

## 14.0 SIGNING, PAVEMENT MARKING, AND LIGHTING INFRASTRUCTURE

This Section 14 includes the requirements for the signing, pavement marking, and lighting infrastructure Work for the US 550/160 Connection South Design Build Project (Project). This Work shall be completed in accordance with the Contract Documents.

### 14.1 Administrative Requirements

#### 14.1.1 Standards

The Contractor shall design and construct the Project in accordance with the requirements of the standards in the documents listed in Table 14-1 and those referenced in Book 3. The Contractor shall use the latest adopted edition at the time of the Proposal Due Date.

**Table 14-1. Standards**

Author or Agency	Title
American Association of State Highway and Transportation Officials (AASHTO)	<i>A Policy on Geometric Design of Highways and Streets (PGDHS)</i>
AASHTO	<i>Roadside Design Guide</i>
AASHTO	<i>Standard Specifications for Highway Bridges</i>
Colorado Department of Transportation (CDOT)	<i>Standard Specifications for Road and Bridge Construction (CDOT Standard Specifications)</i>
CDOT	<i>Lighting Design Guide</i>
CDOT	<i>Retroreflective Sheeting Materials Guide</i>
CDOT	<i>Sign Design Manual</i>
CDOT	<i>M&amp;S Standard Plans</i>
CDOT	<i>The Colorado Supplement to the Federal Manual on Uniform Traffic Control Devices</i>
CDOT	<i>Retroreflective Sheeting Materials Guide</i>
Federal Highway Administration (FHWA)	<i>Manual on Uniform Traffic Control Devices (MUTCD)</i>
FHWA	<i>Standard Highway Signs (with supplements)</i>
La Plata Electric Association, Inc. (LPEA)	<i>Electric Service Regulations: <a href="https://www.lpea.com/policies">https://www.lpea.com/policies</a></i>
National Cooperative Highway Research Program (NCHRP)	<i>Report 672 Roundabouts: An Informational Guide, second edition</i>
National Fire Protection Association	<i>National Electrical Code</i>

## **14.2 Design Requirements**

### **14.2.1 Submittals**

All submittals shall be prepared, reviewed, and submitted in accordance with the requirements set forth in Book 2, Section 3.

### **14.2.2 Temporary Traffic Control**

All requirements for temporary traffic control, including, signing, and striping for the Work, are found in this Section and in Book 2, Section 16.

### **14.2.3 Electrical, Power Service, and Communications**

The Contractor shall determine electric, power, and communication requirements for the Project and to develop the Project lighting design and construction requirements.

The electrical designs shall include the electrical and communications requirements for the Intelligent Transportation Systems (ITS), as described in Book 2, Section 19, and all electrical assets. The ITS Equipment can be on the same meter with the lighting or on a separate meter (for billing purposes). The Contractor shall coordinate with all Utility Owners, including, but not limited to La Plata Electric Association (LPEA) and the City of Durango.

The Contractor shall obtain Approval of the power service design from the power service provider and from CDOT and coordinate with and meet all requirements as specified by the power service provider for the complete and operational power service to all required locations. All power connections to devices shall include a quick-disconnect.

The Contractor shall be responsible for the coordination of power source Work. The Contractor shall contact the appropriate electrical supplier to request and process to completion the required coordination to establish the power sources for all Roadway, electrical assets, and Street lighting. The Contractor shall perform all Work necessary to maintain existing or establish new power sources.

The Contractor shall be responsible for installing the power meter(s) and lighting control centers for the Project. All cost charges from the power service provider and all necessary Materials, including meter (if required), labor, and coordination required to maintain existing or establish new power sources, shall be included in the Work.

### **14.2.4 Permanent Signing and Striping**

The Contractor shall provide permanent signing, pavement marking, delineation, and other traffic control devices that facilitate safe travel flow through the completed Project elements.

The Contractor shall submit to CDOT signage and pavement marking plans to CDOT for Acceptance prior to the RFC Documents submittal.

#### **14.2.4.1 Signing Design**

The Contractor shall prepare signing plans for all necessary guide, warning, supplemental, and regulatory signs for the Project. The plans shall also include additions, removals, or modifications to existing signs and appurtenances. See Book 2, Section 19, for requirements for Project related dynamic signage, such as variable message sign (VMS) boards.

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Signing design shall comply with the requirements of the most current publications of the CDOT *Standard Specifications for Road and Bridge Construction (CDOT Standard Specifications)*, *M&S Standard Plans*, and *Sign Design Manual*; and the FHWA *Manual on Uniform Traffic Control Devices (MUTCD)*, as modified by the Colorado Supplement, as well as all Interpretation issued by FHWA. The requirements of the MUTCD shall include both the standard requirements and the guidance recommendations of the manual. Unless stipulated otherwise by CDOT in writing, all MUTCD “should” and “shall” standards and guidance recommendations are to be assumed Project Technical Criteria and as part of the Work. MUTCD standards take precedence over any Request for Proposal (RFP) exhibit or preliminary design.

The conceptual mainline and other Roadway signing, as shown in the Reference Documents, is for information and reference only.

The plans shall include modifications to permanent signing inside and outside the Project that is rendered inaccurate, ineffective, confusing, or unnecessary by the Project. Signing plans shall provide layouts showing the locations of ground-mounted and overhead signs, special sign details, and Structural cross sections for overhead sign Structures. Signs created for use in the CDOT ROW shall meet current CDOT and MUTCD specifications.

New mile markers shall be field-measured from the previous undisturbed existing mile marker to provide precise placement and location of the new markers at 1-mile intervals.

The plans for all signs, including Class III, overhead signs, and regulatory and guide signs, shall identify the location and legend for each sign. The Contractor shall submit sign layouts for all special signs of any size to CDOT for Acceptance prior to the RFC Documents submittal and prior to fabrication of the overhead sign panels.

Sign Structures shall be designed in accordance with Book 2, Section 15, CDOT *Bridge Design Manual*, and CDOT Standards S-614-50 and S-614-60. Where CDOT sign Structure standards cannot be met, the Contractor shall submit custom-designed monotube sign Structures and foundations to CDOT for Acceptance prior to the RFC Documents submittal and prior to fabrication. Permanent signage near Bridges shall not be hung from or be attached to Bridges.

The Contractor shall mount all overhead signs with a minimum vertical clearance of 18.5 feet, measured from the high point on the Roadway surface under the sign panels to the bottom of the guide sign or VMS device over the travel way.

#### **14.2.4.2 Materials**

Wood posts for mounting permanent ground signs shall not be used.

Flexible delineators are required in raised median areas only and shall not be used anywhere else within the Project. Delineators not in raised medians shall have metal posts.

Sheeting shall be Type IV and Type XI, as defined in the CDOT *Retroreflective Sheeting Materials Guide*, and shall conform to Subsections 713.04 and 713.06 when applicable.

#### **14.2.4.3 Pavement Marking Design**

The Contractor shall prepare pavement marking plans for Roads affected by the construction of the Project. These plans shall include, but not be limited to, all striping required for center lines, edge lines, lane lines, gore areas, lane drops, merging lanes, transition lanes, arrows, legends, symbols, object markings, delineation, and other striping, as well as any modifications required for transitions to existing pavement markings.

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Pavement marking design for CDOT facilities shall comply with the requirements of the most current publications of the *M&S Standard Plans* and the FHWA MUTCD (both the standard requirements and the guidance recommendations of the manual).

The conceptual mainline and other Roadway striping, as shown in the Reference Documents, is for information and reference only.

The pavement markings for the number of lanes across the existing Grandview interchange Bridge, between the existing roundabout and the new roundabout, shall be updated to accommodate the new roundabout lane configuration.

All permanent edge lines shall be 6 inches wide.

**14.2.4.4 Materials**

The Contractor shall use pavement marking Materials specified in Table 14-2, and be in conformance with CDOT Standard S-627-1 and CDOT *Standard Specifications* Sections 627 and 713.

**Table 14-2 Pavement Marking Materials**

<b>Location</b>	<b>Pavement Marking Type</b>
All striping line types on asphalt	Pavement Marking Paint (High Build)
Word/symbols/cross walks/stop lines on asphalt	Preformed Plastic Pavement Marking (Inlaid)
Yellow lines of any type on Portland concrete cement pavement (PCCP)	Preformed Plastic Pavement Marking (Type I) (Inlaid)
White lines of any type on Portland concrete cement pavement (PCCP)	Preformed Plastic Pavement Marking (Type II) (Inlaid)(Contrast)
Word/symbols/cross walks/stop lines on Portland concrete cement pavement (PCCP)	Preformed Thermoplastic Pavement Marking (Inlaid)

**14.2.5 Conduit**

The Contractor shall install 2-3 inch and 2-2 inch conduit with pull boxes at the intersection of US 550 and CR 220 connecting all quadrants of the intersection to accommodate future signalization. The conduit shall be in conformance with CDOT Standard S-613 and CDOT *Standard Specifications* Sections 613 and 715. The conduit and pull box layout for the future signalized intersection at CR 220 and US 550 shall be submitted to CDOT prior to the RFC Documents submittal.

The Contractor shall submit a preliminary signal layout for future signalized intersection at CR 220 to CDOT for Review as part of the Preliminary Design Plans submittal. This submittal will be used to review the conduit and pull box locations.

**14.2.6 Lighting**

**14.2.6.1 Permanent Lighting Design**

Permanent lighting shall be provided at the new roundabout and for 400 feet along US 550 to the south of the new roundabout, measured from the outside edge of the roundabout. The illuminance levels at the new roundabout shall be per Exhibit 8-1 of NCHRP 672, based on a functional classification of Major/Major with Low Pedestrian usage.

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Existing lighting within the Project limits shall remain, except for lights impacted by the Project. The lights to be removed shall include, but are not limited to:

- Two lights attached to the existing traffic signals.
- Two lights on existing Farmington Hill, south of US 160.

The Contractor shall prepare lighting plans for the Project and all existing permanent lighting conditions on Roadways impacted by the Project.

Lighting plans shall address both temporary and permanent Work and shall include existing topography, ROW, Utilities, drainage facilities, Structures, and all other existing and new facilities. The plans shall include location and orientation of standards and fixtures, wiring, conduits, pedestals, power sources, lighting control centers, and all other lighting components required to construct the lighting on the Project and shall be submitted to CDOT for Acceptance prior to the RFC Documents submittal .

The Contractor shall prepare lighting calculations, including voltage-drop calculations for each circuit, showing the design meets the performance criteria for roadway design to include average, maximum, minimum foot-candles and average to minimum and maximum to minimum luminance on the horizontal roadway plane. The lighting design shall be per the iso-foot-candle curve plots showing foot-candle levels at 1.0-, 0.5-, 0.2-, and 0.1-foot-candles. The design shall also include circuit layouts showing underground circuits alongside and under the Roadway and through retaining wall and Bridge Structures. The lighting and electrical design calculations shall be submitted to CDOT for Acceptance prior to the RFC Documents submittal.

#### **14.2.6.2 Permanent Lighting Materials**

Lighting Equipment for all permanent installations shall be, as specified in the CDOT *Lighting Design Guide* and CDOT *M&S Standards*.

All permanent lighting within the Project shall be dimmable, Light Emitting Diode (LED) luminaries.

The Contractor shall submit the Materials lists for the lighting to CDOT for Approval prior to ordering Material.

The Contractor shall be responsible for lighting maintenance for the Project.

### **14.3 Construction Requirements**

No Material, part, or attachment of any Equipment shall be substituted or applied contrary to a manufacturer's recommendations and standard practices.

#### **14.3.1 Existing Signing**

The Contractor shall remove and dispose of all existing sign Structures, ground-mounted signs, and delineators within the Project area that conflict with Project modifications or do not meet current standards and specifications. All existing removed signs and poles shall become the property of the Contractor.

#### **14.3.2 Permanent Signing**

The Contractor shall coordinate with Colorado Logos, Inc. in removal, resetting, and accommodation of final placement of Colorado Logos, Inc. signs.

Sign posts shall be installed plumb. Vertical deviation shall not exceed 0.5 inch in 10 feet.

### 14.3.3 Pavement Marking Removal

Removal of existing markings and temporary markings shall be hydroblasted prior to placing permanent markings.

### 14.3.4 Power Sources

All power connections to devices shall include a Colorado State Permit and an electrical inspection performed by a journeyman electrician licensed in the State of Colorado.

### 14.3.5 Lighting Removal

The Contractor shall return all Salvaged Materials to CDOT at 20581 West Hwy 160, Durango, CO 81301.

### 14.3.6 Permanent Lighting

All electrical work shall meet current National Electrical Code (NEC) requirements and be performed by a journeyman electrician licensed in the State of Colorado.

### 14.3.7 Temporary Signalization

Refer to Book 2, Section 16, for temporary signal requirements for construction operations.

### 14.3.8 Signalization Removal

All existing traffic signal equipment and lighting equipment that is attached to existing traffic poles that are to be removed, shall become the property of CDOT.

The Contractor shall return all Salvaged Materials to CDOT at 20581 West Hwy 160, Durango, CO 81301.

### 14.3.9 Wildlife Detection System

The Contractor shall coordinate with CDOT for the removal or reset of the existing wildlife detection system on US 550.

## 14.4 Deliverables

The Contractor shall submit the following to CDOT for Review, Acceptance, or Approval:

**Table 14-3 Deliverables**

Deliverable	Review, Acceptance, or Approval	Schedule
Power service design	Approval	As needed to establish power connections
Signage and pavement marking plans	Acceptance	Prior to the RFC Documents submittal
Class III, overhead signs, and regulatory and guide signs plans	Acceptance	Prior to the RFC Documents submittal and prior to fabrication of overhead sign panels

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<b>Deliverable</b>	<b>Review, Acceptance, or Approval</b>	<b>Schedule</b>
Sign layouts for all special signs of any size	Acceptance	Prior to the RFC Documents submittal
Custom-designed monotube sign Structure and foundation plans	Acceptance	Prior to the RFC Documents submittal and prior to fabrication
Preliminary signalized intersection layout at CR 220 and US 550	Review	As part of the Preliminary Design Plans submittal
Conduit and pull box layout for the future signalized intersection at CR 220 and US 550	Acceptance	Prior to the RFC Documents submittal
Permanent lighting plans	Acceptance	Prior to the RFC Documents submittal
Lighting and electrical design calculations	Acceptance	Prior to the RFC Documents submittal
Materials lists for the proposed lighting	Approval	Prior to ordering material

## 14.5 Project Special Provisions

The following Project Special Provisions supplement or modify the CDOT *Standard Specifications for Road and Bridge Construction* and take precedence over the CDOT *Standard Specifications* and plans. The Contractor is responsible to have a copy of the CDOT *Standard Specifications* at all times on the Project Site.

### Index of Project Special Provisions

Revision of Sections 613 and 715      LED Roadway Luminaires

#### **REVISION OF SECTIONS 613 AND 715 LED ROADWAY LUMINAIRES**

Sections 613 and 715 of the Standard Specifications are hereby revised for this Project as follows: In subsection 613.02, delete (e) and replace with the following:

(e) *Luminaire*. A complete luminaire includes the housing, lens, Light Emitting Diode (LED) luminaire, luminaire housing, ballast or power generator, slip-fitting clamp or approved manufacturer mounting, all necessary internal wiring, and photoelectric control. Luminaires shall operate at either 120 VAC, 60 Hz or 277 VAC, 60 Hz. Luminaires shall meet electrical utility company requirements.

In subsection 613.02 (i), delete (4), (6), (7) and (8) and replace with the following:

- (4) Luminaire manufacturer’s product information including data in Illuminating Engineering Society of North America (IESNA) format, IESNA photometric distribution type for vertical and lateral distribution (example: full cutoff, Type III), and a photograph or line drawing.
  - (6) Luminaire Lumen Range shall be no less than 8500 lumens and no greater than 10,500 lumens LED Driver or Power Supply.
  - (7) Lighting Control Centers and Photoelectric Control Devices.
- Subsection 613.02 shall include the following:

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- (j) *LED Luminaire Warranty.* The Contractor shall ensure that the LED Roadway Luminaire has a minimum standard warranty of 10 years for all parts, materials and shipping required to repair or replace the luminaire.

The warranty shall cover all failures including:

- (1) Failure in luminaire housing, wiring, connections, drivers and photoelectric control devices.
- (2) More than 10 percent decrease in lumen output
- (3) Significant change in color.

The warranty shall begin upon the date of receipt. Bill of lading shall be provided to the department prior to final payment of the lighting.

- (k) *Technical Support.* During the warranty period, technical support shall be available from the manufacturer via telephone within 24 hours of the time the call is made from the Department, and this support shall be made available from factory certified personnel or factory certified installers at no additional charge to the Department.

In subsection 613.06, delete the first paragraph and replace with the following:

**613.06 Luminaires and Lamps.** Roadway Luminaires shall be mounted on the mast arm by a slip-fitter clamp or other approved device. Luminaires shall be adjusted vertically and horizontally to provide the required orientation and maximum light distribution on the roadway and to meet Illuminating Engineering Society of North America (IESNA) TM-15 U0.

In subsection 613.06, delete the fourth paragraph and replace with the following:

Luminaires of the specified type and lumen output shall be installed as shown on the plans. The type and lumen output shall be marked on each luminaire or pole in accordance ANSI specifications. ANSI approved tags shall be provided and installed by the contractor

In subsection 715.04 (a), delete 2. and 4. and replace with the following:

2. Optical Chamber. The luminaire distribution shall be equal to or less than an Illuminating Engineering Society of North America (IES) TM15-11 Backlight Uplight and Glare (BUG) ratings listed below in Table 715-1 based on initial lumens or Light Loss Factor (LLF) = 1.0. Luminaires with a U value greater than U0 shall not be accepted. The optical chamber shall be completely sealed from the housing, or the housing shall be completely sealed. A seamless one piece memory-retentive gasket shall seal the optical chamber or housing against the luminaire lens door. All wires entering the optical chamber shall be gasketed at their point of entry. Socket mountings, rivets used in the construction or support of the reflector system, and all other penetrations into the optical chamber shall be completely sealed. The optical chamber shall be water tight when the luminaire door is closed.



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**Table 715-1  
 BACKLIGHT, UPLIGHT AND GLARE (BUG) VALUES**

Luminaire Mounting Location	Minimum Initial Luminaire Lumen Range	Backlight (B) Rating Maximum	Uplight (U) Rating Maximum	Glare (G) Rating Maximum
Non median-mounted	Less than 5,000	B2	U0	G1
	5,000 - 22,000	B3	U0	G2
	Above 22,000*	B3	U0	G3
Median-mounted	Less than 5,000	B3	U0	G1
	5,000 - 22,000	B4	U0	G2
	Above 22,000*	B4	U0	G3
*By special application only.				

In subsection 715.04, delete (b) through (e) and replace with the following:

- (b) *Roadway Luminaires.* Roadway luminaires shall be LED type with integral driver, flat lens, aluminum housing, and be UL Listed for wet locations. All luminaires for the project shall be the same type and design unless the plans specify otherwise.
- (1) The luminaire and all components shall be UL or Intertek Testing Services (ETL) listed for Wet Location and shall have minimum Ingress Protection Rating of IP66.
  - (2) Light source shall be comprised of LED modules connected to a non-integrated driver and ready for connection to a production line luminaire. Luminaires utilizing integrated driver LED light sources, screw-based or panel retrofit products shall not be accepted.
  - (3) The luminaire shall have a Type II or III distribution for non-median mounted luminaires, and Type II, III, IV or V for median mounted luminaires.
  - (4) Transmissive optical components shall be applied in accordance with LED manufacturer's Original Equipment Manufacturer (OEM) design guidelines to ensure suitability for the environment in which the luminaire is installed.
  - (5) Luminaires shall utilize an adjustable slipfitter-type mounting system for installation on 1.25- inch (1.66-inch o.d.) to 2-inch (2.375-inch o.d.) outside diameter pipe tenons. Slipfitter shall consist of a two-piece clamp and four 9/16-inch hex bolts. Slipfitter shall allow for a vertical tilt adjustment of  $\pm 5$  percent in order to mount luminaire plumb for a U0 rating. Luminaires shall be equipped with integrated leveling bubble.
  - (6) Access to all internal parts requiring replacement shall not require tools (i.e. "tool-less entry").
  - (7) The luminaire housing shall be constructed of aluminum alloy.
  - (8) Power Supply/Driver shall be provided in compliance with section 715.05(a). Driver must be internal and thermally separated from LED compartment.
  - (9) Dimming photocell receptacle shall conform to (d) below.
  - (10) Luminaire finish shall be corrosion resistant Super triglycidyl isocyanurate TGIC polyester powdercoat. Color shall be gray.
    - a. Powder coat: Super TGIC polyester powder coat 2.5 mil nominal thickness.
    - b. Finish shall exceed a rating of six (6) per ASTM D1654 after 1000hrs of

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testing per ASTM B117.

- c. The coating shall exhibit no greater than 30% reduction of gloss per ASTM D523, after 500 hours of QUV testing at ASTM G154 Cycle 6.
- (11) Effective Projected Area (EPA) for wind-loading calculations shall be no greater than 1.2 square feet.
  - (12) Luminaire weight shall not exceed 45 pounds.
  - (13) Luminaire shall be tested in accordance with IES LM79 and TM21 certifying photometric performance and rated life, respectively. LM79 (performance) and TM21 (predicted life at 55<sup>0</sup>C) testing shall both be for the same luminaire's operating drive current as specified.
  - (14) Luminaire shall have a maximum Backlight rating as shown in Table 715-1, an Uplight rating of U0, and a maximum Glare rating as shown in Table 715-1.
  - (15) Luminaire system efficacy shall be no less than 68 luminaire lumens per input watt.
  - (16) Luminaire shall have an external label per ANSI C136.15 and internal label per ANSI C136.22
- (c) *Light Sources.* LED luminaires shall not be retrofit to existing luminaire housing; the contractor shall replace housing along with the luminaire as a single unit. Light sources shall be compatible with dimmable drivers supplied with the luminaires in which they are to be installed. All light sources of a similar type shall be provided by the same manufacturer. LED light sources shall meet or exceed the following requirements:
- (1) CCT, CRI and Flux:
    - a. Correlated Color Temperature (CCT) – All LED light sources shall emit white light and have a CCT no less than 2700K and no greater than 4000K nominal in accordance with ANSI C78.277.
    - b. Color Rendering Index (CRI) – All LED light sources shall have a minimum Color Rendering Index (CRI) of 70 per the LM79 test results.
    - c. Luminous Flux – LED light sources shall not exceed the junction temperature recommended by the LED manufacturer. Luminous flux differences between LEDs shall not exceed 10 percent.
  - (2) LEDs shall have a minimum rated life of 70,000 hours per IES TM-21 at 55<sup>0</sup>C at the normal operating driver current for the specific luminaire. The lumen output shall be maintained at 70 percent of initial rated lumens (L70) or greater at the rated life of the luminaire.
  - (3) LEDs shall be temperature rated for operation and storage within the range of -40°C to +50°C, and shall withstand low and high frequency vibration (ANSI C136.31 Vibration Level 3G) over the rated life of the light source.
  - (4) Cooling System
    - a. Mechanical design of protruding external surfaces (e.g. heat sink fins) shall facilitate hose-down cleaning and discourage debris accumulation.
    - b. The cooling system must be passive utilizing heat sinks, convection or conduction.
    - c. Fans, diaphragms, pumps, or liquids shall not be acceptable.

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(d) *Photocontrol Receptacle.*

a. Each roadway luminaire shall be furnished with a multi-contact twist-lock outdoor lighting dimming receptacle in accordance with ANSI C136.41.