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SECTION 1: INTRODUCTION AND STANDARDS

Good visibility under day or night conditions is one of the fundamental requirements enabling motorists to move along roadways in a safe and coordinated manner. Properly designed and maintained street lighting should produce uniform lighting levels conforming to industry standards. Those levels should facilitate the visibility of motorists, pedestrians, and other objects at night or in situations in which light levels are diminished (i.e., a tunnel).

VIRGINIA’S LIGHTING LAW (SENATE BILL SB379 & SB1351)

Senate Bills SB379 and its amendment SB1351 were passed by the Virginia Assembly and signed into law effective July 1, 2003. The law provides strict requirements on the procurement of light fixtures. The law states:

> Require state public bodies to procure only shielded outdoor light fixtures and provide for waivers of this requirement when the Division determines that a bona fide operational, temporary, safety or specific aesthetic need is indicated or that such fixtures are not cost effective over the life cycle of the fixtures. For the purposes of this subdivision, "shielded outdoor light fixture" means an outdoor light fixture that is (i) fully shielded so that no light rays are emitted by the installed fixture above the horizontal plane or (ii) constructed so that no more than 2 percent of the total luminaire lumens in the zone of 90 to 180 degrees vertical angle is permitted, if the related output of the luminaire is greater than 3200 lumens. In adopting regulations under this subdivision, the Division shall consider national standards for outdoor lighting as adopted by the Illuminating Engineering Society of North America (IESNA).

Effective July 1, 2003, the Virginia Department of Transportation shall design all lighting systems in accordance with current IESNA standards and recommended practices. The lighting system shall utilize fixtures that minimize glare, light trespass, and skyglow, all as defined by the IESNA, while still providing a comfortable, visually effective, safe, and secure outdoor environment in a cost-effective manner over the life cycle of the lighting system.

- Any roadway lighting designed, installed or funded under the auspices of the Department must be in accordance with this legislation. This includes, but is not limited to, construction projects, lighting installed by permit, intersection lighting (including that installed by Regional Signal Contracts), etc. Typically the Central Office Location and Design (L&D) Division Traffic Engineering Design Section designs or reviews designs of others to ensure the lighting designs are appropriate.

- For VDOT traffic signal projects with proposed intersection lighting, if a standard design does not apply to a specific intersection configuration, VDOT Central Office L&D Division Traffic Engineering Design Section shall review or provide lighting designs for those locations to ensure compliance.
Additionally, any maintenance or maintenance replacement of the lighting system must be done in a manner not to alter the integrity of the original design. Any luminaire replacement must be identical to those originally installed or a new design or design review will need to occur.

1.1 ACKNOWLEDGMENTS
The following references are used throughout the Section:
- FHWA Roadway Lighting Handbook
- AASHTO An Informational Guide for Roadway Lighting
- The National Electric Code (NEC), National Fire Protection Association (NFPA). (Latest adopted NFPA 70/NEC by VDOT)

1.2 LIGHTING ANALYSIS METHODS
VDOT requires all roadway lighting designs to meet the lighting criteria as discussed in the current IESNA publication, Recommended Practices for Roadway Lighting (RP-8). The illuminance criteria must be met for all sections of a roadway project. This guideline also includes meeting the criteria for the Veiling Luminance Ratio \( \left( \frac{L_v}{L_{ave}} \right) \) and The Luminance Method.

The AGI-32 lighting design software or other lighting design software shall be utilized to determining the levels required for the final roadway light plan.

1.3 LIGHTING LEVELS
The design must be appropriate for the site and must provide the level and uniformity of light suggested in the current IESNA publication, Recommended Practices for Roadway Lighting (RP-8). The recommended design values represent the minimum maintained average lighting level. Facilities may be designed with higher average lighting levels, but must provide the required uniformity. In all cases, the VDOT Traffic Engineering/Location and Design Manager must approve higher lighting levels.

1.4 LAMP AND LUMINAIRE DEPRECIATION FACTORS
The lighting system designer must consider the luminaire maintenance factor, or light loss factor (LLF) in determining the light output for a luminaire (LLF detail in Figure 2-1). For further information, see the FHWA Roadway Lighting Handbook at: http://safety.fhwa.dot.gov/roadway_dept/night_visib/lighting_handbook/.
Specifically: The LLF for a conventional luminaire is:
LLF = 0.8(LLD) x 0.85(LDD) x 0.95(ballast factor) = 0.65

The following values for LLF are used on VDOT lighting projects:

Conventional and Offset lighting standards:
LLF = 0.65

High Mast lighting standards:
LLF = 0.72

Architectural lighting
LLF = 0.72

Figure 2-1: Light Loss Factor

1.5 VDOT LIGHTING STANDARDS

Pole Standard LP-1
Used for Conventional (Cobra Head) or Shoebox Luminaires. The most common structure used is the 30-foot to 50-foot pole with a luminaire and bracket arm. The bracket arm typically places the luminaire directly over the edge of the travel lane.

Pole Standard LP-2
Used for Offset or Shoebox Luminaires. The offset pole is typically a 30-foot to 50-foot pole with a luminaire. New offset luminaires are frequently mounted with a 0-degree tilt, or pointing straight down, with single or double tenon.
Pole Standard LP-3
Used for High Mast Luminaires. High mast lighting implies an area type of lighting with 3 to 12, 250-watt, 400-watt, 750-watt, or 1000-watt HPS luminaires mounted on poles or towers, at heights varying from approximately 60 feet to 150 feet. At these mounting heights, high-output luminaires develop a uniform light distribution. The luminaire assembly is hoisted to the top of the tower by a winch located in the base of the pole. Although the VDOT Road and Bridge Standards only note standard pole lengths from 70 to 140 feet, other lengths are available from several manufacturers.

Transformer Bases
Conventional and offset lighting poles may be mounted to the concrete foundation anchor bolts using a transformer base. The transformer base provides a convenient splice point for the electrical system and can provide an economical alternative to placing a junction box at the base of each pole.

1.6 VDOT LIGHTING POLE FOUNDATIONS

Conventional and Offset Lighting Standard Pole Foundation (LF-1)
The VDOT Standard LF-1 Type A Foundation provides support for the LP-1 and LP-2 lighting standards. This foundation is cast-in-place, 8-feet deep, with a 30-inch diameter. It is also known as a “drilled shaft” foundation.

The design engineer cannot assume that this foundation will work in every case. The engineer sealing the lighting plan must recognize soil characteristics and finished grade, along with the light pole loading, to provide a foundation suitable to support the light pole. In areas with marshy soil, or shifting sands, or in areas that have very shallow hard rock formations, the lighting designer should consider specifying a special design pole foundation. The Department must approve non-standard foundations.

High Mast Lighting Pole Foundation
The contractor will provide the design of the high mast pole foundation based on a test bore specified on the plans. All high mast pole foundations require a test bore. The requirements for the structure and test bore are covered in the VDOT Road and Bridge Specifications at: [http://www.vdot.virginia.gov/business/const/spec-default.asp](http://www.vdot.virginia.gov/business/const/spec-default.asp).

Bridge Mount Lighting Pole Foundation
The VDOT Standard Bridge Conduit System includes a light pole foundation suitable to support a 40’ cobrahead lighting pole with a 6’ luminaire arm. A more complete discussion of this foundation’s capabilities can be found under the, “Notes to Designer”, for the bridge conduit system.
1.7 VDOT ELECTRICAL SERVICE

VDOT roadway lighting systems are typically powered by 480/277 VAC 3-phase Y connection service. Roadway lighting/signal combination poles operate on 120/240 VAC, single-phase power for intersection. Remote sign lights and ITS equipment also operate on 120/240 VAC, single-phase power. The following is a description of the standard electrical services and lighting control centers used by VDOT for roadway lighting. Drawings are in VDOT Road and Bridge Standards, Section 1300, available at: http://www.vdot.virginia.gov/business/locdes/2008_road_and_bridge_standards.asp.

Type A or Type B configurations are chosen depending on the service entrance, overhead or underground.

Electrical Service SE-9 Type A and B

- The SE-9 is the primary VDOT standard for electrical service, which is used for the distribution of 480/277 VAC, 3-phase power system.
- **The Type A** system, provides a separate concrete foundation for a control center cabinet. This configuration is typically used for the majority of the VDOT lighting control centers.
- **The Type B** system provides a lighting control center cabinet mounted to the metal frame. This configuration should be considered when only a few circuits are required and the loads are small.
- Some situations may require the roadway lighting system to share an electrical service with the ITS system. In this case, a separate Lighting Control Center (CCW-1) and a separate concrete foundation (CF-2) would be required along with a modified SE-9 with 2 safety switches and step down transformer(s).

Electrical Service SE- 1, 2, 3, 4, 5, 6, 7, 8, 10, 11

These Electrical Service standards are used on 120/240 VAC, single-phase power systems. Some lighting systems may be located where 3-phase power is not available, or the systems may have very low power requirements and can operate on 120/240 VAC, single-phase power. See detail drawings in VDOT Road and Bridge Standards, Section 1300 at: http://www.vdot.virginia.gov/business/locdes/2008_road_and_bridge_standards.asp.

Example:
The SE-6 Electrical Service includes a meter base, a fused safety switch, with an associated ground mounted cabinet that is more suitable to a large system that requires plenty of room for circuits and contactors.

The SE-7 and SE-8 Electrical Service includes a meter base, a fused safety switch, conduit, grounding equipment, and a wood pole for mounting the hardware.

The SE-8 also provides for the installation of a small lighting control cabinet and photocell, as shown Figure 2-5. This system might be used in powering several overhead signs and/or an under bridge lighting system at various locations around an interchange.
The **SE-10** and **SE-11** Electrical Services are designed with two (2) meter bases and safety switches to accommodate flexibility in order to separate street lighting and traffic signal services.

**VDOT Standard Lighting Control Centers**

The lighting plans must identify the rating of the contactors and breaker to be installed. The contactors, controlled by the photocell provide the on-off switching of the lighting system at dusk and dawn. It is not uncommon to oversize them. For example, most roadway lighting contactors’ operating circuits carrying 15-amps to 35-amps, and are rated 60-amps per pole. Circuit breakers are single pole and normally sized at 125% of normal operating current.

VDOT standard **CCW-1 Type D, or Type H** Control Center is required on roadway lighting projects involving the distribution of 3-phase, 480/277 VAC power system for \( \Delta \) configuration.

VDOT standard **CCW-1 Type C, or Type G** Control Center is required on roadway lighting projects involving the distribution of single-phase, 120/240 VAC power system.

### 1.8 CONDUIT

VDOT specifications recognize all NEC conduit trade sizes. However, the following items have become the preferred standards:

- PVC schedule-40 conduit is used for all buried conduit runs.
- Metal conduit is preferred for all exposed conduit runs.
- 2” conduit is typically the smallest size used throughout a roadway electrical system, except as branch conduits for under bridge lighting and sign lighting.
- 1” and \( \frac{3}{4} \)” metal conduit work best for an under bridge lighting system.
- 3” or 4” conduit sizes are frequently specified when the NEC conduit fill requirements demand a size larger than 2”.
- Placing multiple conduits in the same trench is an acceptable practice as far as they are spaced properly.
- When running conductors under a bridge, the exposed bridge abutment can provide a suitable location for the exposed conduit, as shown in Figure 2-6.
- The Equipment Grounding Conductor (EGC) is incidental to the installation of new conduit.
- Metal conduit does not require an EGC, but shall be bonded in accordance with NEC.

### 1.9 TRANSFORMER BASES VERSUS JUNCTION BOXES

The transformer base provides a convenient splice point for the electrical system and can provide an economical alternative to placing a junction box at the base of each pole.
The requirement to install a transformer base with a light pole does not necessarily imply the use of a breakaway base. The breakaway base can be installed with or without a transformer base.

1.10 CONDUCTOR CABLE
The Power conductor cable shall be copper. The VDOT Road and Bridge Specifications, Section 238 for conductor cable run in conduit requires the use of THWN. The following should be applied to each roadway lighting plan:

- The minimum cable size used in any main conduit run for a roadway lighting plan should be a #8 AWG. This procedure is required due to the high tensile strength needed to complete a long conduit pull. For short distances (i.e. from base of the pole or structure to the fixture), or where cable flexibility is an issue, #10 AWG may be used if found suitable to accommodate the current draw.
- The maximum cable size should be #000 AWG. Larger sizes can be difficult to pull.
- The VDOT Road and Bridge Specifications require all luminaires to be supplied with conductors (typically #10 AWG) from the base of the pole to the luminaire.
- The EGC installed in any non-metal conduit should be the same size as the largest phase/power conductor unless otherwise specified on the plans.

1.11 STANDARD LIGHTING SYSTEMS UTILIZED BY VDOT
VDOT lighting systems are generally designed for state maintained roadways. The systems typically include poles, luminaires, conduit, wire, and lighting control centers. The systems are frequently designed as complete, stand-alone systems that are maintained by the state.

Typical VDOT roadway lighting projects include the following types:
- **Partial Interchange Lighting** is the lighting of ramp terminals and on/off ramps found along a freeway or interstate road design.
- **Complete Interchange Lighting** places lights in the merging traffic and gore areas in the same locations as partial interchange lighting. In addition, lighting is placed along the ramps and on the crossroad between the ramp terminals. This configuration may not include lighting the mainline running through the interchange.
- **Continuous Freeway Lighting** includes complete interchange lighting and also includes lighting between interchanges along the mainline. Continuous lighting can include a number of interchanges and is usually provided in urban areas.

Each of the above typical roadway designs is discussed in detail in both the AASHTO and FHWA lighting warrant sections.
**Underpass Lighting**

Where the AASHTO Guide indicates that underpass lighting is desirable, the luminaires used are typically High Pressure Sodium fixtures (HPS) mounted on the abutment of the bridge or on a pier cap.

*Note: In all cases, VDOT Bridge and Structures Section must be consulted to approve placement of any item on a bridge or tunnel structure.*

Luminaires are typically located on the bottom of the bridge deck or fixed to the bridge girders when mounting would otherwise place them more than about 10 feet from the edge of the paved shoulder. This option, when compared to mounting locations further away, can improve light level uniformity, reduce the number of required luminaires, and discourage vandalism.

AASHTO recommends that the lighting level duplicate the lighting values on the adjacent roadway. However, due to the luminaire mounting height it is typically necessary to provide higher light levels in order to achieve the required uniformity. **Thus, it is not unusual for the underpass light level to be twice that of the adjoining roadway.**

**Lighting on Bridges**

The roadway on a bridge is normally treated the same as other parts of the roadway. If there is no lighting on the adjacent roadway, there is normally no need for lighting on the bridge. An exception is a very long bridge, which may be lighted even though the roadway is not lighted at other locations. In this situation, the lighting designer should consider placing roadway lighting in advance of the bridge to allow the driver’s eyes to transition into the brighter roadway on the bridge.

The transition zone is discussed in general terms in IESNA RP-8-00. However, a thorough discussion of the subject is presented in IESNA RP-22-96 (Tunnel Lighting). Specifically, increasing the light pole spacing, or using a staggered pole arrangement to reduce the roadway illumination to 1/3 creates the transition zone the average level on the bridge. Many times this reduced lighting level can be accomplished using the same type and wattage luminaire installed on the bridge. The length of the transition zone is based on the wet pavement safe stopping distance.

Where lights are to be installed on a bridge, the lighting designer should submit the proposed lighting standard locations to VDOT Structure and Bridge Division for review and approval. VDOT may then suggest alternate pole locations for the lighting designer to review and determine compatibility with the lighting criteria. This iterative procedure applies to any bridge structure requiring lighting.

The installation of navigation and air obstruction lights can occasionally be an integral part of bridge and lighting design. The VDOT Structure and Bridge Division may ask the lighting designer to coordinate electrical service points for the roadway lighting and navigational/air obstruction lighting. FAA, Coast Guard, and Corps of Engineer circulars should be consulted for more detailed recommendations of the placement of lights.
Lighting Near Airports
Slopes extending from various points relative to the airports and runways define the clear zones. Light poles can easily extend into the clear zone if the designer does not recognize changing elevations around the airport. The lighting designer should make every effort to contact the airfield safety officer to review the placement of light standards. Local and military regulations may be more stringent than FAA standards.

Tunnel Lighting
A tunnel is defined as a structure over a roadway that restricts the normal daytime illumination, such that the driver’s visibility is substantially reduced. Unlike an interstate roadway underpass, vehicular tunnels greatly reduce visibility either due to their length or due to the reduced size of the tunnel portal. Vehicular tunnels are classified by AASHTO and IESNA RP-22-96 as:

- **Long Tunnel**: Having a length greater than the minimum wet pavement stopping sight distance. Distances are then established delineating the Entrance Zone, Transition Zone, and Interior Zone. AASHTO recommendations provide the lighting designer with illumination levels in these zones that effectively taper the lighting levels, allowing the driver’s eyes to adapt to the reduced lighting within the interior of the tunnel. The length of each zone is based on the design speed of the roadway and the minimum safe stopping distance.

- **Short Tunnel**: Having a length of less than the minimum wet pavement stopping sight distance. Lighting levels are not typically tapered because the driver’s eyes never have a chance to adapt to the darkness.

The AASHTO criteria for tunnel lighting provide a range of illuminance values and uniformity ratios. The IESNA RP-22-96 recommendations provide a range of luminance values and ratios. Recent advancements in the AGI32 lighting design software allow the designer to consider reflectance of the tile walls within a tunnel and calculate the resultant luminance of the tunnel’s roadway surface. The luminance method is much preferred over using a simple illuminance model.

Lighting for Other Streets and Highways
Lighting levels and uniformity ratios for local streets and urban arterial roadways are contained in IESNA RP-8. The lighting designer should fully understand the unique requirements of the municipality and pay close attention to the lighting levels at intersections.

Lighting at Intersections or Other Isolated Traffic Conflict Areas
Luminaires should be placed on or near prominent decision points. When intersection lighting is provided at a signalized intersection, the lighting should be provided from a luminaire bracket arm attached to the signal pole to avoid excessive poles at an intersection. Additional light poles may be necessary when the intersection has channelization or has complex turning lanes.
Luminaires on traffic signal poles may be powered from the traffic signal service point and will require a photocell for day/night control. Additionally, luminaires on MP-1 Combination Signal Poles may be powered from a local power company feeder. In this situation, the feeder is routed into a fused safety switch located on one of the signal poles. Branch circuits are then run from the fused safety switch to each luminaire/signal pole.

Lighting at isolated intersections or other traffic conflict areas serve to alert the driver approaching the conflict area. These situations are discussed in detail in the IESNA RP-8-00 section, Situations Requiring Special Consideration. Intersections, such as a remote fire station entrance, have no continuous roadway lighting leading to them. The lighting designer should make an effort to taper the lighting levels leading up to and away from the brighter intersection. Providing too much illumination, without tapering the lighting near this intersection, will cause excessive glare, and will reduce the contrast between the traffic signal and the background lighting. Effectively, the driver will require more time to notice a changing traffic signal.

The level of illumination of a signalized intersection is dictated by the area classification of the roadway. Suggested levels of illumination are given in the IESNA RP-8-00 section, Recommended Illumination Levels for Intersections.

**Sign Lighting**
Overhead sign structures are typically lighted wherever surrounding roadway lighting is employed. However, ultimate authority on whether structures shall or shall not be lighting rest with the Regional Traffic Engineer office and/or the District administration. The number of luminaires installed on a sign structure must be determined before the design engineer can develop the electrical plan for the lighting system.

Currently, VDOT installs and maintains only 150-watt HPS sign luminaires. Luminaires on overhead sign structures are mounted 2 feet below the lower edge of the sign and 4 feet in front of the sign (reference VDOT Road and Bridge Standards at: [http://www.vdot.virginia.gov/business/locdes/2008_road_and_bridge_standards.asp](http://www.vdot.virginia.gov/business/locdes/2008_road_and_bridge_standards.asp).)

The illumination criteria for sign structure lighting are found in the IESNA RP-19 and the AASHTO Informational Guide for Roadway Lighting.

Additional information on sign lighting can be found in Chapter 3, Signing and Pavement Marking Design Standards.
SECTION 2: PLAN REQUIREMENTS

2.1 GENERAL

VDOT Lighting Plans shall follow the standards described below and shall utilize the symbology, formatting and spacing for plan items as defined in the VDOT MicroStation cell library, maintained by Central Office Traffic Engineering Design group in the L&D Division and shown in the sample plans provided in the Appendix. In addition, the VDOT CADD Manual provides additional information relative to the file management of CADD files used for Traffic Signal Design. Contact CADDsupport@vdot.virginia.gov by email or by phone at (804) 786-1280 to obtain the appropriate MicroStation files and cell libraries to be used.

Depending on the nature of the project, plans will be developed either as stand-alone lighting plans or as part of a complete set of roadway construction plans. The advertisement and construction of a lighting plan varies under these circumstances. A complete discussion of the plan elements for each of these scenarios is included below.

The following elements are generally included in every roadway lighting plan set:

Detail sheets that show items unique to the project. Items that are found in the VDOT Road and Bridge Standards should not be shown in the lighting plans unless required for clarification or modification.

For example:
- Under bridge lighting systems
- Special conduit attachments to bridge structures
- Clarification of pole placement relative to guardrail or edge of shoulder
- Panelboard schedule

Each plan sheet should clearly identify the required pay items and include:
- A layout of the roadway and graphical representation of the lighting standard locations, control centers, overhead sign structures, and conduit runs.
- Call-outs with cable/conduit quantities and sizes.
- Luminaire call-outs with wattage, circuit assignments, service panels, mounting height, bracket arm length, and tilt angle.
- Lighting standard call-outs with pole locations (station & offset), pole number, and pole type.
- Junction box type (station & offset is optional).

The following plan sheets are required for both stand-alone plans and plans that are part of a complete roadway construction project:
- **General Notes.** The General Notes should include the required lighting criteria (e.g., average illumination, uniformity, etc.) for the project.
• **Summary of Quantities.**

• **Luminaire Details.** This detail sheet should include a diagram of the luminaire and iso-footcandle curves if required for clarification.

• **Typical Pole Details.** This detail sheet may be required for clarification of pole installation.

• **Other Detail Sheets.** These sheets may include specially modified items required for the project, such as a modified electrical service or a special design pole foundation.

• **Legend.** Refer to the example in the Appendix.

• **Under Bridge Lighting System Detail Sheets.** The detail should include the following items:
  - Enlarged plan view of the bridge structure showing luminaire placement and conduit routing.
  - Elevated or section views of the piers or abutments showing luminaire, conduit, and junction box placement.
  - Electrical schematic showing the conductor cable routing and splice points.

• **Panelboard Schedules.** The lighting system designer must provide the circuit breaker size and contactor size.

### 2.2 STAND-ALONE TRAFFIC ENGINEERING LIGHTING PLANS

Stand-alone lighting projects are advertised and constructed separately from a complete roadway construction project. They may also be developed as part of an area improvement project. Once the scope of the project is understood, developing the project’s survey will typically be the lighting designer’s first task. Refer to TEDM Section V – Roadway Lighting, Chapter 4, 4.8.4 for a discussion on survey and alignment procedures commonly used in roadway lighting plans.

The roadway lighting plan set is assembled with the following components:

• **Title Sheet.** The title sheet for stand-alone lighting plans must meet all the requirements of a standard VDOT title sheet with the following exceptions:
  - Stand-alone lighting projects do not typically include acquisition of right of way. The Right of Way Signature blocks may not be needed and can be removed from the Title Sheet.
  - The Index of Sheets is typically a short list. This list should be added to the upper-left corner of the Title Sheet.

• **Location Map.**
• **Plan Sheet Index.** The Plan Sheet Index provides an overview of all the plan sheets in the project. It allows quick reference to a particular area of the project. On most roadway lighting projects, the plan sheet index can be incorporated onto the Title Sheet. However, large projects may require a separate Plan Sheet Index for clarity.

• **Revision Data Sheet.** This sheet is included with the final plan set, but is left blank with the exception of the project numbers and sheet number, as discussed in the IIM.

• **Alignment Data Sheets, Survey Alignment Coordinate Data Sheets, and Benchmarks.**

• **Maintenance of Traffic.** Occasionally, the maintenance of traffic may be simple, and can be included in the contract documents. Other projects may require a plan sheet to describe the lane closure times and other Work Area Protection items.

• **Roadside Development Sheet.** When required, and as directed by the project manager.

• **Plan Sheets.** Sheet numbers begin at “3”.

2.3 LIGHTING PLANS INCORPORATED INTO A COMPLETE SET OF ROADWAY CONSTRUCTION PLANS

On large roadway construction projects, the Title Sheet, Revision Data Sheet, Roadside Development Sheet, and Maintenance of Traffic Sheet are not required as part of the lighting plan set. The Location Map may be added at the discretion of the TE/L&D Manager or the lighting designer.

The roadway lighting plan set is assembled with the following components:

• **Plan Sheet Index.** On roadway construction projects, the roadway lighting plans will typically follow the roadway construction plan sheet numbering. However, in some cases, the roadway lighting portion of the construction project may not require every roadway construction plan sheet. In this case, the roadway lighting plan sheets may be renumbered. The Plan Sheet Index will then provide a reference to the overall construction project.

• **Plan Sheets.** The plan sheet scale should match the roadway construction plans.

• **Plan Sheet Number Series** will be obtained from the construction TE/L&D Manager.
SECTION 3: VDOT PROJECT DEVELOPMENT PROCESS

The following is a brief description of how the lighting design process ideally aligns with the VDOT Project Development Process.

1. Scoping Phase:
   a. Determine if survey needs to be completed for the subject project and, if so, schedule/or obtain the appropriate survey information.
   b. Determine if there is sufficient right of way for lighting installation.
   c. If required, complete an airport clearance review.
   d. Verify that lighting warrant analysis has been completed, and that the lighting is approved for installation by the District Traffic Engineer as detailed in Step 1.

2. Preliminary Design Phase:
   a. Select Pole and Luminaire types and place poles, as detailed in Steps 2 and 3.
   b. Determine the power source and locate the electrical service and controller cabinet, as detailed in Steps 4 and 5.
   c. Prepare the preliminary plan sheets required for the specific project.

3. Detailed Design Phase:
   a. Complete detailed design including laying out the conduit and wiring system, calculating voltage drops, determining sizes for wiring, conduits, and junction boxes as detailed in Steps 6 and 7.

4. Final Design Phase:
   a. Complete Steps 8 through 10. This includes preparing the plan package, developing specific details, legends, diagrams, charts and notes. Also develop general, quantity summaries, and plan notes.
SECTION 4: LIGHTING DESIGN PROCESS

This Chapter presents various considerations that the lighting designer must recognize in the early stages of design. Some of these issues are discussed during the Scoping Meeting, but most of them must be established by Field Inspection and Public Hearing.

STEP 1 – PERFORM LIGHTING WARRANTS
If requested by a VDOT TE/L&D Manager, the engineer shall perform lighting warrants.

The primary purpose of warrants is to assist administrators and designers in evaluating locations for lighting needs and selecting locations for installing lighting. Warrants give conditions that should be satisfied to justify the installation of lighting. Meeting these warrants does not obligate the state or other agencies to provide lighting or participate in its cost. Conversely, local information in addition to that reflected by the warrants, such as roadway geometry, ambient lighting, sight distance, signing, crash rates, or frequent occurrences of fog, ice, or snow, may influence the decision to install lighting. The design stage can begin once the decision has been made to install new lighting.


STEP 2- SELECT POLE AND LUMINAIRE TYPES
The VDOT Regional/Area Traffic Engineer may have a general concept on how the facility should be lighted. Together with the Residency Administrator, they best understand the requirements of the residents and the flow of traffic through the facility. The designer should review lighting options with the TE/L&D Manager and local VDOT personnel prior to the initial selection of light pole and luminaire equipment.

The following items should be considered when selecting poles and luminaires:

Conventional or Cobrahead Pole
- The most common equipment used is the 30-foot to 50-foot pole with a luminaire and bracket arm.

- The bracket arm typically places the luminaire directly over the edge of the travel lane, as shown previously in Figures 2-11 and 2-12.

- Maintenance of these luminaires will, almost certainly, require a shoulder closure, and, in many cases, will require a lane closure.

- Generally, this type of pole allows greater spacing between luminaires than the offset style pole.
Offset
- The offset pole is typically a 30-foot to 50-foot pole with a luminaire mounted to the top without a bracket arm.

- The pole is typically placed offset from the roadway, beyond the edge of the shoulder (i.e. in the grass). This location reduces the need for a lane closure to perform installation or maintenance.

Architectural Lighting
- Shoebox style or architectural luminaires are often appropriate for rest areas, park & ride areas, or to provide some aesthetic value to outdoor lighting.

- Architectural lighting is non-standard to VDOT, and requires modification of the Specifications for completion of the bid documents.

High Mast Luminaire and Pole Combination
- High mast lighting provides an area type of lighting typically using 3 to 12, 250-watt, 400-watt, 750-watt, or 1000-watt HPS luminaires mounted on poles (also referred to as towers), at heights varying from approximately 60 feet to 150 feet.

- At these mounting heights, high-output luminaires develop a uniform light distribution.

- High mast lighting is used principally where continuous lighting is desirable, such as:
  (a) Interchange lighting,
  (b) Lighting of toll plazas,
  (c) Rest areas and parking areas,
  (d) General area lighting,
  (e) Continuous lighting on highways having wide cross-sections and a large number of traffic lanes.

- This type of lighting system is not desirable where there is residential impact from spill light. Shielding may be required to reduce the impacts of the lighting on nearby residential areas.

- The system is desirable where maintenance of conventional lighting units may be a hazard to the traveling public and maintenance personnel.

- High mast lighting typically provides reduced glare levels when compared to conventional or offset lighting.

- Several roadways can usually be illuminated from a single high mast tower.
• High mast lighting provides the motorist with an exceptionally wide field of vision.

• Performance of the system under adverse weather conditions is good.

• The cost of a single high mast lighting tower and luminaire assembly is higher than that of a conventional or offset lighting standard. As a rule of thumb, the light that is provided by one high mast tower should replace 6 to 8 conventional lighting standards.

• The high mast tower cannot be fitted with a breakaway base and thus must be located outside the clear zone or protected from traffic by means of guardrail or barrier service.

• High mast lighting standards must be located such that they are accessible to a crane for maintenance crews in the event the luminaire ring becomes hung at the top of the tower.

STEP 3 – PREPARE BASE PLAN

The level of detail for a typical lighting base plan when prepared from a roadway construction plan is shown below and in the Appendix.

• Prepare base map in accordance with the VDOT CADD Manual Standards.
• Retain coordinates within CADD file (if possible).
• Check CADD file(s) for corrupt elements.
• Show the locations of underground and overhead utilities.
• Show elements of the existing survey that will impact the installation of light pole foundations and conduit trenching as well as “Finished” roadway elements.
• Perform a field site visit and review plan/profile drawings to ensure that roadway geometry is appropriate for the installation of the lighting system.

“Finished” roadway elements are defined as the combined existing and proposed curb lines, roadway edge of pavement, sidewalks, drainage, curb ramps, etc., as well as, existing and proposed right of way that will be in place when the project is complete.

The base plan sheet includes the following (at a minimum):

• North arrow.
• Graphic Scale.
• Street names.
• Finished roadway elements (to scale).
• All existing and proposed underground and overhead utilities in place when project is completed.

Existing curb lines and roadway features that are to be removed or relocated during construction may need to be shown on the lighting plans to insure the contractor understands the any potential conflicts. For Example: The Contractor should clearly understand that the plan requires installation of light poles and conduit in an area that was once an asphalt parking lot, but is now planned to be a grassy landscaped area.
STEP 4 – PLACE POLES

Pole placement is an engineering decision which should be based upon geometry, character of the roadway, lighting design calculation analysis, physical features, environment, available maintenance, economics, aesthetics, and overall lighting objectives. The physical roadside conditions may require adjustment of the spacing determined during the conceptual lighting design. The following points should be considered in every lighting design:

- VDOT requires all roadway lighting design calculations to meet the lighting criteria as discussed in the current IESNA publication, Recommended Practices for Roadway Lighting (RP-8).

- The lighting designer should plan a site visit early in the design process. Terrain features may alter the choice of lighting equipment, and the routing of conduit.

- Site considerations affecting pole placement include the presence of noise walls, retaining walls, existing guard rail, rock, narrow roadside clearances, power lines, nearby airports, traffic signals and nearby residential neighborhoods.

- The placement of light poles near power lines requires the lighting designer to coordinate with the local power company. In many cases, poles cannot be placed within 10-feet of a distribution line and 25’ of a Transmission line as measured in any direction.

- Poles should be placed behind noise walls only if the site permits access for maintenance. The location of required doors should be noted and brought to the attention of the Project Manager.

- The lighting designer should recognize that pole foundations placed directly behind a retaining wall might be in conflict with the tiebacks associated with the wall.

- Poles should also be placed outside the roadway clear zone whenever possible, as discussed later in this Chapter and located to minimize knockdowns. If placement outside the clear zone is not feasible, then poles shall be installed with breakaway bases.

- When placed behind guardrail, poles shall be placed at a distance that will allow clearance for guardrail deflection upon impact. Guardrail deflection requirements can be found in Appendix I of the VDOT Road Design Manual at: http://www.vdot.virginia.gov/business/locdes/rdmanual-index.asp.

- Pole and luminaire placement should be uniform. Inconsistencies in the luminaire positioning over the roadway, and the distance from the shoulder to the base of the pole, can be a source of distraction to the driver.
• When streetlights are installed in conjunction with traffic signals, the lights should be installed on the same poles as the traffic signals (i.e. VDOT Standard Combination Signal Pole, MP-1 - see the VDOT Road and Bridge Standards, Section 1300) at: http://www.vdot.virginia.gov/business/locdes/2008_road_and_bridge_standards.asp
It is not unusual for these luminaires to be powered from a separate source. In this case, the lighting designer should coordinate with the Signal Designer for the location of junction boxes and signal conduits, and the position of the luminaires and bracket arms.

• Light pole placement should consider maintenance issues. Bucket trucks must be nearly level to operate and are limited in the height and distance from the roadway that the bucket can reach. Different types of trucks may have different working ranges. The lighting designer should verify with the VDOT District Maintenance section as to the availability and attributes of their bucket trucks.

Clear Zone and Breakaway Base Considerations
Clear zone requirements can be found in Appendix A of the VDOT Road Design Manual at: http://www.vdot.virginia.gov/business/locdes/rdmanual-index.asp. Poles should always be placed outside the clear zone. Poles placed within the clear zone should be fitted with a breakaway base.

Where poles are placed behind guardrail, they must be located outside the deflection zone of the guardrail and should not be fitted with a breakaway base. The guardrail deflection zone can be found in Appendix I of the VDOT Road and Bridge Standards at: http://www.vdot.virginia.gov/business/locdes/2008_road_and_bridge_standards.asp under the Guard Rail Installation Criteria.

Following are several points to consider in the placement of light poles:

• The clear zone requirements vary with design speed, Average Daily Traffic (ADT), and the grade of the paved and unpaved shoulder.

• The clear zone at the gore of an interstate/freeway exit ramp can be as long as 414 feet from the beginning of the theoretical gore. It is imperative that the lighting designer does not place a lighting standard in this area. The pole will be prone to collision. Elimination of this lighting standard will greatly reduce visibility at this critical location. The lighting designer must review the clear zone requirements as discussed in the VDOT Road Design Manual at: http://www.vdot.virginia.gov/business/locdes/rdmanual-index.asp.

• The transformer base may be configured with an AASHTO approved breakaway system or constructed of frangible material (see VDOT Road and Bridge Specifications, Section 229 and Section 700 at: http://www.vdot.virginia.gov/business/const/spec-default.asp.) As an alternative, a breakaway base may be provided with a set of couplings and a skirt having only 4-inches of clearance from the top of the concrete foundation.
• A lighting pole located outside the clear zone or beyond the deflection zone of the guardrail should **not** be fitted with a breakaway base.

• Limited right-of-way or terrain restriction may prevent the placement of lighting standards outside the deflection zone for standard GR-2 metal guardrail. In this situation, the lighting plans may require strengthening the guardrail to a GR-2A with a 2-foot deflection zone.

• When all alternatives have been exhausted, and placement of the lighting standard results in a location within the guardrail deflection zone, concrete barrier service should replace the guardrail.

**Median Barrier Lighting Considerations**

Median barrier lighting can be a very attractive option in areas of limited right-of-way. The lighting system can be powered from a single conduit and wire run, versus two trenching and conduit runs placed along both edges of the roadway.

Both conventional and offset lighting standards can be mounted on median barriers utilizing a twin arm mounting system. This lighting configuration provides several benefits, but may not be the best answer for every situation:

• The median barrier technique of mounting lighting poles reduces the number of poles and conduit runs, and has the added benefit of utilizing the house-side light from the luminaire.

• However, without the presence of trees or a sound wall along the outside shoulder, light may be thrown toward residential communities adjacent to the roadway.

• Maintaining the lighting system requires placing service vehicles on the inside shoulder directly adjacent to the fast lane. Median barrier mounted lights should not be used in high volume areas without a 10-foot minimum inside shoulder.

• Vehicles stopped in the breakdown lane, on the outside shoulder, may receive only the minimum amount of illumination.

• Coordination with the median barrier designer must be made to insure the pole foundation dimensions and bolt circle configuration match the attributes of the proposed lighting pole.

• The lighting designer must recognize the dimensions of the pole foundation blister, and location of the shy-line as described by the VDOT Standard Median Barrier (MB-7, MB-8, MB-12, MB-13).

• The lighting design must consider the location of drainage structures under the median barrier.
• The beginning and ending of a median barrier typically requires a section of wall that tapers in height. Lighting standards should not be placed on this section of the wall.

• The lighting designer must insure that the median barrier design provides for a junction chamber of sufficient size to accommodate the conduit and conductor cables at the base of each pole.

For example:
A junction chamber (d=6" x h=12" x l=18") at the base of the pole, embedded in the median barrier, would provide a pull box for a 2” conduit with five #2 AWG cables (3-phase conductors, 1-neutral, and 1-ground). This chamber would also provide a splice point for the 1” conduit coming down from the pole base, and the four #10 AWG wires delivering power to the luminaires and grounding for the pole (2-phase conductors, 1-neutral, and 1-ground).

• At locations where dual mount lighting standards provide illumination to roadways of differing elevations, the mounting height for both luminaires should be measured from the roadway with the higher elevation. The lighting designer should provide a detail of this lighting standard in the plans clarifying the placement of the luminaire relative to the roadway.

STEP 5 - FIELD VISIT AND DETERMINE THE POWER SOURCE
A field visit with the power company representative should be organized shortly after completing the system characterization. The lighting designer should provide the power company representative with an estimated transformer (kVA) power requirement.

The lighting designer must meet and discuss the source of power prior to completing the layout of the lighting system.

Every service feed provided by the local power company must be coordinated with a field representative. The lighting designer should never assume that power is easily accessible.

• Grid Maps. Prior to meeting the power company representative, the lighting designer should request grid maps indicating the location of primary electrical feeders that are local to the proposed facility. Reviewing these maps will enable the designer to develop a conceptual conduit layout plan.

• Primary Power. During a field visit, the designer should make an effort to identify potential sources of primary power. The typical primary power delivered by the local power company is 13,900 VAC or 19,500 VAC. The power company will step down this primary power through a transformer to provide secondary power at the voltage required for the lighting system.
Overhead 3-phase primary power can be recognized as three small wires running at the top of wooden utility poles. The lighting designer should take the time to notice these lines during the field reconnaissance and note the pole numbers for later reference.

- **Easements and Right-of-Way.** The lighting designer cannot assume that a property owner will allow the power company to cross privately owned land to deliver power to the VDOT right-of-way.

- **Locate primary power directly adjacent to the VDOT right-of-way if possible.** The power company will typically place transformers at the top of the utility pole, step down the voltage, and run the secondary power to the meter base on the VDOT electrical service.

  The distance from the source of primary power should be kept as short as possible to minimize losses due to voltage drop.

- Secondary 277/480Y VAC power is never run in excess of 2,000 feet from the transformer to the meter base.

- Secondary 120/240 VAC single-phase power is never run more than 700 feet from the transformer to the meter base.

If these distances are exceeded, primary power must be pulled to the VDOT electrical service and a step down transformer placed near the meter base.

**STEP 6 - PLACE ELECTRICAL SERVICE AND LIGHTING CONTROL CENTER**

The lighting designer must recognize the following issues when selecting a location for the electrical service and control center cabinet:

- **Clear-Zone.** The structure must be placed well outside the clear-zone or located behind guardrail or barrier service.

- **Accessibility.** In many VDOT districts/regions, the local power company meter reader is not permitted to stop on an interstate roadway to read the meter. Thus, the meter must be located within the VDOT right of way, but easily accessible from a side street. Furthermore, the control center must be accessible to the VDOT electrician.

For example:

- A lighting control center located behind a noise wall should be accessible either through a door in the wall, or a local street behind the wall, or within walking distance of the end of the wall.

  In another example, where the VDOT electrical service is located directly adjacent to the right-of-way fence, the fence should be routed around the electrical service such that the power company representative and VDOT electrician can access the equipment without jumping over the fence.
STEP 7 - LAYOUT THE CONDUIT AND WIRING SYSTEM
The conduit and wiring system is best prepared by plotting the lighting plan on a large-scale plot. The designer should incorporate the following procedures into the lighting plan:

- Junction boxes are placed on either side of jacked pipe or pipe sleeve.
- A junction box should be placed at the base of each overhead sign structure.
- On long, uninterrupted conduit runs, a junction box should be placed every 250 feet to ease in pulling the wire.
- Junction boxes should be placed at the base of each light pole where #0 AWG wires or larger are used to feed power to the pole. For wire sizes #1 or smaller, a transformer base may be used to splice the luminaire wires to the feeder conductors.
- Conduit used in roadway lighting is typically no smaller than 2 inches. Conduit used for under bridge lighting systems should be 1 inch or smaller.
- On projects that require the VDOT contractor to install conduit from the local power company service drop to the VDOT meter base and control center, the lighting designer should verify the required conduit size and number with the power company representative.
- Conduit size is based on the NEC 40% fill rule.

STEP 8 - CALCULATE VOLTAGE DROP, WIRE SIZE, CONDUIT SIZE AND JUNCTION BOX SIZE
Voltage drop calculations must be performed for the entire roadway lighting system. The designer should incorporate the following procedures into the lighting plan:

- VDOT does not require a particular wire size to be used in roadway lighting systems, however, due to issues with tensile strength, #8 conductor cable is the minimum suggested wire size in any feeder or branch circuit.
- Wire sizes over #000 are discouraged, but not prohibited. They are difficult to pull and splice over the long distances associated with roadway lighting projects, especially when the splice point is in a lighting pole transformer base.
- The total voltage drop in all circuits should not exceed 3%. This requirement provides for future expansion of the system and flexibility to make field modifications during construction.
• #10 AWG wire is installed from the base of all lighting standards to the luminaires, including high mast lighting standards that may be as much as 150 feet in height. This wire is incidental to the cost of the luminaire per VDOT Road and Bridge Specifications, Section 705 and not included in the summary of quantities or cost estimate.

• The pole wire is spliced to the branch circuit in the base of the pole. Sufficient space must be allowed in the pole base to make the splice. The NEC provides guidance on volume requirements and junction box sizing.

• Consider providing separate poles to accommodate lighting (instead of through traffic signal poles) when operating at voltages higher than 120 volts for maintenance and signal technician safety purposes.

• #10 AWG wire is installed between the fused safety switch and the luminaires on overhead sign structures. This wire will rise at least 20’ and may reach as far as 60’ across the roadway. The cost of this wire is incidental to the sign structure.

• The panelboard schedule is created and included in the final plan set. Circuit breaker and contactor sizes are chosen in accordance with NEC requirements and specified on the plans.

• Circuit breakers are intended to protect the conductor cables and contactors. However, NEC requirements state that the circuit breaker ratings not exceed 125% of the normal operating load, except to round up to the nearest commercially available breaker size.

• Contactors switch the lights on and off at dusk and dawn in conjunction with the photovoltaic cell. On 3-phase control centers, contactors are normally 3-pole with a 277-volt coil. They must have a rating that exceeds the circuit breaker protecting it. Due to the cost of replacing contactors, it is usually best to require a rating far in excess of the normal load. Using the previous example, it would be sufficient to install a 3-pole contactor rated at 60-amps per pole.

STEP 9 – PLAN SHEET DEVELOPMENT

After the development of the entire layout of the roadway lighting plan based on Steps 1 through 8 is completed in MicroStation, the various roadway lighting symbols are added to the plan sheets. Call-outs are placed on the plan sheet indicating each required item to be installed by the contractor. These call-outs and symbols must exactly match the plan pay items. A sample plan that includes call-outs is included in the Appendix.

Luminaire Call-outs
Each luminaire call-out should include an annotation indicating its source of power. For a 3-phase lighting system, this note should reference the phase, circuit, and control center from which it is fed.
**Conventional** luminaire call-outs must include a reference to wattage, bracket arm length, and mounting height.

**Offset** luminaire call-outs must include a reference to wattage, tilt angle, and mounting height. If the tilt angle is the same for all luminaires (e.g., 0-degrees), the angle may be stated in the General Notes or in the plan details. The offset tilt angle written on the plans is referenced to straight down. It is important to note that some lighting manufacturers (in their IES file) reference the nadir (0-degrees) for their offset luminaires as 45-degrees from straight down. The manufacturer’s convention should not be confused with the construction plan’s convention of referencing the luminaire tilt angle. This issue should be made very clear to the contractor in the light pole details included with the plan set.

**High mast** luminaire assembly call-outs must include a reference to wattage and number of luminaires on the assembly. The pole length is frequently included in the luminaire call-out for clarity, however, this annotation may be redundant to the “Pole Type” associated with the pole call-out. If a high mast luminaire must be installed with its optics oriented at a particular bearing, an arrow must be added to the symbol to indicate the luminaire’s aiming direction.

**Pole Call-outs**
The pole call-out provides the contractor with a pole location, pole number, pole type, and whether or not the pole is to be equipped with a breakaway base.
- The pole location usually references a survey baseline as explained earlier in this document.
- The pole type refers to the lighting standard pay item and pole length.
- The base of each pole symbol must be placed on the plan sheet at its required location and oriented to match the required aiming direction.

For Example:
An LP-1 pole intended to be placed at a specific station & offset should be shown on the plan sheet with the pole base at the required point relative to the baseline. The symbol should then be oriented such that the LP-1 bracket arm and luminaire are aimed in the direction that provides the best illumination of the roadway. Many times this orientation results in placing the bracket arm and luminaire perpendicular to the edge of the curb.

**Conduit Call-outs**
The conduit call-outs must include the size of the conduit (proposed or existing) and/or pipe sleeve, and the number/size of conductor cables. Additional information may be included to clarify circuit connections. For example, the call-out might include an annotation regarding any special requirements such as “Metal”, “Conduit mounted to bridge abutment”, etc.
Circuit Details
Some plan sheets may require a more detailed description of the electrical circuitry involved with construction. These details may involve complicated splicing at a junction box. An example of a circuit detail is shown in the Appendix.

Lighting System Survey and Alignment

The Traffic Engineering Design Section of L&D may require a lighting design that is not constructed in conjunction with a roadway construction project. In some cases, the roadway construction project may be nearing completion, and the lighting project may simply utilize the survey and as-built roadway plans. In other situations, the lighting designer may need to acquire full aerial mapping and survey to complete the lighting plan. In either case, a stand-alone lighting project must include a complete set of survey and alignment plan sheets.

Survey and Alignment Based on Roadway Construction Plans.
Projects that are constructed during or immediately following a roadway construction project may utilize the roadway construction baselines to establish the light pole locations. This system is used in the example plan sheet presented in the Appendix. For example, a lighting standard is frequently located with a station and offset such as:

STA. 103+15, 35’ LT.
RT-460 CONST. B_L

If the lighting plans are not included in the complete set of roadway construction plans, the roadway lighting plan set is considered a stand-alone project and should utilize:

- The Survey including existing and proposed roadway alignment.
- The Proposed Alignment Data Sheets.
- Benchmarks.

Stand-Alone Roadway Lighting Projects
Stand-alone lighting projects that require a complete new set of aerial mappings and survey can establish the location of the proposed lighting standards in several ways:

Option 1. A construction baseline can be established in the same manner as that of a roadway construction project.

Option 2. Lighting standard locations may also be established using a set of swing ties. Three swing-ties should be established for every standard as shown in Figure 2-14.
Option 3. The lighting designer may elect to locate the lighting standards using a coordinate system referenced to the VDOT Project Coordinate System. This system provides the construction surveyor the ability to use a GPS instrument to locate the proposed pole locations and deliver to VDOT the final as-staked (as-built) pole locations. These pole coordinates may be used to develop a pole inventory in a GIS format.

This method is advantageous in cases where the cost of maintenance of traffic to establish baselines may be prohibitive. Also, it may be impractical to expect a surveyor to rely on survey points separated by difficult topography, such as densely wooded ramp systems or high median barriers.

**STEP 10 - DETERMINING SALVAGE AND REMOVAL ITEMS**

The lighting designer should incorporate all components of the existing lighting system into the proposed lighting plan.

- In most situations, a field review of the site will be the only way to verify the type of roadway lighting currently utilized on the site.
- The engineer should collect all as-built plans of the site.
- The lighting engineer should make every attempt to understand the layout of existing lighting systems and Traffic Management Systems.

Once the lighting designer has a good understanding of the existing lighting system, the Regional Traffic Engineer must be contacted to determine those items that should be maintained, removed, replaced, modified, or abandoned. *VDOT Road and Bridge Specifications, Section 510* provides procedures for working with existing lighting systems.
STEP 11 - DETERMINING QUANTITIES

The VDOT Specifications provide measurement and payment for most items in a roadway lighting project. Specific items not covered under the Specifications are addressed through Special Provisions or Special Provision Copied Notes.

The pay item on the Summary of Quantities sheet should exactly match the standard VDOT pay items. A current list of standard pay items can be found on the VDOT website.

The following section describes items that require special attention in calculating estimated quantities.

Conduit, Cable, and Trench

The Summary of Quantities includes the amount of conduit required for each plan sheet. However, in computing the amount of conduit, cable and trenching required on a plan sheet, the lighting designer should make some consideration for cable splices and conduit bends around the various drainage structures and other features found along the roadway, i.e., variation of terrain. Similarly, conductor cable will not lie perfectly straight or flat in the conduit. The sum totals of the following items should be increased to compensate for variation encountered during construction. The percentages noted below are some representative sample rules-of-thumb that may be used to accommodate those conditions:

- Conductor cable: increased 10%
- Conduit: increased 5%
- Trench: increased 5%

Bored Conduit

Trench Excavation is not required in areas where Jacked Pipe Sleeve or Bored Conduit is installed.

Pipe Sleeve

The current Specifications and Standards do not cover Pipe Sleeve. A modification to the VDOT Specification must be included in the contract documents in those cases where Pipe Sleeve is required on a lighting plan. The Summary of Quantities should include trenching (ECI-1) wherever Pipe Sleeve is required.

Equipment Grounding Conductor (EGC)

The EGC is incidental to the installation of new conduit. That is, there is no separate pay item for the EGC. The lighting designer should not account for any EGC proposed for installation into new conduit. The contractor must include all costs associated with the installation of the EGC with the cost of installing new conduit. However, where conductor cables are pulled through existing conduit, (e.g., retrofit of an existing lighting system, or installation of cables in an existing bridge parapet) the lighting designer should indicate on the plans the requirement to install the correct size EGC. The required length of EGC is added to the quantity of conductor cable.