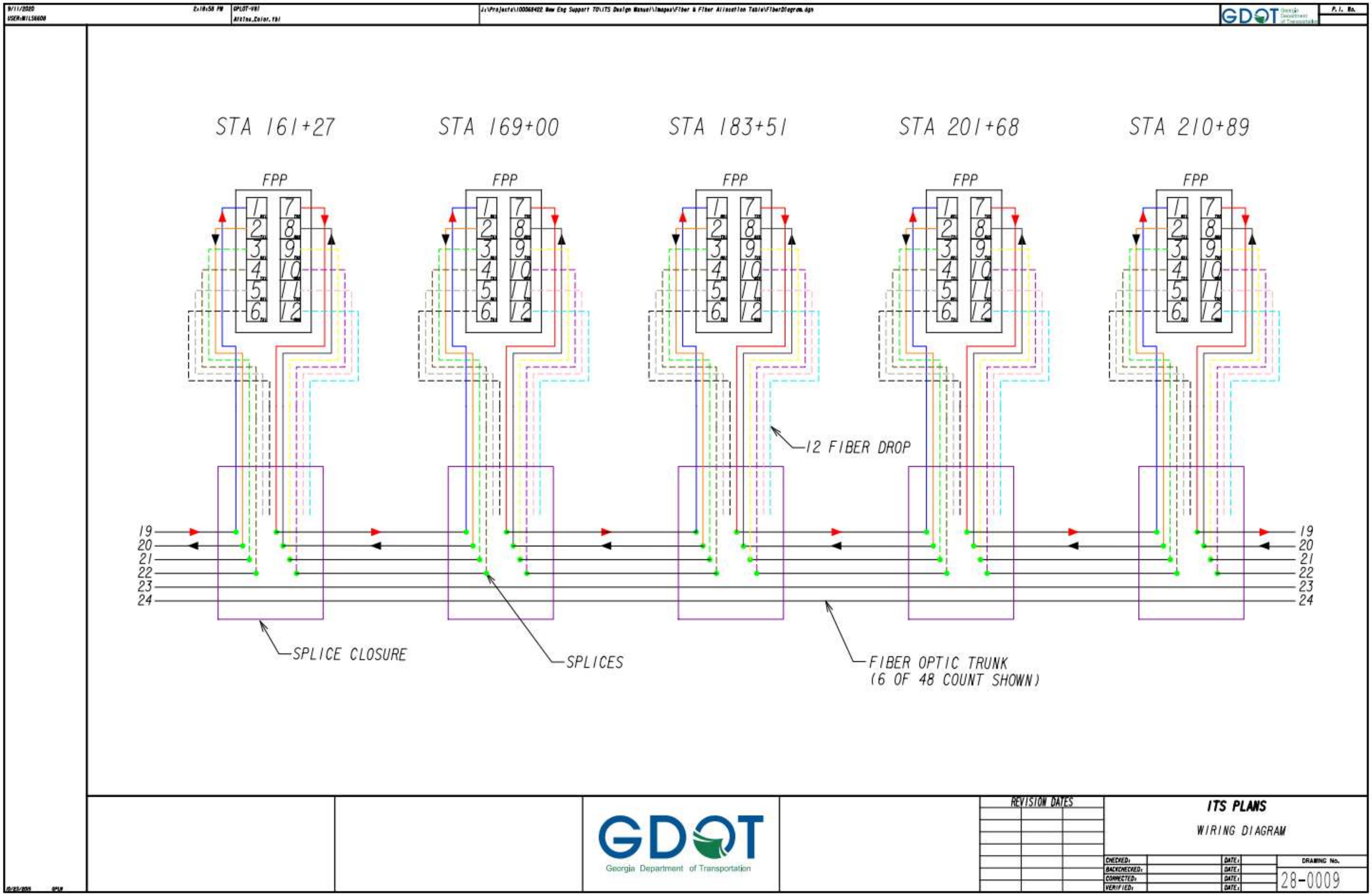
STA 161+27
STA 169+00
STA 183+51
STA 201+68
STA 210+89
FPP
12 FIBER DROP
SPLICE CLOSURE
SPLICES
FIBER OPTIC TRUNK
(6 OF 48 COUNT SHOWN)
19
20
21
22
23
24
REVISION DATES
ITS PLANS
WIRING DIAGRAM
CHECKED:
BACKCHECKED:
CORRECTED:
VERIFIED:
DATE:
DRAWING No.
28-0009
Georgia Department of Transportation

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