

City and County of Denver
Small Cell Infrastructure Design Guidelines

Department of Public Works
Engineering Division

May 2019

MEMORANDUM

To: Small Cell Design Guidelines Users

From: Department of Transportation & Infrastructure, Right of Way Services Division, Engineering & Regulatory

Date: January 30, 2020

**RE: City and County of Denver Small Cell Infrastructure Design Guidelines – May 2019
Errata 1 – Notice of Corrections**

Revisions to the May 2019 edition of the Small Cell Infrastructure Design Guidelines are hereby published for immediate use.

SMALL CELL INFRASTRUCTURE DESIGN GUIDELINES, THROUGHOUT:

DELETE:

Department of Public Works
Public Works Department

REPLACE:

Department of Transportation & Infrastructure

SMALL CELL INFRASTRUCTURE DESIGN GUIDELINES, THROUGHOUT:

DELETE:

SNO

REPLACE:

SONO

CHAPTER 1 BACKGROUND AND PURPOSE, FIGURE 1.2 TYPICAL SMALL CELL INSTALLATIONS, TYPE 4 FREESTANDING SMALL CELL, PAGE 8:

DELETE:

This equipment may be installed when no existing streetlight of other appropriate location is within 25 feet of the proposed freestanding location.

REPLACE:

This equipment may be installed when no existing streetlight of other appropriate location is within 250 feet of the proposed freestanding location.

CHAPTER 2 SMALL CELL FACILITY GENERAL GUIDANCE, SUBSECTION GENERAL LUMINAIRE CRITERIA, 1ST SENTENCE, PAGE 9:

DELETE:

When Type 2 combination small cell infrastructure is proposed, street lighting luminaire selection shall follow the luminaire specifications and design requirements set forth in the *City and County of Denver Street Lighting Design Guidelines*.

City and County of Denver Department of Transportation & Infrastructure
Right of Way Services | Engineering & Regulatory
201 West Colfax Avenue, Dept 507 | Denver, CO 80202
www.denvergov.org/doti
Phone: 720-913-1311

REPLACE:

When Types 2, 3 or 5 combination small cell infrastructure is proposed, street lighting luminaire selection shall follow the luminaire specifications and design requirements set forth in the *City and County of Denver Street Lighting Design Guidelines*.

CHAPTER 2 SMALL CELL FACILITY GENERAL GUIDANCE, SECTION 2.1 FINISHES, 1ST BULLET, PAGE 12:

DELETE:

Agate "Medium" Gray (RAL 7038) – Default finish to be used in new-build corridors when a predominant new finish was not otherwise selected, or in downtown or heavily urbanized locations where there are trends of galvanized light standards or gray streetlight heads.

All attachments located on wooden poles shall be agate "medium" gray.

REPLACE:

"Light" Gray (RAL 7047) – Finish to be used in new-build corridors when a predominant new finish was not otherwise selected, or in downtown or heavily urbanized locations where there are trends of galvanized light standards or gray streetlight heads.

All attachments located on wooden poles shall be "Light" Gray.

CHAPTER 2 SMALL CELL FACILITY GENERAL GUIDANCE, SECTION 2.1 FINISHES, 4TH BULLET, PAGE 12:

DELETE:

"Light" Gray (RAL 7047)

CHAPTER 2 SMALL CELL FACILITY GENERAL GUIDANCE, SECTION 2.2 GENERAL SMALL CELL INFRASTRUCTURE PLACEMENT REQUIREMENTS, 5TH BULLET, PAGE 12:

DELETE:

Equal distance between trees when possible, with a minimum of 25 feet of separation to the tree trunk such that no proposed disturbance shall occur within 5 feet of the critical root zone (drip-line) of any tree.

REPLACE:

Equal distance between trees when possible, with a minimum of 15-25 feet of separation to the tree trunk such that no proposed disturbance shall occur within 5 feet of the critical root zone (drip-line) of any tree unless otherwise agreed to in writing by the Office of the City Forester (OCF) of CCD. The CCD reserves the right to reduce minimum tree separation criteria based on adjacent tree species and condition and/or tree mitigation efforts.

CHAPTER 3 TYPE 1 ATTACHMENTS TO UTILITY POLES AND UTILITY LINES, 2ND PARAGRAPH, PAGE 15:

DELETE:

All attachments to utility poles shall be approved by CCD and Xcel Energy prior to installation. All equipment shall meet Xcel Energy's utility requirements and CCD's *Small Cell Design Guidelines and simple Statement of No Objection process*.

REPLACE:

All attachments to utility poles and utility lines shall be approved by CCD and Xcel Energy prior to installation. All equipment shall meet Xcel Energy's utility requirements and CCD's *Small Cell Design Guidelines and Statement of No Objection process*.

CHAPTER 4 TYPE 2 ATTACHMENTS TO WOODEN STREETLIGHT POLES, 2ND SENTENCE, PAGE 17:

DELETE:

Please note that CCD guidelines require that any existing wooden streetlight pole location sought for locating small cell equipment up be converted to a Type 3 metal streetlight installation.

REPLACE:

Please note that CCD guidelines require that any existing wooden streetlight pole location sought for locating small cell equipment be converted to a Type 3 metal streetlight installation.

CHAPTER 5 TYPE 3 COMBINATION SMALL CELL AND METAL STREETLIGHT POLE, 1ST PARAGRAPH, 1ST SENTENCE, PAGE 19:

DELETE:

This Chapter is to be applied in the rare instance when small cell equipment is replacing an existing streetlight pole with a combination small cell and metal streetlight pole.

REPLACE:

This Chapter is to be applied when small cell equipment is replacing an existing streetlight pole with a combination small cell and metal streetlight pole.

CHAPTER 5 TYPE 3 COMBINATION SMALL CELL AND METAL STREETLIGHT POLE, 3RD PARAGRAPH, 2ND SENTENCE, PAGE 19:

DELETE:

All proposals to replace existing streetlights owned by Xcel Energy shall meet Xcel Energy standards as well as CCD's small cell and street lighting design guidelines and associated permit procedures.

REPLACE:

All proposals to replace existing streetlights owned by Xcel Energy shall meet Xcel Energy standards as well as CCD's small cell and street lighting design guidelines and associated approval procedures.

CHAPTER 6 TYPE 4 FREESTANDING SMALL CELL INFRASTRUCTURE, SECTION 6.2, TABLE 6-1 TYPE 4 FREESTANDING POLE SPECIFICATION OVERVIEW, EQUIPMENT CABINET DIMENSIONS, PAGE 30:

DELETE:

Round 5'10" maximum height from the top of the concrete foundation to the top of the equipment cabinet transition shroud, maximum 20-inch diameter.

REPLACE:

Round 5'10" maximum height from the top of the concrete foundation to the top of the equipment cabinet, maximum 20-inch diameter.

CHAPTER 6 TYPE 4 FREESTANDING SMALL CELL INFRASTRUCTURE, SECTION 6.3, 4TH BULLET, PAGE 31:

DELETE:

Not be closer than 250 feet way, radially, from another privately owned Type 4 freestanding small cell.

REPLACE:

Not be closer than 250 feet way, radially, from another privately owned Type 4 or Type 6 freestanding small cell.

**CHAPTER 6 TYPE 4 FREESTANDING SMALL CELL INFRASTRUCTURE, SECTION 6.3, FIGURE 6-6:
FREESTANDING SMALL CELL LOCATION BETWEEN RESIDENTIAL PROPERTY AND TREES, PAGE 32:**

DELETE:

25FT (MIN)

REPLACE:

15-25FT (MIN)

**CHAPTER 7 TYPE 5 COMBINATION SMALL CELL AND PEDESTRIAN LIGHT, 2ND PARAGRAPH, LAST
SENTENCE, PAGE 35:**

DELETE:

Combination small cell aesthetics and proposed locations shall meet the *CCD Freestanding Small Cell Infrastructure ROW Permit Requirements*.

REPLACE:

Combination small cell and pedestrian light aesthetics and proposed locations shall meet CCD's small cell and street lighting design guidelines and associated approval procedures.

**CHAPTER 8 TYPE 6 MULTI-CARRIER FREESTANDING SMALL CELL INFRASTRUCTURE, SECTION 8.2,
TABLE 8-1: TYPE 6 MULTI-CARRIER POLE SPECIFICATION OVERVIEW, POLE HEIGHT, PAGE 41:**

DELETE:

The freestanding multi-carrier small cell shall not exceed 40 feet above finished grade.

REPLACE:

30 – 40 feet based on the typical height of poles and street lights in the area (subject to DOTI approval) and shall not exceed 40 feet above finished grade.

**CHAPTER 9 RADIO FREQUENCY CERTIFICATION REPORT, SECTION 9.2, 1ST PARAGRAPH, 1ST
SENTENCE, PAGE 46:**

DELETE:

The site-specific RF Location Certification, prepared for each specific local application bundle, shall include the information below for each specific proposed antenna location.

REPLACE:

The site-specific RF Location Certification, prepared for each specific local application bundle (both freestanding and co-location alike), shall include the information below for each specific proposed antenna location.

**APPENDIX A DETAILS, STANDARD DRAWING NO. SS-01 SMALL CELL DEPLOYMENT TYPE 1A: UTILITY
POLE MOUNTED, DIMENSION FROM FINAL GRADE TO TOP OF ELECTRICAL CONDUIT:**

DELETE:
24" (MIN.)

REPLACE:
36" (MIN.)

APPENDIX A DETAILS, STANDARD DRAWING NO. SS-02 SMALL CELL DEPLOYMENT TYPE 1B: UTILITY POLE STRAND MOUNTED, DIMENSION FROM FINAL GRADE TO TOP OF ELECTRICAL CONDUIT:

DELETE:
24" (MIN.)

REPLACE:
36" (MIN.)

APPENDIX A DETAILS, STANDARD DRAWING NO. SS-11 SMALL CELL DEPLOYMENT TYPE 6A: MULTI-CARRIER FREESTANDING POLE A, DIMENSION FROM FINAL GRADE TO TOP OF POLE:

DELETE:
40'-00" MAX.

REPLACE:
30' - 40'

APPENDIX A DETAILS, STANDARD DRAWING NO. SS-12 SMALL CELL DEPLOYMENT TYPE 6B: MULTI-CARRIER FREESTANDING POLE B, DIMENSION FROM FINAL GRADE TO TOP OF POLE:

DELETE:
40'-00" MAX.

REPLACE:
30' - 40'

APPENDIX A DETAILS, STANDARD DRAWING NO. SS-13 SMALL CELL DEPLOYMENT: CONDUIT BURIAL DETAIL, DIMENSION FROM SURFACING OR FINISHED GRADE TO TOP OF CONDUIT:

DELETE:
24" MINIMUM UNDER GROUND
48" MINIMUM UNDER TREE LAWNS
48" MINIMUM UNDER ROADWAY
48" MINIMUM UNDER RAILROAD TRACKS

REPLACE:
36" MINIMUM
48" MINIMUM PREFERRED UNDER LANDSCAPE AREAS/TREE LAWNS
48" MINIMUM UNDER RAILROAD TRACKS

APPENDIX A DETAILS, STANDARD DRAWING NO. SS-15 SMALL CELL DEPLOYMENT: IN-GRADE PULL BOX / SPLICE BOX, DIMENSION FROM FINAL GRADE TO TOP OF CONDUIT:

DELETE:
24" MIN.

REPLACE:
36" MIN.

APPENDIX A DETAILS, STANDARD DRAWING NO. SS-16 SMALL CELL DEPLOYMENT: SMALL CELL ELECTRICAL DETAIL IN SOFTSCAPE, DIMENSION FROM FINAL GRADE TO TOP OF CONDUIT:

DELETE:
24" MIN.

REPLACE:
36" MIN.

APPENDIX A DETAILS, STANDARD DRAWING NO. SS-17 SMALL CELL DEPLOYMENT: SMALL CELL ELECTRICAL DETAIL IN HARDSCAPE, DIMENSION FROM BOTTOM OF PAVEMENT TO TOP OF CONDUIT:

DELETE:
24" MIN. DIMENSION

REPLACE:
36" MIN. DIMENSION FROM FINAL GRADE TO TOP OF CONDUIT

APPENDIX A DETAILS, STANDARD DRAWING NO. SS-20 SMALL CELL DEPLOYMENT: PIER FOUNDATION, DIMENSION FROM FINAL GRADE TO CENTER LINE OF CONDUIT:

DELETE:
2'-0" DIMENSION

REPLACE:
3'-0" MIN. DIMENSION FROM FINAL GRADE TO TOP OF CONDUIT

APPENDIX A DETAILS, STANDARD DRAWING NO. SS-21 SMALL CELL DEPLOYMENT: SPREAD FOOTING FOUNDATION, DIMENSION FROM FINAL GRADE TO CENTER LINE OF CONDUIT:

DELETE:
2'-0" DIMENSION

REPLACE:
3'-0" MIN. DIMENSION FROM FINAL GRADE TO TOP OF CONDUIT

APPENDIX B SPECIFICATIONS, SUBPARAGRAPH CONDUIT, 2ND TO LAST PARAGRAPH, PAGE B-4:

DELETE:
Excavate minimum 24 inches below base depth of each junction box, backfill and compact with 1" clean stone gravel to permit draining of water

REPLACE:
Excavate minimum 36 inches below base depth of each junction box, backfill and compact with 1-inch diameter clean stone gravel to permit draining of water

Developed by:



The City and County of Denver Public Works Department

CLANTON & ASSOCIATES



LIGHTING DESIGN AND ENGINEERING

Clanton & Associates, Inc.

JACOBS

Jacobs Engineering Group

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List of Abbreviations

AASHTO – American Association of State Highway and Transportation Officials
ACI – American Concrete Institute
ASCE – American Society of Civil Engineers
CCD – City and County of Denver
dBA – A-Weighted Decibels
FCC – Federal Communications Commission
IBC – International Building Code
IOT – Internet of Things
LED – Light Emitting Diode
MPE – Maximum Permissible Exposure
MPH – Miles Per Hour
mW/cm² – Milliwatts per Square Centimeter
NEC – National Electric Code
NESC – National Electrical Safety Code
PAR – Pedestrian Accessible Route
PVC – Polyvinyl Chloride
RF – Radio Frequency
ROW – Right of Way
SNO – Statement of No Objection
TIA – Telecommunications Industry Association
UPR – Utility Plan Review
V - Volts



1 BACKGROUND AND PURPOSE

To meet current cellular demands by citizens and visitors to the City and County of Denver (CCD), wireless providers and wireless infrastructure companies have been requesting permits to install small cell poles in the public right of way (ROW). Applicants for small cell infrastructure in CCD must, at a minimum, meet the requirements of this Guideline and obtain a permit as identified in CCD's *Freestanding Small Cell Infrastructure ROW Permit Entrance Requirements*. Small cells installed on private property are not bound to the requirements of this guide; although, the public ROW small cell guidelines may inform these installations.

This document establishes guidelines for installing small cell equipment and poles in the City and County of Denver's rights of way.

Six different types of small cell infrastructure installations are permitted within CCD rights of way. These types include:

- Type 1 – attachments to utility poles and utility lines
- Type 2 – attachments to wooden streetlight poles
- Type 3 – combination small cell and metal streetlights
- Type 4 – freestanding small cell infrastructure
- Type 5 – combination small cell and pedestrian light
- Type 6 – multi-carrier freestanding small cell infrastructure

An overview of each type is included on the following pages.

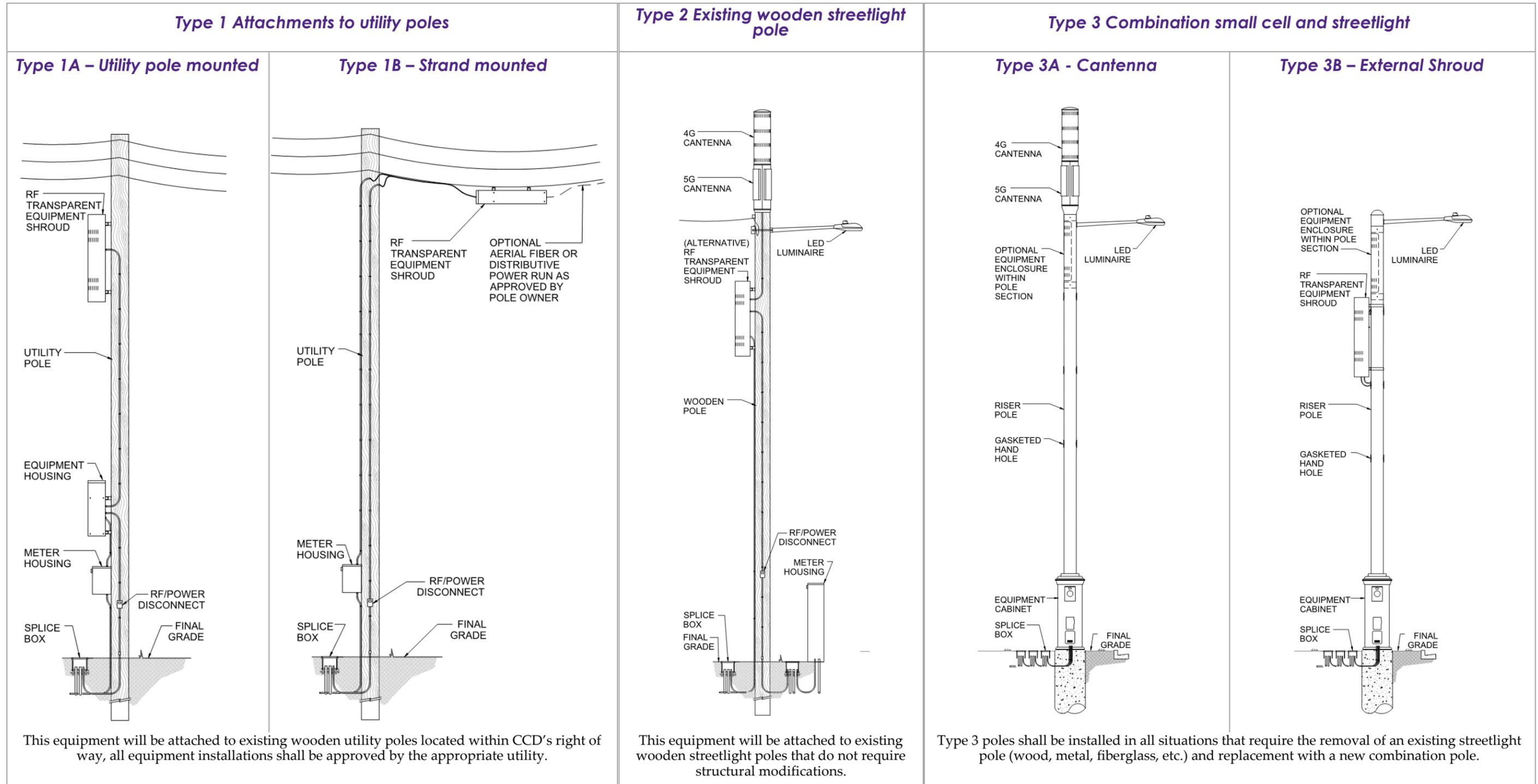
1.1 Typical Approval Process

The following table describes the typical small cell approval process for both Xcel Energy and CCD.

Table 1-1: Typical Small Cell Approval Processes

Small Cell Deployment Category	Approval Process
Co-location onto Xcel Energy owned infrastructure Examples: <ul style="list-style-type: none"> • Type 1 attachments to utility poles and utility lines • Type 2 attachments to wooden streetlight poles • Type 3 combination small cell and metal streetlight pole 	<ol style="list-style-type: none"> 1) Applicant proposes co-locations to CCD by submitting for a Statement of No Objection (SNO) approval. CCD Design Guidelines and Xcel Energy Guidelines shall be followed. 2) Applicant receives SNO from CCD. 3) Applicant applies to Xcel Energy for all CCD approved SNO locations. 4) Applicant and Xcel Energy complete power walk and undergrounding permits. 5) Xcel Energy completes permitting and construction process for each location.
New freestanding poles and infrastructure Examples: <ul style="list-style-type: none"> • Types 4 and 6 freestanding small cell infrastructure 	<ol style="list-style-type: none"> 1) Applicant follows CCD Small Cell Design Guidelines and associated permitting procedures. 2) Applicant submits batches of Freestanding Small Cell Infrastructure ROW Permit (Tier II Encroachment Permit) 3) Outcome of permit process is approval to proceed to ROW Construction Permitting after obtaining Tier II Encroachment Permit and Utility Plan Review approval. 4) Applicant files for appropriate construction permitting through the Department of Public Works.

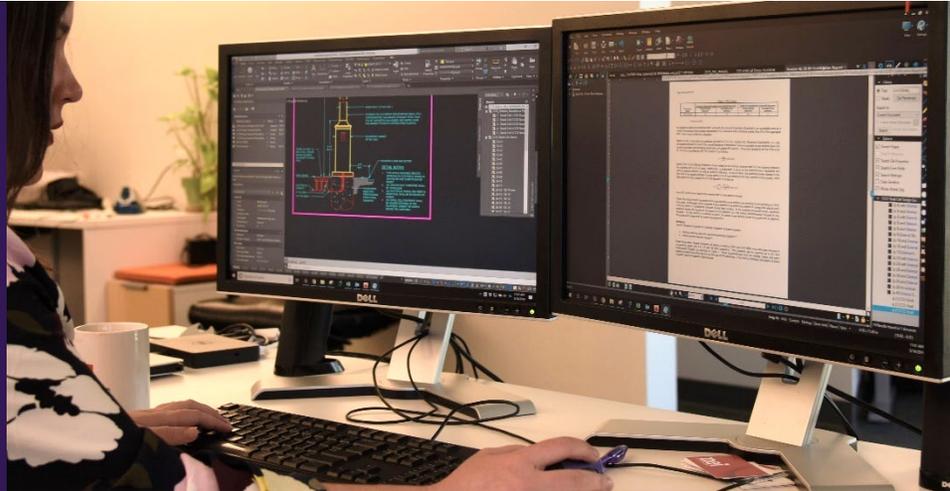
1.2 Typical Small Cell Installations



Type 3 Combination small cell and streetlight (Cont.)		Type 4 Freestanding small cell	Type 5 Combination small cell and pedestrian light	Type 6 Multi-Carrier freestanding small cell	
<p>Type 3C – Antenna and External Shroud</p>	<p>Type 3D – Distributive Power with Antenna and External Shroud</p>			<p>Type 6A – Potential Multi-Carrier form factor</p>	<p>Type 3B – Potential Multi-Carrier form factor</p>
<p>Type 3 poles shall be installed in all situations that require the removal of an existing streetlight pole (wood, metal, fiberglass, etc.) and replacement with a new Type 3 pole.</p> <p>To qualify for an external shroud permit, the Applicant must demonstrate that proposed deployment(s) cannot be integrated into the equipment cabinet or the antenna.</p>		<p>This equipment may be installed when no existing streetlight or other appropriate location is within 25 feet of the proposed freestanding location. To qualify for an external shroud permit, the Applicant must demonstrate that proposed deployment(s) cannot be integrated into the pole assembly.</p>	<p>This equipment may be installed with prior CCD Public Works Department approval for pedestrian lighting locations within CCD's public right of way.</p>	<p>Various Type 6 pole aesthetics will be considered. All Type 6 poles must be approved by the CCD Public Works Department prior to applying for a permit.</p>	

Chapter

2



Refer to Chapter 2 for general guidance applicable to all small cell installations.

2 SMALL CELL FACILITY GENERAL GUIDANCE

All small cell wireless facility attachments or installations in Denver shall be approved by CCD. All equipment shall meet the requirements of this Guideline and *CCD's Freestanding Small Cell Infrastructure ROW Permit Entrance Requirements*. The same small cell pole aesthetic is to be used in the same area to maintain a cohesive appearance. The CCD Public Works Department reserves the right to approve deviations from these guidelines as long as any deviations meet the general intent of this guide and are approved in writing.

Figure 2-1: General Small Cell Pole

General Aesthetic Criteria

Small cell infrastructure in Denver must consider the aesthetics of the existing streetlights and neighborhoods adjacent to proposed small cell locations prior to submitting an application. New small cells shall consider and make best efforts as stated within these Guidelines to match existing, adjacent streetscape character. In addition, when new small cell infrastructure is proposed to be installed in a Special District or neighborhood that maintains unique streetlight aesthetics, the applicant must consider and propose infrastructure that most closely matches adjacent themed infrastructure to the maximum extent feasible, see Figure 2-1 for an example of a general small cell pole. The characteristics of unique assemblies may include mast arms, decorative pole bases, architectural luminaires, mounting heights, pole colors, etc. that deviate from these guidelines.



General Luminaire Criteria

When Type 2 combination small cell infrastructure is proposed, street lighting luminaire selection shall follow the luminaire specifications and design requirements set forth in the *City and County of Denver Street Lighting*

Design Guidelines. No small cell devices shall be installed on a streetlight without confirming that the intended installation has no impact on the streetlight's operational performance including the streetlight control system.

General Facility Relocation Criteria

As a condition of all small cell infrastructure permits, any privately owned infrastructure shall be removed and relocated at no cost to CCD, if CCD or Xcel Energy identifies a conflict and/or decides to remove the co-located equipment in the future. Once notified in writing, small cell infrastructure must be removed within a reasonable time frame (within 90 days or as agreed to in writing), and reasonable accommodations will be made to identify and permit suitable alternate locations for said conflicting infrastructure.

General Electrical and Fiber Criteria

All installations shall meet or exceed all applicable structural standards, clearance standards, and provisions of the latest National Electric Code (NEC) or National Electrical Safety Code (NESC), and applicable CCD construction standards. In case of conflict, the most stringent requirements shall prevail. All necessary permits shall be obtained by the Applicant and provided to the pole owner and CCD. CCD, and Xcel Energy when applicable, shall approve all associated fiber and power source locations prior to installation. Electrical services shall be separated by owner with separate conduit, splice box(es), equipment access, and dividers within the pole.

Details showing conduit burial; pull box dimensions; small cell standard foundations; grounding; combination small cell and light standards; and pole bases can be found in Appendix A.

General Existing Pole Criteria

Prior to submitting any request for approval of Type 1 or 2 small cell infrastructure deployments, the Applicant is responsible for demonstrating existing supporting pole(s) are appropriately sized and have sufficient strength to accommodate the additional small cell equipment loadings along with all other accompanying uses or applications (banners, for example). If not structurally capable, it is expected that the Applicant will be responsible for replacing any existing pole.

Please note that when proposing to replace any existing wood streetlight in CCD, whether owned by Xcel Energy or not, the existing wood pole is required under these Guidelines to be removed and replaced with a Type 3 metal combination pole, unless CCD and Xcel Energy agree during review processes that it is unreasonable to do so because of site specific issues.

Table 2-1: Small Cell Facility Specification Overview

Electrical Service	Per Xcel Energy’s requirements.
Grounding	Per Xcel Energy’s requirements.
Utility Equipment	Per Xcel Energy’s requirements.
Separation of Service	All new electrical conduit and fiber shall be separated (by owner of service) in pull/splice boxes located adjacent to the small cell facility. For example, metered small cell electrical service shall be separate from streetlight electrical service.
Finish	Per Section 2.1 below.
External Equipment Shroud	49”H x 19”W x 13”D maximum
Cantenna Height	If a cantenna is located on top of the pole, then the cantenna height measured from the top of the riser pole to the top of the cantenna shall not exceed 6’-8”.
Cantenna Diameter, Top Mounted	16-inch maximum outer diameter (14-inch is preferred). 5G remote mounted antennas will be allowed a 19-inch outer diameter protrusion.
Cantenna Diameter, Side Mounted	If the cantenna is mounted to the side of the pole it shall be located inside a shroud of 9.0 cubic feet maximum. The width, depth, or diameter of the shroud size shall not be greater than 16” (maximum).
RF Equipment Disconnect	Radio frequency equipment shall have a disconnect that meets or exceeds Xcel Energy’s requirements.
Pole Mounted Warning Label	If required, radio frequency warning labels shall be mounted exterior to Carrier’s equipment.
Strand Mounted Warning Label	Radio frequency warning labels shall be mounted on the equipment, and clearly mark both sides of the enclosure and be visible from the ground, roadside, and field side.
Owner Identification	A 4-inch by 6-inch (maximum) aluminum plate with the Carrier’s name, location identifying information, and emergency telephone number shall be permanently fixed to the shroud.

See following Chapters for more information on specific small cell specification requirements.

2.1 Finishes

For all new small cell installations in CCD, small cell equipment color shall be selected and proposed from the list of available colors below at time of application. Should it be determined that a unique or non-standard color is appropriate based on character of adjacent infrastructure, the Applicant shall propose appropriate colors for approve by CCD in writing.

Color selection from the standard color chart below shall be made from a conscious and thoughtful effort by the Applicant to best match proposed small cell equipment with the predominant color of existing pole infrastructure within one block of the proposed location, as well as general character of the corridor where the equipment will be located. The Applicant shall perform a visual inspection (online street images may be considered sufficient unless adjacent infrastructure was updated after the images were published) prior to submitting a permitting application confirm existing aesthetics. When in doubt, additional guidance has been provided below to assist in color selection. The Public Works Department reserves the right to modify proposed finishes prior to approval.

- **Federal Green (RAL 6012)** – Default finish to be used in residential neighborhoods or other corridors with established tree canopies, or in long serving areas with predominantly wood utilities and streetlight poles. When finish selection in these areas is still in doubt, use when Federal Green poles can be found within several blocks from the proposed location.

- **Agate “Medium” Gray (RAL 7038)** – Default finish to be used in new-build corridors when a predominant new finish was not otherwise selected, or in downtown or heavily urbanized locations where there are trends of galvanized light standards or gray streetlight heads.
All attachments located on wooden poles shall be agate “medium” gray.
- **Black (RAL 9017)**
- **Dark Gray (RAL 7039)**
- **Light Gray (RAL 7047)**
- **Per the Historic District allowed finish**
- **Per the Special District allowed finish**
 - **Cherry Creek North BID: Matthews Paint – MP18249 “Dark Metallic Gray”**
 - **Downtown Denver BID: Diamond Vogel – Cadaver Gray**
 - **University of Denver: Maroon**
(Pantone PMS 202 C; Hex color: #8B2332; RGB: 139, 35, 50; CMYK: 29, 96, 76, 29)

Poles located in Historic Districts or Special Districts that are not owned by Xcel Energy may offer additional opportunities to coordinate with adjacent predominant infrastructure finish. CCD is prepared to approve color codes whenever appropriate to match adjacent District infrastructure.

2.2 General Small Cell Infrastructure Placement Requirements

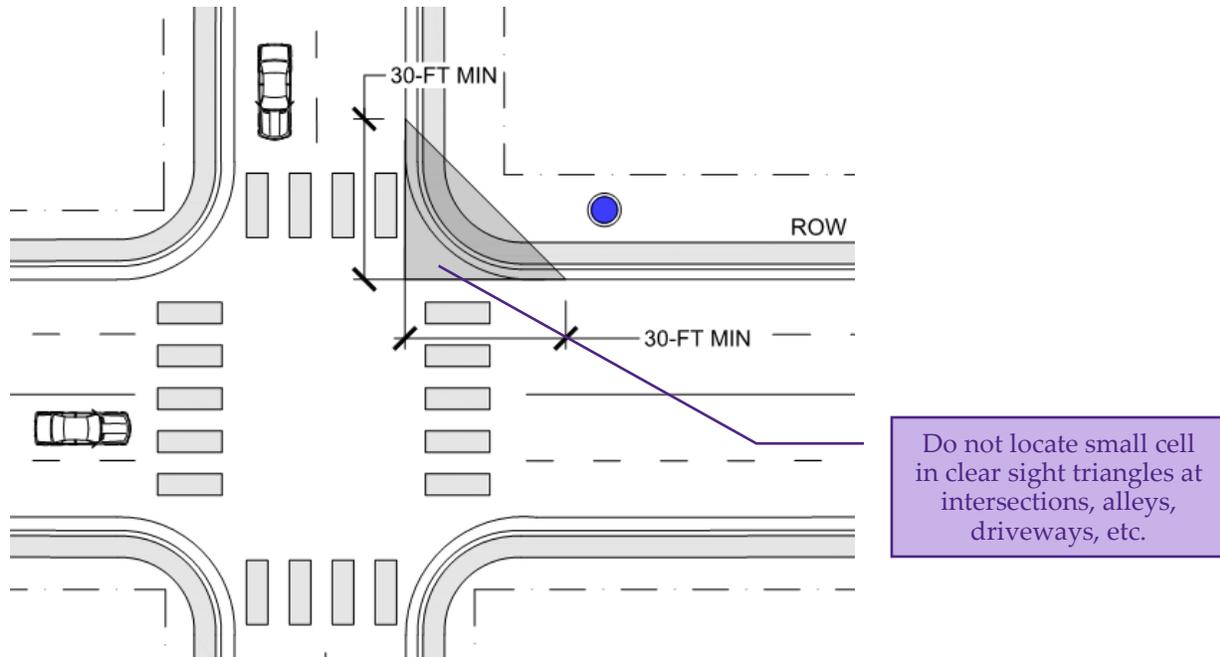
All small cell infrastructure placed in the CCD ROW shall be located:

- In a manner that does not impede, obstruct, or hinder operation of any emergency service, nor the usual pedestrian or vehicular access or travel including to or from private properties and of legally parked vehicles or permitted items in the public ROW.
- In alignment with existing trees, utility poles, and streetlights.
- Within the street amenity zone whenever possible, as shown in Figure 2-2.
- All electrical and fiber optic conduit proposed to each pole shall be located to avoid unpaved area between roadway curb and sidewalk, generally referred to as “tree lawn” or “amenity zone” to the maximum extent feasible.
- Equal distance between trees when possible, with a minimum of 25 feet of separation to the tree trunk such that no proposed disturbance shall occur within 5 feet of the critical root zone (drip-line) of any tree.
- With appropriate clearance from existing utilities.
- Outside of clear sight triangles per CCD Transportation Standards and Details as follows:
 - 5-foot leg pedestrian sight triangle at each residential driveway,
 - 10-foot leg pedestrian sight triangle at each driveway and alley,
 - 30-foot leg corner sight triangle,
 - Roadway sight triangles shall be based on AASHTO standards for each driveway, alley, and intersection.
- Outside of traffic signal equipment clear zones per CCD Transportation Standards and Details.
- So as not to be located along the frontage of a historic building, deemed historic on a federal, state, or local level.
- So as not to significantly create a new obstruction or unreasonable visual blight or obstruction to primary property sight lines beyond that expected of other legally permitted encroachments or utility infrastructure in the Public ROW of CCD in adjacent or similar zones or districts.
- So as not to be along any designed parkway or adjacent to any designated park unless otherwise agreed to in writing by the Parks Department of CCD.
- So as to not impact any existing bridges or retaining walls.

Figure 2-2: Freestanding Small Cell in Amenity Zone



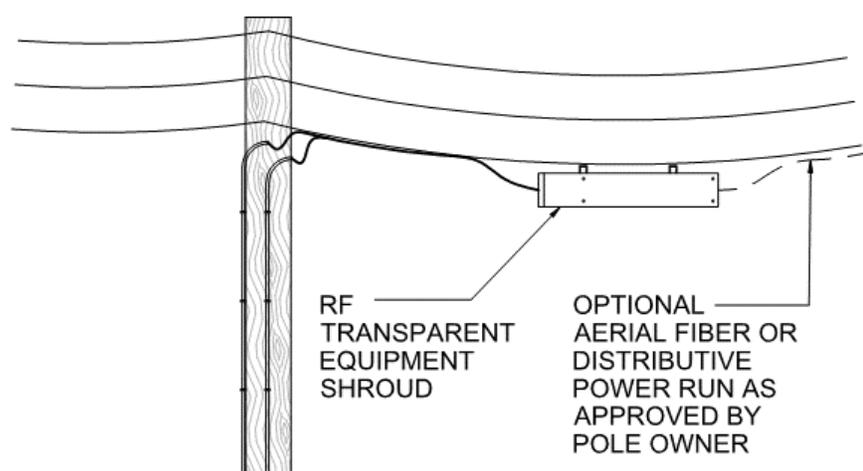
Figure 2-3: Standalone Small Cell Sight-line Requirements



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Chapter

3



3 TYPE 1 ATTACHMENTS TO UTILITY POLES AND UTILITY LINES

Refer to Chapter 3 when attaching equipment to utility poles and utility lines.

This Chapter is to be applied when Carriers desire to locate small cell infrastructure on existing Xcel Energy or other privately (non CCD) owned utility poles or utility lines. Refer to Chapter 4 for projects involving existing wooden streetlight small cell attachments.

All attachments to utility poles shall be approved by CCD and Xcel Energy prior to installation. All equipment shall meet Xcel Energy's utility requirements and CCD's *Small Cell Design Guidelines and simple Statement of No Objection process*.

All small cell carrier equipment in CCD shall be visually concealed (ie: behind a shroud). Only two enclosures, including the disconnect and antenna, shall be installed at each utility pole location. No ground mounted enclosures, except for meters when required by Xcel Energy, including backup power supply shall be allowed. No strand mounted small cell devices shall be installed on poles with mounted streetlights.

3.1 Type 1 Utility Pole Small Cell Attachments Specification Overview

Prior to moving forward with any specific location, the carrier shall request that the pole owner (Xcel Energy in most cases) verify the existing utility pole being sought for co-location is appropriately sized and has sufficient strength and structural integrity to accommodate the additional small cell equipment loads. The small cell equipment loads shall be provided by the Applicant.

All installations shall meet or exceed all applicable structural standards, clearance standards, and provisions of the latest NESC, and applicable CCD construction standards. In case of conflict, the most stringent requirements shall prevail. All necessary permits shall be obtained by the Applicant and provided to the pole owner and CCD.

Aerial only fiber and power strand installations are allowed even though Figure 3-2 shows an example of an undergrounded fiber and power installation.

Figure 3-1: Type 1A Utility Pole Attachment

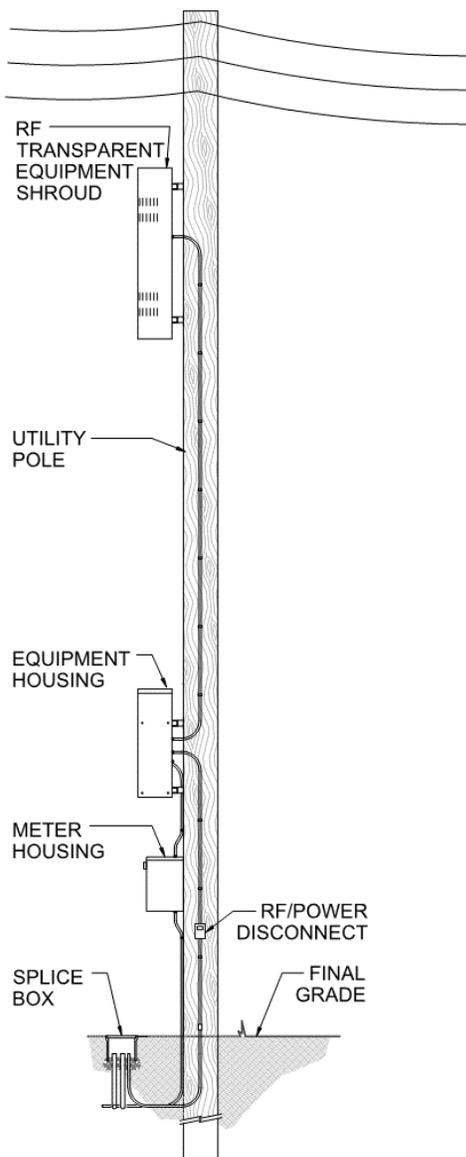


Figure 3-2: Type 1B Strand Mounted Attachment

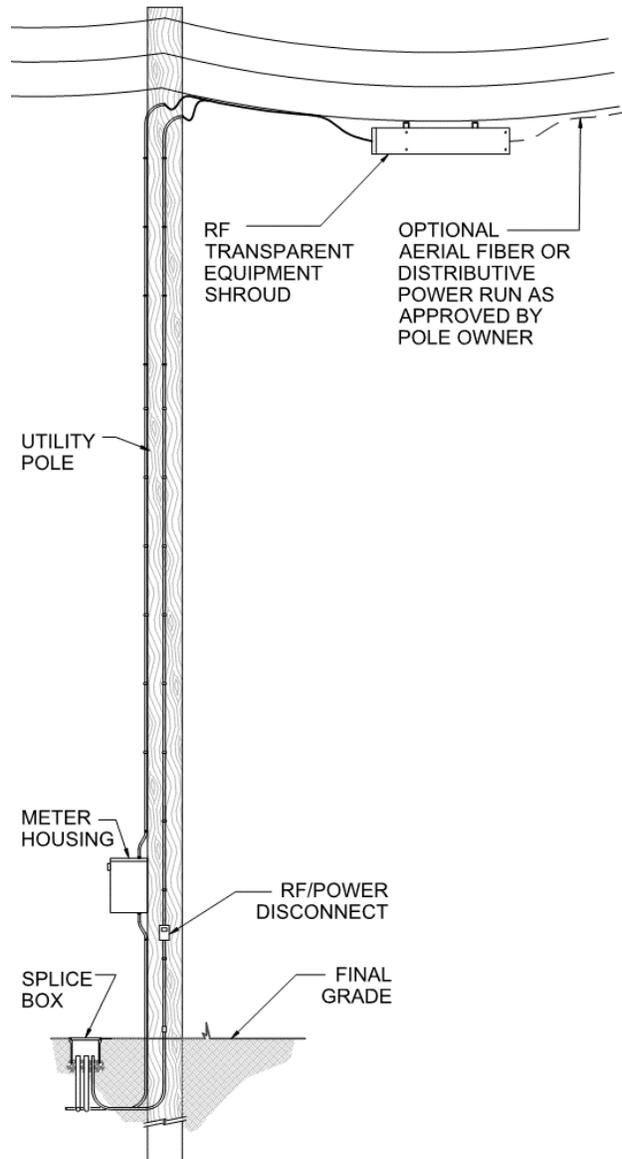


Table 3-1: Type 1 Pole Specification Overview

Pole Mounted Equipment Shroud	49"H x 19"W x 13"D maximum Only one equipment shroud, containing all required small cell equipment, shall be installed per pole. Except, one additional equipment shroud shall be allowed per pole if the antenna is located within the second equipment shroud.
Strand Mount Equipment Shroud	9.0 cubic feet maximum strand mount equipment shroud. Only one equipment shroud shall be installed per permit location.
Meter Housing	Any meter housing shall be located so as to not violate pedestrian or vehicle accessibility requirements.

Chapter

4



4 TYPE 2 ATTACHMENTS TO WOODEN STREETLIGHT POLES

Refer to Chapter 4 for information about small cell equipment mounted to an existing wooden streetlight.

This Chapter is to be applied in the rare instance when small cell equipment is located on existing wooden streetlights. Please note that CCD guidelines require that any existing wooden streetlight pole location sought for locating small cell equipment up be converted to a Type 3 metal streetlight installation.

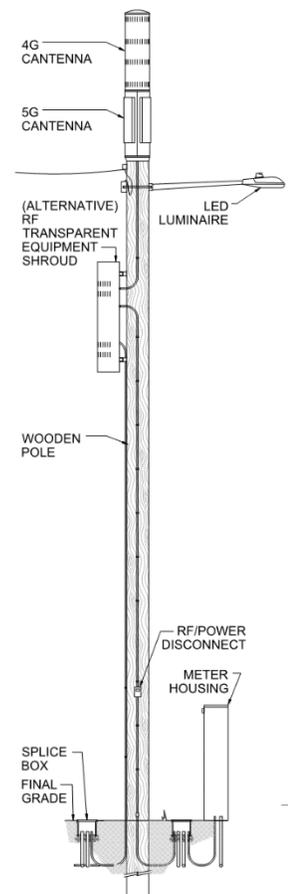
Exceptions to this requirement are granted by CCD on a case by case basis if determined that a particular location is overly burdensome to convert (as determined by separate CCD and Xcel Energy maximum extent feasible criteria) or would otherwise create an uncompliant location.

Some locations may also qualify for a two-phase wood to metal conversion plan if coordinated in advance with CCD and Xcel Energy. For instance, some locations can be approved for immediate co-location onto existing poles per Type 2 criteria until additional nearby poles are approved for small cell infrastructure, at such time the subject location must be converted to a Type 3 pole by the Applicant at no cost to CCD or Xcel Energy. Overall, all wooden poles that do not meet maximum extent feasible criteria must be converted to a Type 3 within two (2) years of Statement of No Objection approval by CCD.

If any small cell equipment is approved by CCD to be mounted upon an existing wood streetlight pole, said pole will then be carefully studied by Applicant and Xcel Energy to determine structural integrity and capacity. In many cases, existing wood poles are required by Xcel Energy to be replaced with new, more structurally capable wood poles.

Lighting design shall meet the luminaire specifications and design requirements set forth in the *City and County of Denver Street Lighting Design Guidelines*. These guidelines provide information about luminaire aesthetics, lighting criteria, typical streetlight spacing, specifications and details. The network provider shall provide all documentation required by the *Street Lighting Design Guidelines* to CCD during the permitting process. All luminaires shall be mounted at a similar or consistent height as surrounding streetlights.

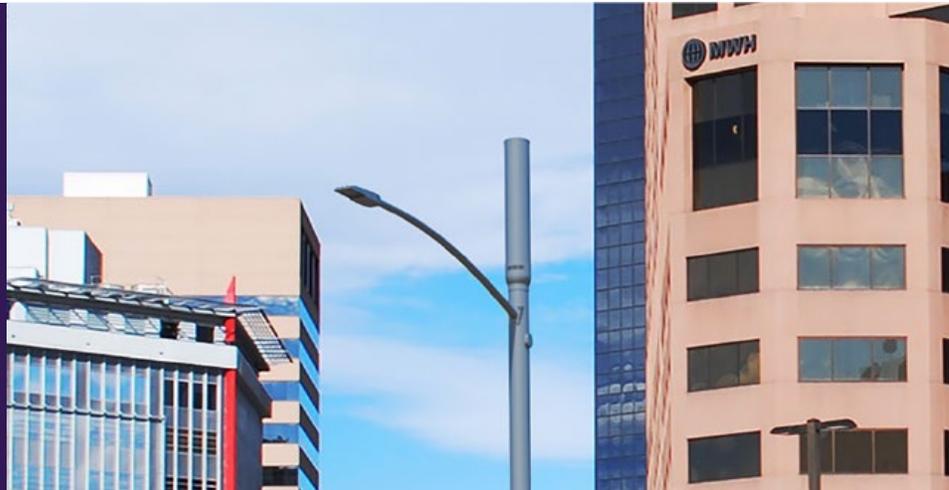
Figure 4-1: Type 2 Attachment to Wooden Streetlight Pole



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Chapter

5



5 TYPE 3 COMBINATION SMALL CELL AND METAL STREETLIGHT POLE

Refer to Chapter 5 when installing a metal combination small cell and streetlight pole.

This Chapter is to be applied in the rare instance when small cell equipment is replacing an existing streetlight pole with a combination small cell and metal streetlight pole. The combination small cell and streetlight poles referenced in this Chapter have often been referred to as “combination poles”, “co-located poles”, or “removed and replaced poles. However, for the purposes of these Guidelines, this deployment type is referred to as Type 3.

A Type 3 combination small cell and streetlight pole is typically located where an existing wooden or metal streetlight pole is approved to be removed and replaced, or at a new privately owned location where it has been identified that a streetlight is necessary.

Existing streetlights in CCD are typically owned by Xcel Energy. All proposals to replace existing streetlights owned by Xcel Energy shall meet Xcel Energy standards as well as CCD’s small cell and street lighting design guidelines and associated permit procedures.

5.1 Type 3 Basis of Design

Components of a Type 3 pole include the foundation, equipment cabinet, riser pole, luminaire, mast arm, luminaire control node if applicable, antenna or antenna enclosure, and all hardware and electrical equipment necessary for a complete assembly.

All small cell carrier equipment shall be housed internal to the pole or visibly screened / hidden behind an exterior shroud. No network provider equipment shall be mounted to the exterior of the pole unless it meets the Type 3B, Type 3C, or Type 3D requirements.

All Type 3 pole components shall be shaped to be visually pleasing and proportional to each other. Type 3 poles include a decorative transition over the base equipment cabinet upper bolts, hidden hardware connections, and a restriction of horizontal flat spaces greater than 1.5 inches to prevent cups, trash, and other objects from being placed on the pole components. Each pole component shall be architecturally compatible to create a cohesive aesthetic. Examples of an unacceptable and acceptable small cell installation can be found in Figures 5-1 and 5-2. Four variations of Type 3 poles are currently allowed in the City and County of Denver (Types 3A through 3D), to allow flexibility for deployment as described in the following sections.

Chapter title image courtesy of Comptek

Figure 5-1: Unacceptable Type 3 Installation

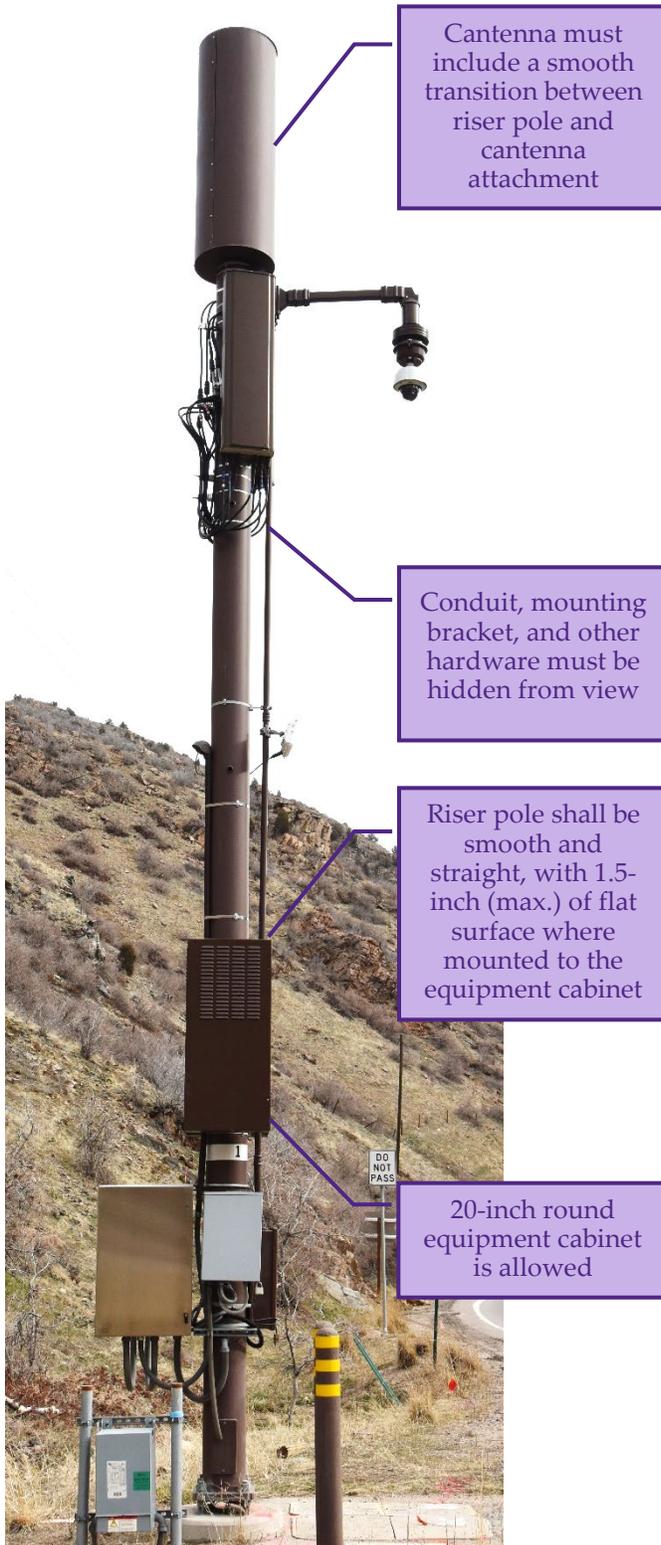


Figure 5-2: Acceptable Type 3 Installation



Image courtesy of Comptek

5.1.1 Type 3A Combination Pole with Cantenna

The Type 3A pole is composed of an equipment cabinet, riser pole, optional internal RF transparent section in the riser pole, streetlight, and cantenna. All equipment shall be located internal or recessed to the appropriate enclosure, including requirements of Xcel Energy when applicable.

5.1.2 Type 3B Combination Pole with External Shroud

The Type 3B pole is composed of an equipment cabinet, riser pole, optional internal RF transparent section in the riser pole, streetlight, and externally mounted equipment shroud. All equipment shall be located internal, shrouded, or recessed with only exceptions per electrical code requirements of Xcel Energy. The antenna, radio head, mounting brackets, and all hardware necessary for a complete installation shall be located inside an aesthetically pleasing and proportional equipment shroud, securely strapped to the pole.

Wires and cabling shall be hidden from view. Cables and wires shall be located internal to the pole until they reach a cable grommet. Weatherproof grommets shall be installed at all cable entry points. All pole openings shall be weatherproofed to prevent interior rusting of the pole.

Figure 5-3: Type 3A – Combination Pole with Cantenna

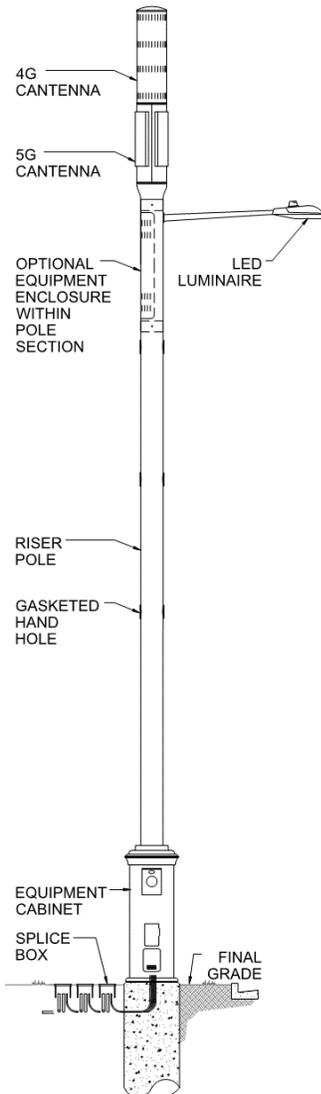
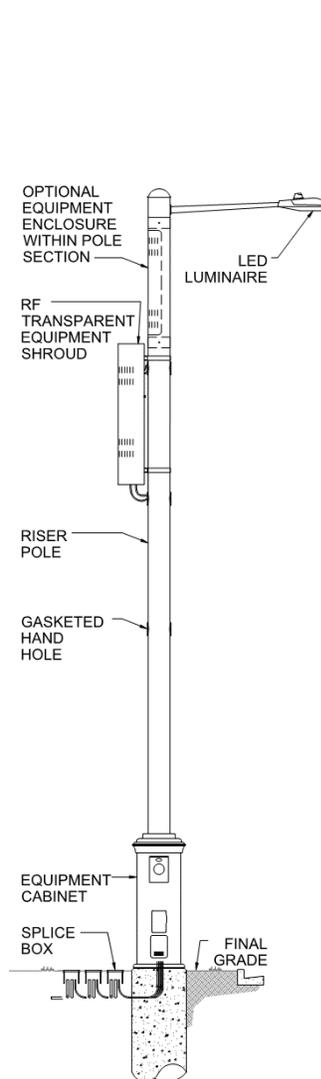


Figure 5-4: Type 3B – Combination Pole with External Shroud



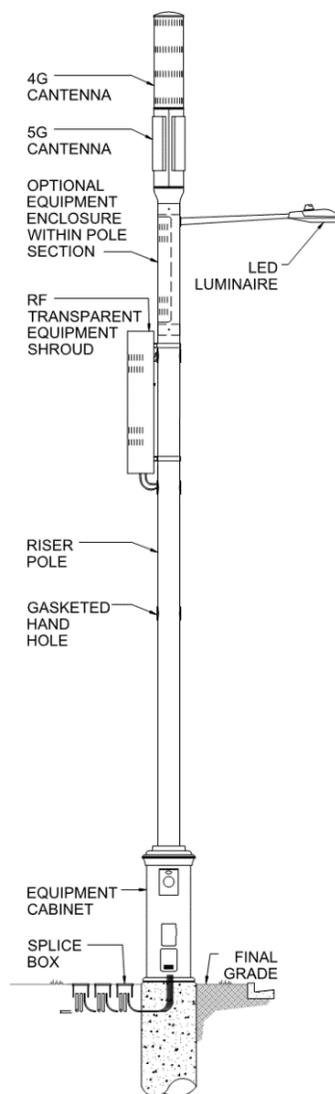
5.1.3 Type 3C Combination Pole with Cantenna and External Shroud

The Type 3C pole will be allowed when the equipment for two (2) separate providers is proposed to be installed on a single pole. To qualify for this permit, the Applicant must demonstrate that proposed deployment(s) cannot be integrated into the equipment cabinet or the cantenna.

This Type 3C pole is composed of a single equipment cabinet, riser pole, optional internal RF transparent section in the riser pole, streetlight, cantenna, and a single externally mounted equipment shroud.

The exterior mounted equipment shroud shall match the pole aesthetics. Care should be taken to integrate the mounting attachments into the enclosure design. The enclosure shall be securely strapped to the pole. Wires and cabling shall be hidden from view. Cables and wires shall be located internal to the pole until they reach a cable grommet. Weatherproof grommets shall be installed at all cable entry points. All pole openings shall be weatherproofed to prevent interior rusting of the pole.

Figure 5-5: Type 3C – Combination Pole with Cantenna and External Shroud



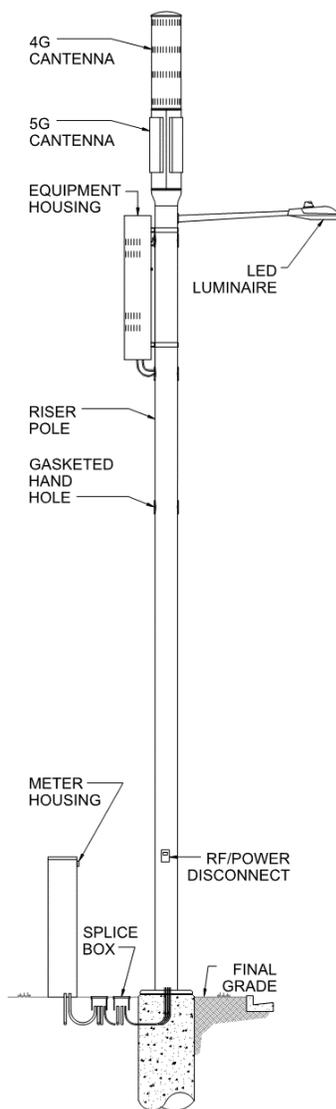
5.1.4 Type 3D Distributive Power Combination Pole

The Type 3D pole will only be allowed when power is delivered to the proposed locations via distributed, privately owned power supply. To qualify for this option the Applicant must permit multiple small cell locations that will receive power from a single remote meter service pedestal. This option will not be allowed if only one pole will be installed at the time of the permit application.

This Type 3D pole is composed of a single meter power pedestal serving multiple locations, riser pole, streetlight, antenna or a single RF transparent shroud, and equipment housing

The exterior mounted equipment shroud shall match pole aesthetics. Care should be taken to integrate the mounting attachments into the enclosure design. The enclosure shall be securely strapped to the pole. Wires and cabling shall be hidden from view. Cables and wires shall be located internal to the pole until they reach a cable grommet. Weatherproof grommets shall be installed at all cable entry points. All pole openings shall be weatherproofed to prevent interior rusting of the pole.

Figure 5-6: Type 3D – Distributive Power Pole with Cantenna and External Shroud



5.2 Type 3 Specification Overview

Table 5-1: Type 3 Pole Specification Overview

Luminaire	Per the <i>CCD Street Lighting Design Guidelines</i> (and Xcel Energy approved LED luminaire catalogue if owned by Xcel Energy).
Luminaire Mast Arm	Length to match existing streetlight mast arm lengths: 1', 6', or 10'.
Electrical Service	Per Xcel Energy's requirements, streetlights shall be single phase 120V.
Pole Requirements	At least 15% of the pole design structural capacity shall be reserved for future CCD installations.
Pole Type	12.75-inch (max.) round, straight, galvanized steel.
Total Pole Height	The top of the cantenna shall be no greater than 6'-8" above the top of the riser pole and attachment point. The top of the cantenna shall be located no more than 6'-8" above the adjacent streetlight heights, 36'-8" is typical. All luminaires shall be the same height as adjacent streetlights.
Design Wind Velocity	115 mph minimum per TIA-222 rev G, IBC 2012 with ASCE 710, and amendments for local conditions.
Foundation	Precast concrete or cast-in-place pole foundations shall be designed per CCD standard to meet ACI 318. While CCD accepts cast-in-place foundations, precast concrete foundations are preferred and should be installed whenever possible.
Conduit Sweeps in Foundation	Eight (8) 2.5" PVC conduit sweeps shall be installed. Conduit shall accommodate CCD electrical, CCD fiber, and small cell carrier electrical and fiber with up to four (4) spare sweeps for future service.
Bolt Circle	24-inch bolt circle. Anchor bolts shall either be hidden from view (preferred) or treated and painted to match the pole color
Potential Shroud	All fixed connections shall be hidden from view.
Electrical Separation	An internal divider shall separate electrical wiring and fiber, per Owner. Separation of service shall meet Xcel Energy's requirements.
Hand Holes	Six (6) gasketed, waterproof hand holes shall be provided along the riser pole, each set to be spaced 5'-0" apart, to maintain CCD fiber and electrical service for streetlights and future IOT attachments.
Grommets	Weatherproof grommets shall be integrated into the pole design to allow cable to exit the pole, for external shrouds, without water seeping into the pole.

Table 5-2: Type 3 Equipment Cabinet Specification Overview

Equipment Cabinet Dimensions	Round, 5'-10" maximum height from the top of the concrete foundation to the top of the equipment cabinet transition shroud, maximum 20-inch diameter.		
Equipment Cabinet Access Doors	Utility Access	City Access	Carrier Access
	Per Xcel Energy's meter access requirements. The meter shall be recessed as much as possible into the pole base	Hand hole	Lockable access door sized to install, maintain, and remove all small cell equipment as needed.
Required Equipment	Utility Equipment*	City Equipment*	Carrier Equipment*
	Per Xcel Energy's requirements	Fused power disconnect	Per small cell carrier requirements
	*All equipment shall be located internal to the equipment cabinet or recessed in the equipment cabinet to meet Utility requirements. All equipment shall be mounted per the Owner's requirements.		
Equipment Separation	All equipment shall be separated by Owner. All access doors shall be secured by Owner requirements.		
Ventilation	Passive louvers and/or other passive ventilation systems shall be provided as the primary means of temperature control.		
Motorized Ventilation	If required, fan(s) shall not emit noise greater than 50dBA at one meter (3.28 feet).		
Cantenna Shroud Transition	The antenna and riser pole attachment shall be shrouded to meet CCD aesthetics. A tapered transition between the riser pole and cantenna shall be included.		

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Chapter

6



6 TYPE 4 FREESTANDING SMALL CELL INFRASTRUCTURE

Refer to Chapter 6 when installing freestanding small cell poles.

This Chapter is to be applied when installing a freestanding small cell pole. The specifications provided in this Chapter are for freestanding, privately owned single carrier pole installations within the public ROW only. Multi-carrier Type 6 poles can be found in Chapter 8.

All freestanding small cell permitting applications shall be approved by CCD *Freestanding Small Cell Infrastructure ROW Permit* process prior to installation. All equipment shall meet Xcel Energy's utility requirements and CCD design aesthetics. All small cell carrier equipment shall be housed internal to the equipment cabinet, hidden behind the cantenna or specially permitted external shroud, or as otherwise specified in this guideline.

Deviations from this guide may only be approved on a case-by-case basis in writing by the CCD Public Works Department prior to installation.

6.1 Type 4 Basis of Design

All Type 4 pole components shall be shaped to be visually pleasing and proportional to each other. Type 4 poles, as permitted in these guidelines, include a decorative transition over the equipment cabinet upper bolts, hidden hardware connections, and a restriction of horizontal flat spaces greater than 1.5 inches to prevent cups, trash, and other objects from being placed on the pole components. Each pole component shall be architecturally compatible to create a cohesive aesthetic. Examples of an unacceptable and acceptable small cell installation can be found in Figures 6-2 and 6-3.

Figure 6-1: Type 4 Freestanding Small Cell Pole



Figure 6-2: Unacceptable Type 4 Installation

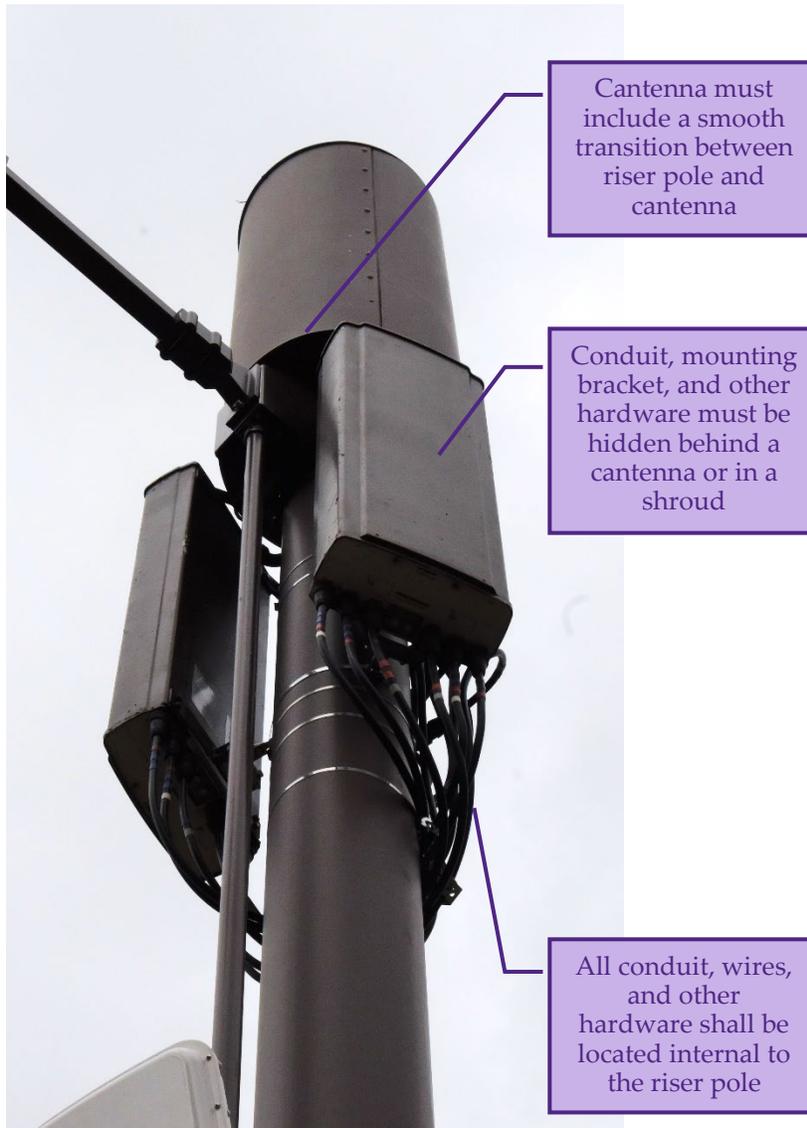


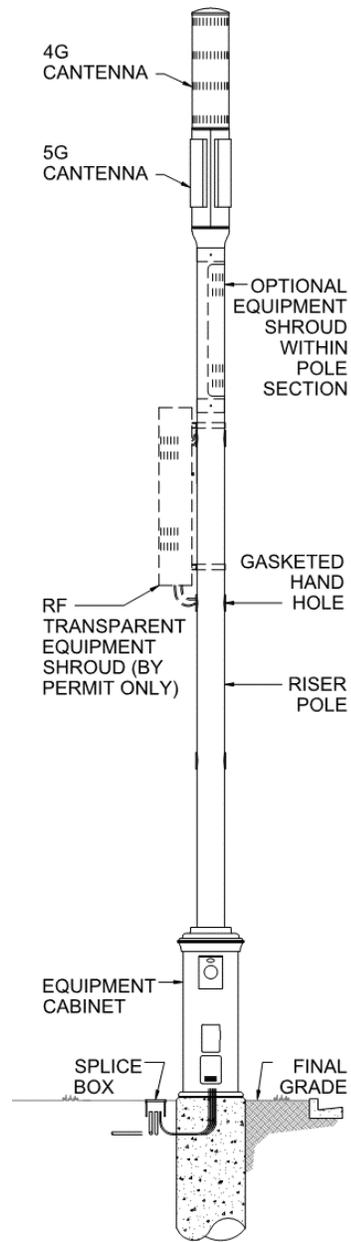
Figure 6-3: Acceptable Type 4 Installation



Freestanding small cell pole components include foundation, equipment cabinet, riser pole, antenna, permitted external shroud, and all hardware and electrical equipment necessary for a complete assembly, as shown in Figure 6-4.

The optional exterior mounted equipment shroud will be allowed when equipment cannot be located internal to the riser pole. To qualify for this permit, the Applicant must demonstrate that proposed deployment(s) cannot be integrated into the equipment cabinet or the antenna. The exterior mounted equipment shroud shall match the pole aesthetics. Care should be taken to integrate the mounting attachments into the enclosure design. The enclosure shall be securely strapped to the pole. Wires and cabling shall be hidden from view. Cables and wires shall be located internal to the pole until they reach a cable grommet. Weatherproof grommets shall be installed at all cable entry points. All pole openings shall be weatherproofed to prevent interior rusting of the pole.

Figure 6-4: Freestanding Small Cell Assembly



6.2 Type 4 Freestanding Small Cell Specification Overview

Table 6-1: Type 4 Freestanding Pole Specification Overview

Pole Type	12.75-inch (max.) round, straight, galvanized steel.				
Pole Height	The freestanding small cell shall not exceed 30 feet. Pole shall be measured from the top of the foundation to the top of the antenna.				
Design Wind Velocity	115 mph minimum per TIA-222 rev G, IBC 2012 with ASC 710, and amendments for local conditions.				
Foundation	Precast concrete or cast-in-place pole foundations shall be designed per CCD standard to meet ACI 318. While CCD accepts cast-in-place foundations, precast concrete foundations are preferred and should be installed whenever possible.				
Conduit Sweeps in Foundation	Eight (8) 2.5" PVC conduit sweeps shall be required. Conduit shall accommodate small cell carrier electrical and fiber with up to four (4) spare sweeps for future service.				
Bolt Circle	24-inch bolt circle. Anchor bolts shall either be hidden from view (preferred) or treated and painted to match the pole color				
Equipment Cabinet Dimensions	Round 5'-10" maximum height from the top of the concrete foundation to the top of the equipment cabinet transition shroud, maximum 20-inch diameter.				
Equipment Cabinet Access Doors	Lockable access door sized to install, maintain, and remove all small cell equipment as needed to meet Carrier's requirements. Utility access shall be per Xcel Energy's requirements. The meter shall be recessed into the pole base				
Equipment Cabinet Required Equipment	All equipment shall be located internal to the equipment cabinet or recessed as much as possible in the equipment cabinet to meet Utility requirements. All equipment shall be mounted per the Owner's requirements. Pole bases shall be sized to handle the listed equipment and all other equipment required by the Owner.				
	<table border="1"> <thead> <tr> <th>Utility Equipment</th> <th>Carrier Equipment</th> </tr> </thead> <tbody> <tr> <td>Per Xcel Energy's requirements</td> <td>Per small cell carrier requirements</td> </tr> </tbody> </table>	Utility Equipment	Carrier Equipment	Per Xcel Energy's requirements	Per small cell carrier requirements
Utility Equipment	Carrier Equipment				
Per Xcel Energy's requirements	Per small cell carrier requirements				
Ventilation	Passive louvers and/or other passive ventilation systems shall be provided as the primary means of temperature control.				
Motorized Ventilation	If required, fan(s) shall not emit noise greater than 50dBA at one meter (3.28 feet).				
Cantenna	Antenna and pole attachment shall be shrouded to meet CCD aesthetics. A tapered transition between the riser pole and cantenna shall be included.				
Cantenna Height	The cantenna shall be sized appropriately to contain all required equipment while remaining aesthetically pleasing - including antenna, radio equipment, brackets, transition shroud, and all other hardware required for a complete installation. The cantenna height measured from the top of the riser pole to the top of the cantenna should be no greater than 7'-6" .				

6.3 Type 4 Specific Placement Requirements

If there is a suitable streetlight within 250 feet of the proposed freestanding small cell, the streetlight must be strongly considered for deployment at an existing streetlight location (Type 3 combination pole).

Otherwise, a freestanding Type 4 small cell pole shall:

- Not be located within 25 feet of an existing Xcel Energy or CCD owned streetlight pole.
- Be located at the intersection of property lines, or along secondary street-facing property.
- Not be located within 100 feet of the apron of a fire station or other adjacent emergency service facility.
- Not be closer than 250 feet away, radially, from another privately owned Type 4 freestanding small cell.

Figure 6-5: Freestanding Small Cell Spacing Radius

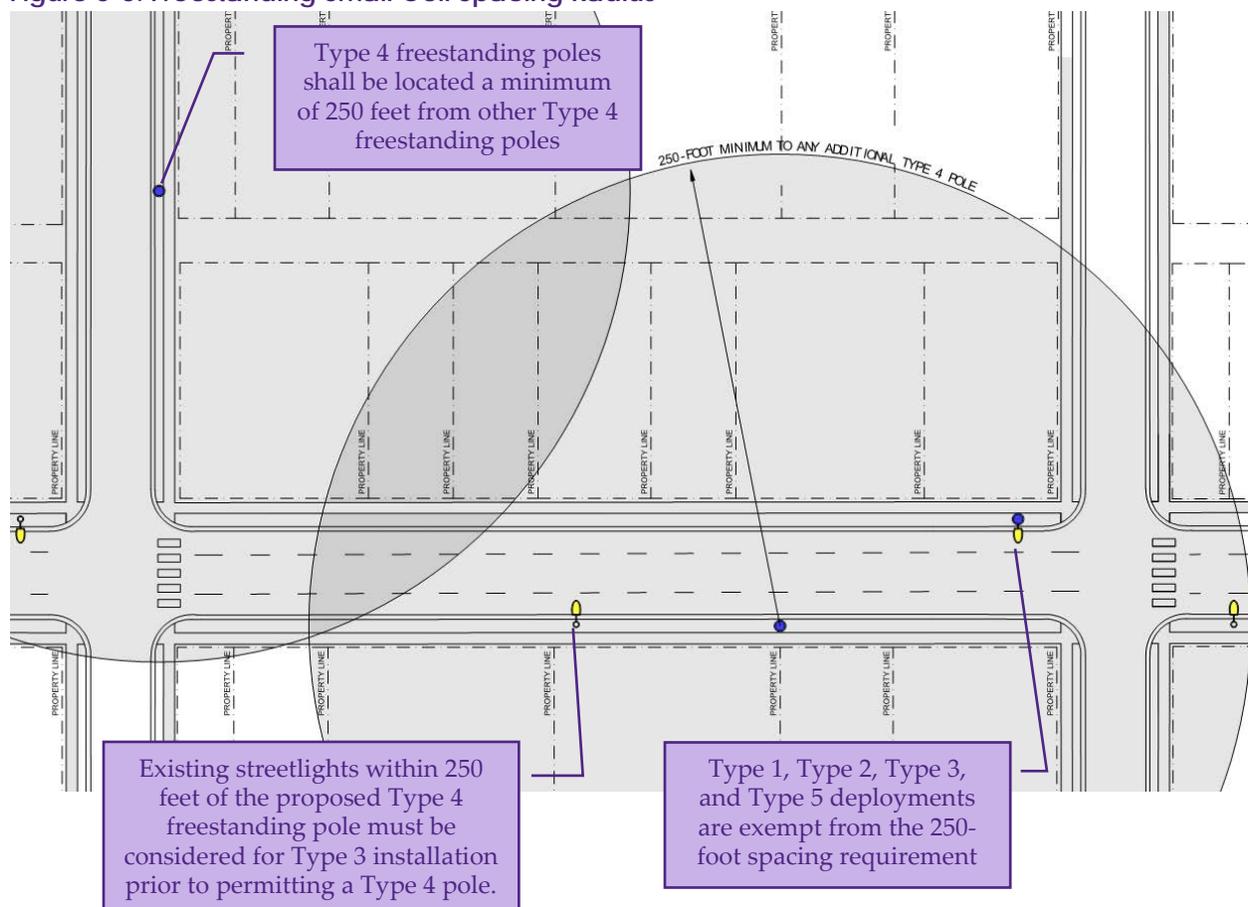
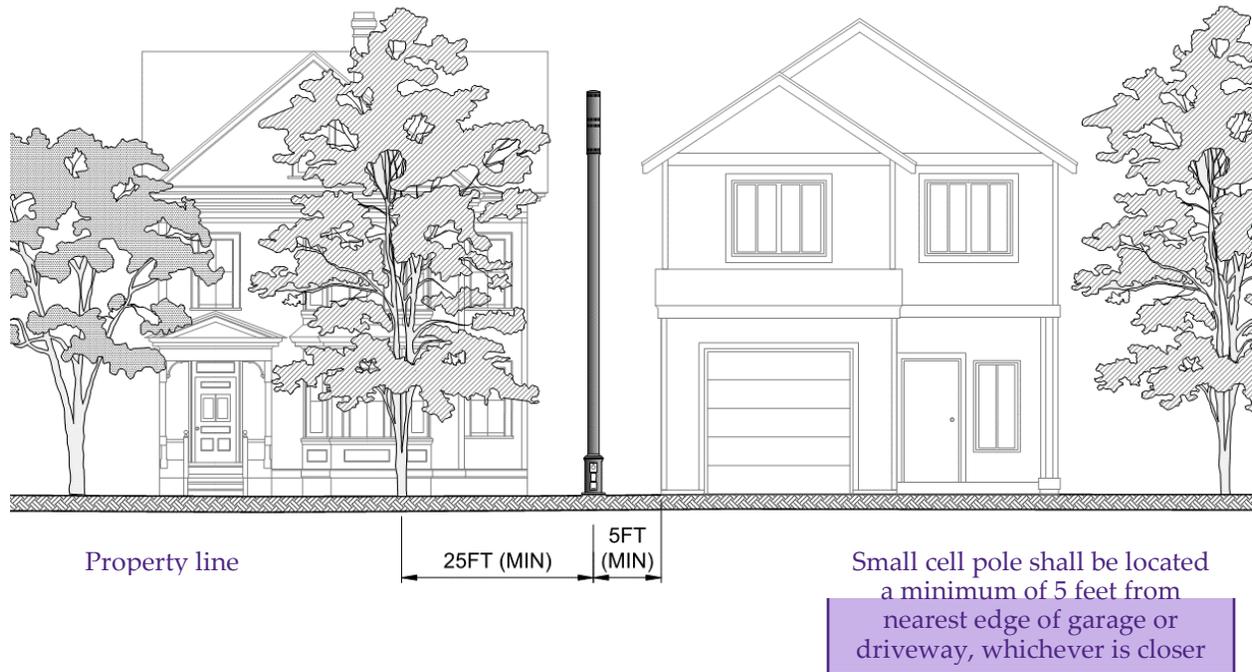


Figure 6-5 shows freestanding small cells which shall be a minimum of 250 feet apart radially. This radius extends around corners and into alleys.

Figure 6-6: Freestanding Small Cell Location Between Residential Property and Trees



The small cells shall not be installed within the perpendicular extension of the primary street-facing wall plane of any single or two-family residence as shown in Figure 6-7. The primary street-facing wall plane is recognized as the plane(s) with a front door.

Figure 6-7: Freestanding Small Cell Between Property Lines

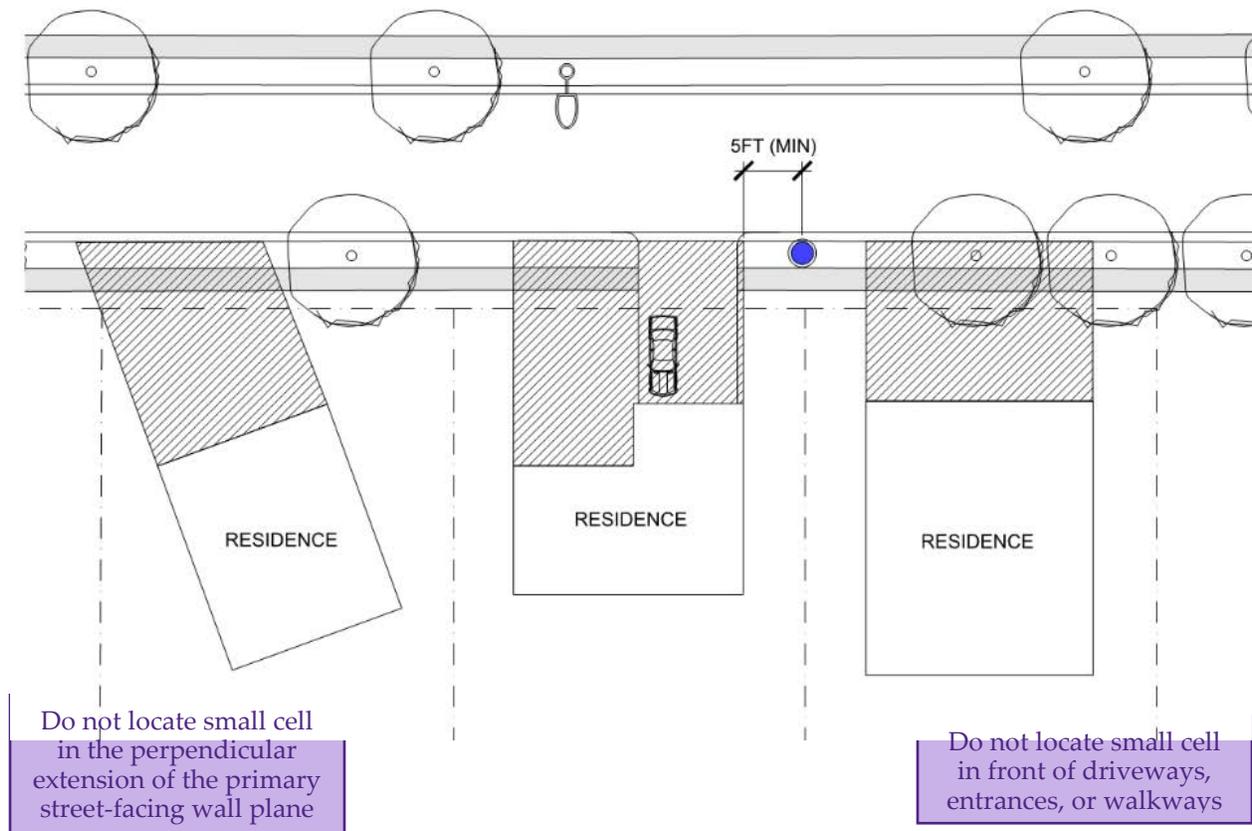


Figure 6-8: Small Cell in Commercial Area



When located adjacent to a commercial establishment, such as an office, store, restaurant, or a multi-family or mixed use structure; care should be taken to locate an adjoining small cell such that it does not negatively impact the adjacent business. Small cells shall not be located in front of adjacent building doorways, accessible balconies, or primary windows and shall be located in a manner that considers view plane enjoyment of adjacent properties. Small cells infrastructure shall not be located in front of primary walkways, entrances or exits, or in such a way that it would impede normal operation or delivery to adjacent properties. Small cells should be located between buildings/properties as much as possible as shown in Figure 6-8.

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Chapter

7



7 TYPE 5 COMBINATION SMALL CELL AND PEDESTRIAN LIGHT

Refer to Chapter 7 when installing combination small cell and pedestrian lights.

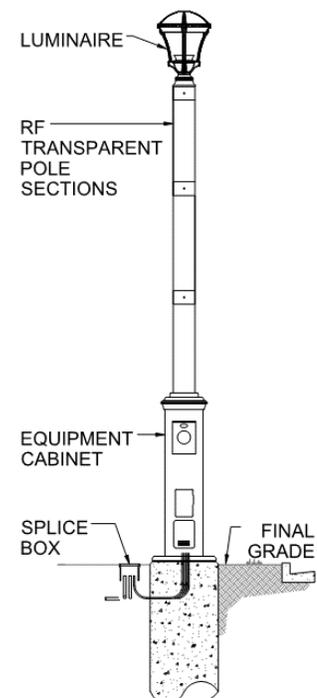
This Chapter is to be applied when installing a new combination small cell and pedestrian light pole.

Combination small cell and pedestrian light permitting applications and aesthetics shall be approved by CCD prior to installation. All equipment shall meet Xcel Energy's utility requirements and CCD's design aesthetics. The same small cell pole aesthetic is to be used in the same area to maintain a cohesive appearance. Combination small cell aesthetics and proposed locations shall meet the *CCD Freestanding Small Cell Infrastructure ROW Permit Requirements*.

The City and County of Denver's *Street Lighting Design Guidelines* provide guidance on luminaire design aesthetics, lighting level criteria, typical streetlight spacing, streetlight specifications, and electrical and streetlight details. The Applicant shall provide all documentation required by the *Street Lighting Design Guidelines* to the City during the permitting process.

All small cell carrier equipment shall be housed internal to the pole.

Figure 7-1: Type 5 - Combination Small Cell and Pedestrian Light



7.1 Type 5 Combination Small Cell and Pedestrian Light Specification Overview

Table 7-1: Type 5 Pole Specification Overview

Luminaire	Per CCD's <i>Street Lighting Design Guidelines</i> .
Pole Type	10-inch (max.) round, straight, galvanized steel. The riser pole may be used to internally house RF antennas and other equipment.
Total Pole Height	The top of the pedestrian light should be mounted 15 feet above finished grade.
Design Wind Velocity	115 mph minimum per TIA-222 rev G, IBC 2012 with ASCE 710, and amendments for local conditions.
Foundation	Precast concrete or cast-in-place pole foundations shall be designed per the City standard to meet ACI 318. While CCD accepts cast-in-place foundations, precast concrete foundations are preferred and should be installed whenever possible.
Conduit Sweeps in Foundation	Eight (8) 2.5" PVC conduit sweeps shall be installed. Conduit shall accommodate CCD electrical, CCD fiber, and small cell carrier electrical and fiber with up to four (4) spare sweeps for future service.
Bolt Circle	Bolt circle per manufacturer. Anchor bolts shall either be hidden from view (preferred) or treated and painted to match the pole color
Potential Shroud	All fixed connections shall be hidden from view.
Electrical Separation	An internal divider shall separate electrical wiring and fiber, per Owner.

Figure 7-2: Type 5 Equipment Cabinet Specification Overview

Equipment Cabinet Dimensions	Round 5'-10" maximum height from the top of the concrete foundation to the top of the equipment cabinet transition shroud, maximum 14-inch diameter.		
Equipment Cabinet Access Doors	Utility access	City access	Carrier access
	Per Xcel Energy's meter access requirements. The meter shall be recessed as much as possible into the pole base	Hand hole	Lockable access door sized to install, maintain, and remove all small cell equipment as needed.
Required Equipment	Utility Equipment*	City Equipment*	Carrier Equipment*
	Per Xcel Energy's requirements	Fused power disconnect	Per small cell carrier requirements
	*All equipment shall be located internal to the equipment cabinet or recessed in the equipment cabinet to meet Utility requirements. All equipment shall be mounted per the Owner's requirements.		
Equipment Separation	All equipment shall be separated by Owner. All access doors shall be secured by Owner requirements.		
Ventilation	Passive louvers and/or other passive ventilation systems shall be provided as the primary means of temperature control.		
Motorized Ventilation	If required, fan(s) shall not emit noise greater than 50dBA at one meter (3.28 feet).		

7.2 Type 5 Basis of Design

The combination pole components include the foundation, equipment cabinet, riser pole, luminaire, mast arm, luminaire control node if applicable, antenna or antenna enclosure, and all hardware and electrical equipment necessary for a complete assembly.

All Type 5 pole assemblies shall be shaped to be visually pleasing and proportional to each other. These Guidelines have considered proportional when defining maximum allowed dimensions, including a study of the transition between the equipment cabinet, RF transparent pole sections, luminaire mounting bracket, and luminaire. Type 5 poles, as permitted in these guidelines, include a decorative transition over the equipment cabinet upper bolts, hidden hardware connections, and a restriction of horizontal flat spaces greater than 1.5 inches to prevent cups, trash, and other objects from being placed on the pole components. Each pole component shall be architecturally compatible to create a cohesive aesthetic.

The Type 5 pole is composed of an equipment cabinet, riser pole, and pedestrian luminaire (style varies). All equipment shall be located internal to the appropriate enclosure.

7.3 Type 5 Specific Placement Requirements

A Type 5 pole should only be located where an existing pedestrian light (typically owned by a private owner or District) can be removed and replaced with the approval of existing owner or District, or at a new location where it has been identified that a pedestrian light is necessary. Type 5 poles would then typically be owned by the applicant (as approved via Encroachment Permit by the City and County of Denver).

When submitting to CCD for approval, the pole design and configuration shall be per CCD standards. When submitting to CCD as a privately owned Type 5 pole, the pole shall be located as follows, in addition to the placement criteria listed in Section 2.2.

- Any new Type 5 pole general location, spacing, and lighting levels shall be as determined by CCD's *Street Lighting Design Guidelines*.

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Chapter

8



8 TYPE 6 MULTI-CARRIER FREESTANDING SMALL CELL INFRASTRUCTURE

Refer to Chapter 8 when installing a multi-carrier freestanding small cell pole.

This Chapter is to be applied when installing a multi-carrier (equipment for no fewer than two wireless carriers) freestanding small cell pole. CCD recognizes the importance of encouraging small cell infrastructure that can consolidate equipment and reduce numbers of freestanding poles in the public ROW. By offering Type 6 deployments, CCD is committed to collaborating with the wireless and infrastructure industry to strategically plan Type 6 deployments as opportunity presents.

CCD also recognizes that the Type 6A and 6B poles shown in these guidelines are to only identify general permitted dimension envelopes for Multi-Carrier poles, and recognize that different pole configurations exist and can be supported. The Type 6 configurations provided herein shall not be prescriptive, and other configurations may be coordinated with Public Works for approval in writing.

Refer to Chapter 6 for projects involving single carrier freestanding small cell installations.

All freestanding Type 6 small cell permitting applications shall be coordinated with CCD Public Works Department prior to first submittal. All equipment shall meet Xcel Energy's utility requirements and the City and County of Denver's design aesthetics. Freestanding small cell aesthetics and proposed locations shall meet the *CCD Freestanding Small Cell Infrastructure ROW Permit Entrance Requirements*.

All small cell carrier equipment shall be housed internal to the multi-carrier freestanding pole. No network provider equipment shall be strapped to the outside of the pole.

8.1 Type 6 Basis of Design

All Type 6 poles shall be shaped to be visually pleasing and proportional to each other. These Guidelines have considered proportional when defining maximum allowed dimensions, including a study of the transition between the equipment cabinet, riser pole, and equipment cantennas. Type 6 poles, as permitted in these guidelines, include a decorative transition over the equipment cabinet upper bolts, hidden hardware connections, and a restriction of horizontal flat spaces greater than 1.5 inches to prevent cups, trash, and other objects from being placed on the pole components. Each pole component shall be architecturally compatible to create a cohesive aesthetic.

Type 6 freestanding small cell pole components include the foundation, riser pole which shall internally house all necessary small cell equipment, and all hardware and electrical equipment necessary for a complete assembly, as shown in Figure 8-1 and Figure 8-2. Various pole styles will be considered by CCD. All Type 6 poles must be approved by CCD Public Works Department prior to the Applicant applying for a permit.

Figure 8-1: Potential Type 6A Multi-Carrier Freestanding Small Cell Assembly

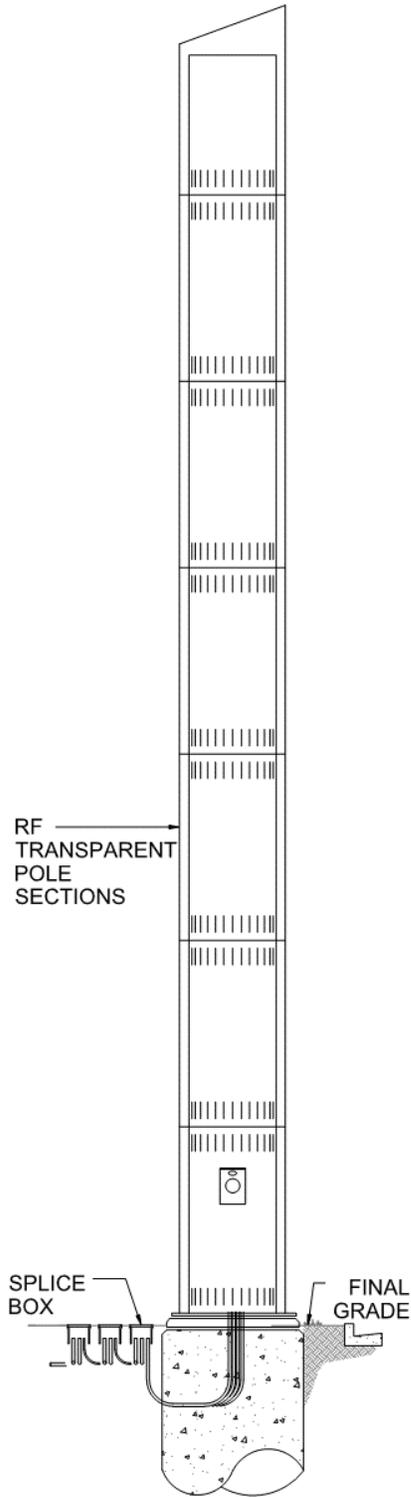
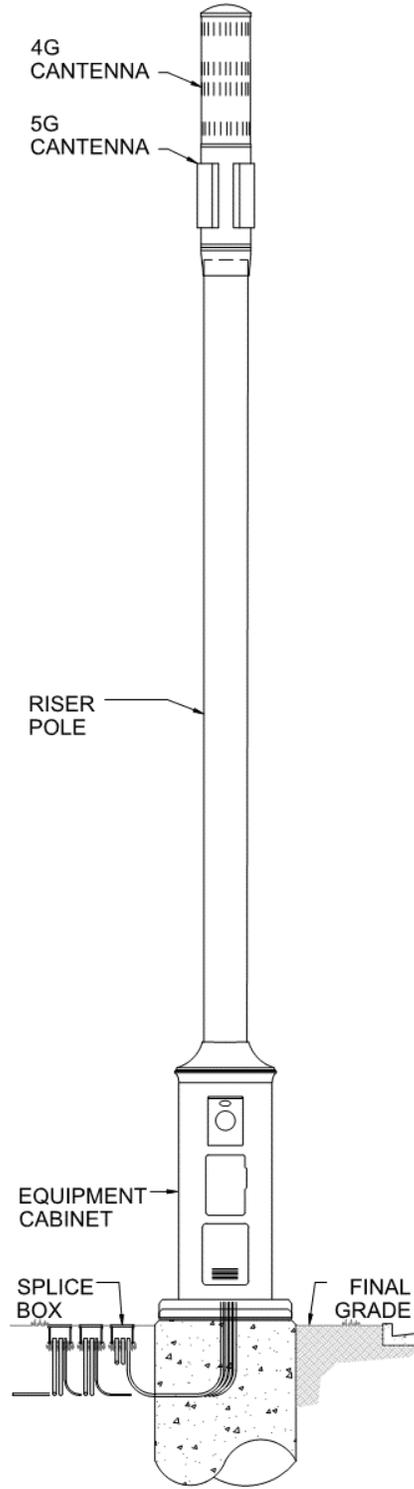


Figure 8-2: Potential Type 6B Multi-Carrier Freestanding Small Cell Assembly



8.2 Type 6 Multi-Carrier Small Cell Specification Overview

Table 8-1: Type 6 Multi-Carrier Pole Specification Overview

Pole Height	The freestanding multi-carrier small cell shall not exceed 40 feet above finished grade.				
Design Wind Velocity	115 mph minimum per TIA-222 rev G, IBC 2012 with ASC 710, and amendments for local conditions.				
Foundation	Precast concrete or cast-in-place pole foundations shall be designed per a Professional Structural Engineer to meet ACI 318.				
Conduit Sweeps in Foundation	2.5" PVC Conduit shall accommodate small cell carrier electrical and fiber with up to four (4) spare sweeps for future service.				
Bolt Circle	Sized per Professional Structural Engineer.				
Width	Maximum 34-inch width. All hardware attachments shall be hidden.				
Equipment Cabinet Access Doors	Lockable access door sized to install, maintain, and remove all small cell equipment as needed shall meet Carrier's requirements. Utility access shall be per Xcel Energy's requirements. The meter shall be recessed into the pole base				
Equipment Cabinet Required Equipment	All equipment shall be located internal to the equipment cabinet or recessed as much as possible in the equipment cabinet to meet Utility requirements. All equipment shall be mounted per the Owner's requirements. Pole bases shall be sized to handle the listed equipment and all other equipment required by the Owner.				
	<table border="1"> <thead> <tr> <th>Utility Equipment</th> <th>Carrier Equipment</th> </tr> </thead> <tbody> <tr> <td>Per Xcel Energy's requirements</td> <td>Per small cell carrier requirements</td> </tr> </tbody> </table>	Utility Equipment	Carrier Equipment	Per Xcel Energy's requirements	Per small cell carrier requirements
Utility Equipment	Carrier Equipment				
Per Xcel Energy's requirements	Per small cell carrier requirements				
Ventilation	Passive louvers and/or other passive ventilation systems shall be provided as the primary means of temperature control.				
Motorized Ventilation	If required, fan(s) shall not emit noise greater than 50dBA at one meter (3.28 feet).				
Antenna	Antenna and all attachments shall be mounted internal to the pole.				

8.3 Type 6 Specific Placement Requirements

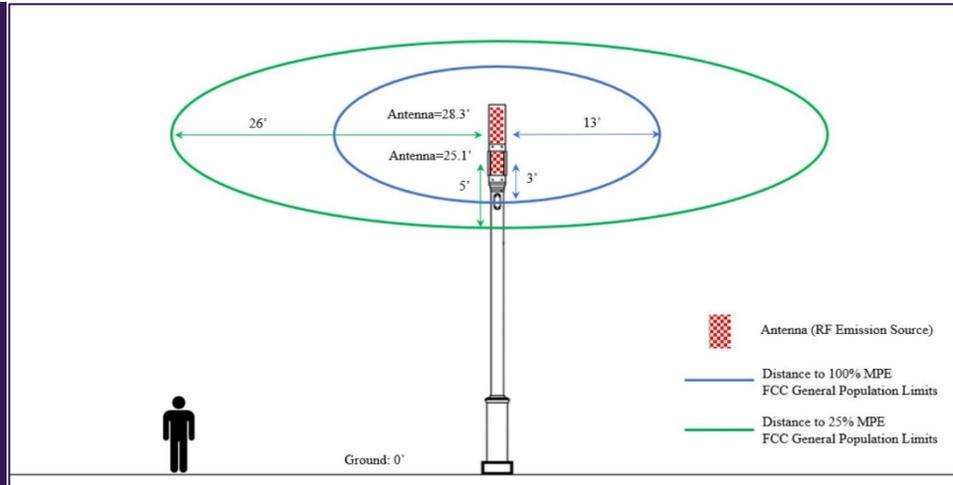
All Type 6 multi-carrier freestanding small cell poles shall be privately owned and must be permitted by CCD via the *Freestanding Small Cell Infrastructure ROW Permit Entrance Requirements*. Type 6 pole placement shall consider the following, along with the placement criteria listed in Section 2.2.

- So as not to significantly create a new obstruction to property sight lines.
- At the intersection of property lines, or along secondary street-facing property.
- Shall not be located within 100 feet of the apron of a fire station or other adjacent emergency service facility.
- No closer than 250 feet away, radially, from another privately owned Type 4 or Type 6 freestanding small cell.
- Shall not be located in residential neighborhoods unless uniquely presented to CCD for approval with thorough rationale for deviating from this requirement.

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Chapter

9



9 RADIO FREQUENCY CERTIFICATION REPORT

Refer to Chapter 8 for the Radio Frequency Certification Report requirements.

The City and County of Denver requires that all new small cellular infrastructure proposed to be placed within CCD to submit a Radio Frequency (RF) Certification Report to allow for responsible recordkeeping of wireless programs.

The goal of the RF Certification Report is to allow the City to accurately record information about each deployment while minimizing repetitive submittals. This is accomplished by requiring each Applicant to file templates for typical equipment deployment types.

An RF Emissions Certification Report will consist of two parts: an RF Emissions Certification template and a site-specific RF Location Certification. Each RF Emissions Certificate shall be signed by a qualified Professional RF Emissions Engineer, filed with CCD as part of the applicable wireless company program, and referenced with each pole application. Each site specific RF Location Certification must be completed and signed by a local Colorado registered RF Professional Engineer who shall certify the siting specifics of the actual location(s).

9.1 RF Emissions Certification Template

The specific information required for the RF Emission Certification Template is detailed in this section. Each Template shall be signed and sealed by a qualified Professional RF Emissions Engineer and filed with CCD in reference to the applicable Wireless Carrier program, and shall contain the following elements:

1. Description of the proposed equipment and deployment type, including heights, associated with the Template. Each unique Template shall be coded per the Carrier's program, such as: 1, 2, 3 or A, B, C.
2. All frequencies on which the proposed equipment will operate.
3. The number of channels that will be used on each frequency.

- A table explaining the Federal Communications Commissions (FCC) Rules and Regulations for the Maximum Permissible Exposure (MPE) limits for general population or occupational situations.

The MPE output levels for proposed equipment shall be clearly shown on a table at the antenna level and ground level with the following columns: predicted power density (mW/cm²), FCC limits of power density (mW/cm²), and FCC general population limits (%MPE)

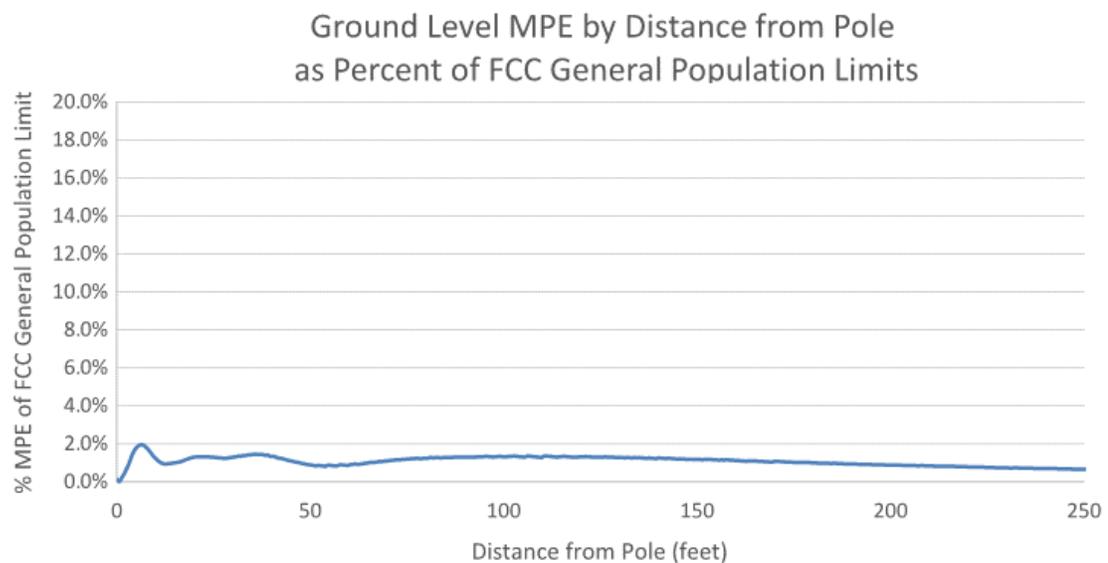
Table 9-1: (Example of) Permissible Exposure Limits*

Location	Predicted Power Density (mW/cm ²)	FCC Limit Power Density (mW/cm ²)	FCC General Population Limits (%MPE)
Antenna level	1.958	1.0	195.8%
Ground level	0.0092	1.0	0.92%

* Data within table is for example only and does not indicate specific requirements or limits.

- A graphic of the predicted FCC General Population Limits (%MPE) at ground level as a function of distance up to 250 feet away from the pole.

Figure 9-1: (Example of) FCC General Population Limits



- A compliance statement noting and depicting any requirement for RF alerting signage and occupational environmental compliance.

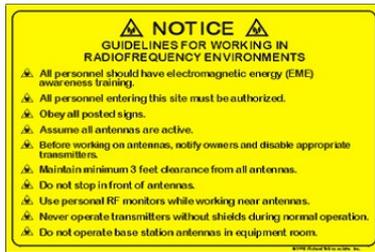
9.1.1 Typical Notification Signage

Portions of any transmitter site may have high power densities that could cause exposures in excess of the FCC Occupational or General Population guidelines.

The companies that operate the antennae are required by law to implement the following:

- Restrict access
- Post notification signs on every access point to increase awareness of the potential for exposure BEFORE one enters an area with antennae.
- Place additional notification signs and visual indicators in an area with antennae (beyond an access point) where RF exposure levels may start to exceed the FCC's limits.

Table 9-2: Typical Notification Signage



(Notice) Radio Frequency Guidelines

Informs people of the basic safety guidelines for working in an RF environment



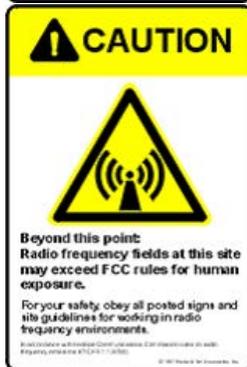
Information

Provides relevant contact information about the pole and/or antenna location for any questions, emergencies, or requests.



(Blue) Notice

Indicates that, beyond the sign, RF exposure levels may exceed the General Population MPE limit but will remain below the Occupational MPE limit.



(Yellow) Caution

Indicates that, beyond the sign, RF exposure levels may exceed the General Population and Occupational MPE limits.

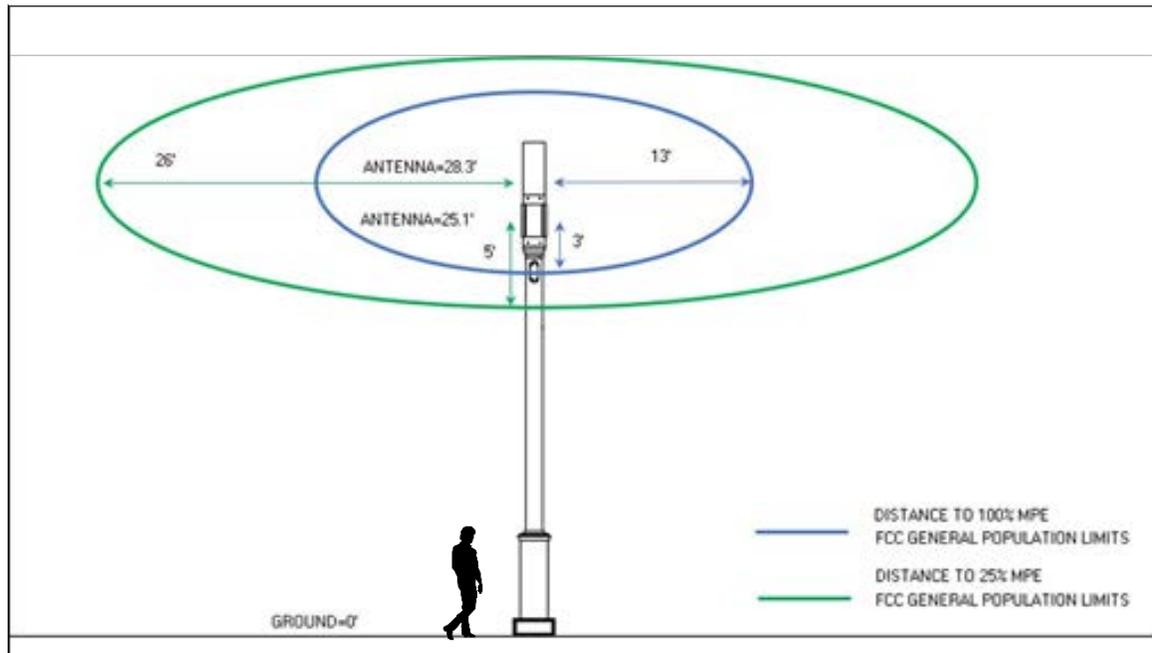


(Red/ Orange) Warning

Indicates that, beyond the sign, RF exposure levels may substantially exceed the General Population and Occupational MPE limits.

7. A graphic, scaled elevation depiction of the maximum power density MPE levels proposed by equipment expressed as proportionally scaled lines at 100% and 25% of the FCC general population limits for continuous exposure. The elevation view shall provide measurements of the height above ground for the lowest point of each proposed transmitter, from ground to the top of the proposed pole, and horizontal distance from transmitter antennas to MPE limit lines. A scaled human figure shall be proposed standing on the ground adjacent to the proposed pole.

Figure 9-2: (Example of) Elevation Depiction of the Proposed Equipment Emissions



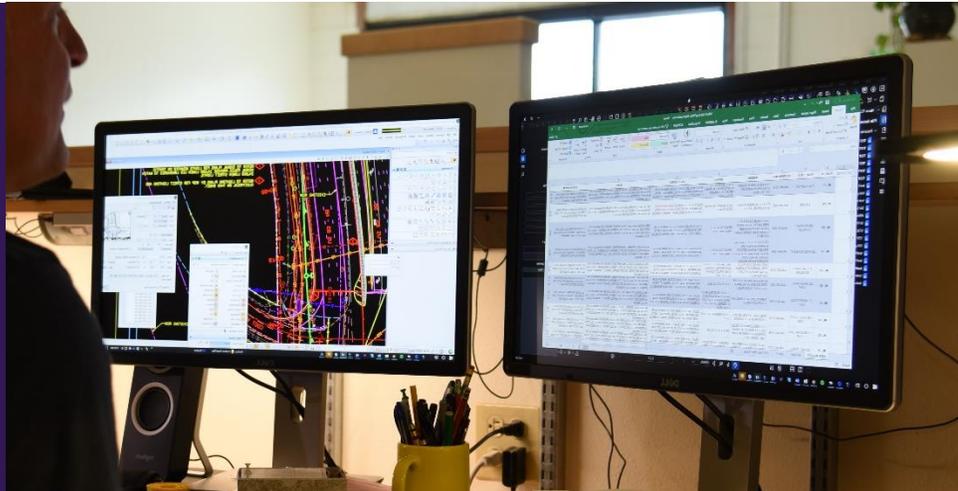
8. Each template shall be signed and sealed by a qualified Professional RF Emissions Engineer.

9.2 RF Location Certification

The site-specific RF Location Certification, prepared for each specific local application bundle, shall include the information below for each specific proposed antenna location. The RF Location Certification shall be signed off by a Colorado Registered Professional Engineer qualified to endorse such a certification.

1. A general summary of the proposed wireless site(s) associated with the bundle, with clear references matching the application address, site code, latitude and longitude, type of structure, RF Emissions Compliance Report Template (also referred to as the Equipment Deployment Template Type) applicable to antenna location, and report date.
2. A scaled location map(s) on color aerial image background indicating proposed site location(s), street name(s), and distance(s) to the nearest occupied structure(s). If any of the equipment proposed would have any portion of the nearest structure within the 100% General Population MPE limits, then the wireless equipment for that location must be “powered down”. A revised signed and sealed report from a Profession RF Emissions Engineer will be required to replace the template for that specific location.
3. Acknowledgement (or statement of none) whether or not there are any nearby commercial wireless radio transmitters that could affect the aggregate MPE of proposed equipment. If so, a revised signed and sealed report from a Professional RF Emissions Engineer will be required to replace the template for that specific location. The Certification shall also acknowledge what percentage the proposed equipment contributes to an aggregate MPE.
4. A stamp and signature from a licensed Professional Engineer with sufficient knowledge about each proposed location associated with the application to affirm site-specific information provided, and that the applicable RF Emissions Template has been properly referenced for each location.

A



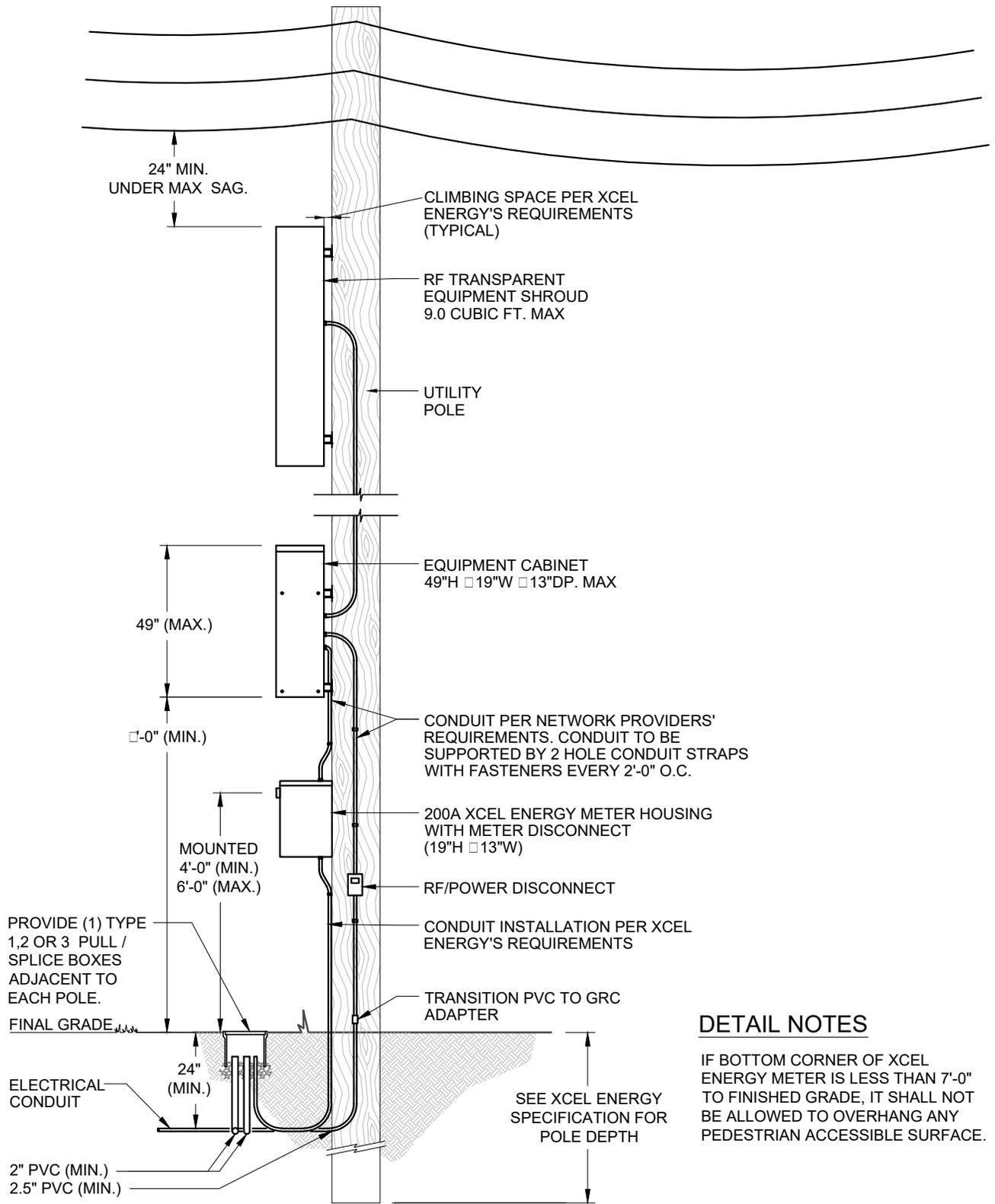
A DETAILS

The following pages provide details to be used for small cell installations in the City and County of Denver. These pages detail the components required for each type of small cell installation, conduit burial, pull box dimensions, poles and housings, pole bases, grounding, and foundations. The details include Xcel Energy electrical requirements. In certain cases, when the pole is to be owned and maintained by CCD, the electrical requirements may vary due to conduit separation requirements. Refer to CCD electrical and street lighting notes where applicable.

CCD's Public Works Department reserves the right to approve deviations from this guide as long as deviations meet the general intent of this guide.

List of Details

Small Cell Deployment: Type 1A: Utility Pole Mounted	SS-01
Small Cell Deployment: Type 1B: Utility Pole Strand Mounted	SS-02
Small Cell Deployment: Type 2: Small Cell – Streetlight on Wooden Pole	SS-03
Small Cell Deployment: Type 3: Equipment Cabinet	SS-04
Small Cell Deployment: Type 3A: Combination Pole with Antenna.....	SS-05
Small Cell Deployment: Type 3B: Combination Pole with External Shroud.....	SS-06
Small Cell Deployment: Type 3C: Combination Pole with Antenna and External Shroud	SS-07
Small Cell Deployment: Type 3D: Combination Pole with Dist. Power, Antenna & External Shroud	SS-08
Small Cell Deployment: Type 4: Single-Carrier Freestanding Small Cell Pole	SS-09
Small Cell Deployment: Type 5: Combination Pedestrian Light	SS-10
Small Cell Deployment: Type 6A: Multi-Carrier Freestanding Pole A	SS-11
Small Cell Deployment: Type 6B: Multi-Carrier Freestanding Pole B	SS-12
Small Cell Deployment: Conduit Burial Detail	SS-13
Small Cell Deployment: Pull Box/ Splice Box Dimensions	SS-14
Small Cell Deployment: In-Grade Pull Box/ Splice Box	SS-15
Small Cell Deployment: Small Cell Electrical Detail in Softscape.....	SS-16
Small Cell Deployment: Small Cell Electrical Detail in Hardscape	SS-17
Small Cell Deployment: Small Cell Electrical Detail Notes	SS-18
Small Cell Deployment: Pole Base Standard.....	SS-19
Small Cell Deployment: Pier Foundation.....	SS-20
Small Cell Deployment: Spread Footing Foundation	SS-21
Small Cell Deployment: General Foundation Structural Notes	SS-22
Small Cell Deployment: General Foundation Structural Notes, Continued	SS-23

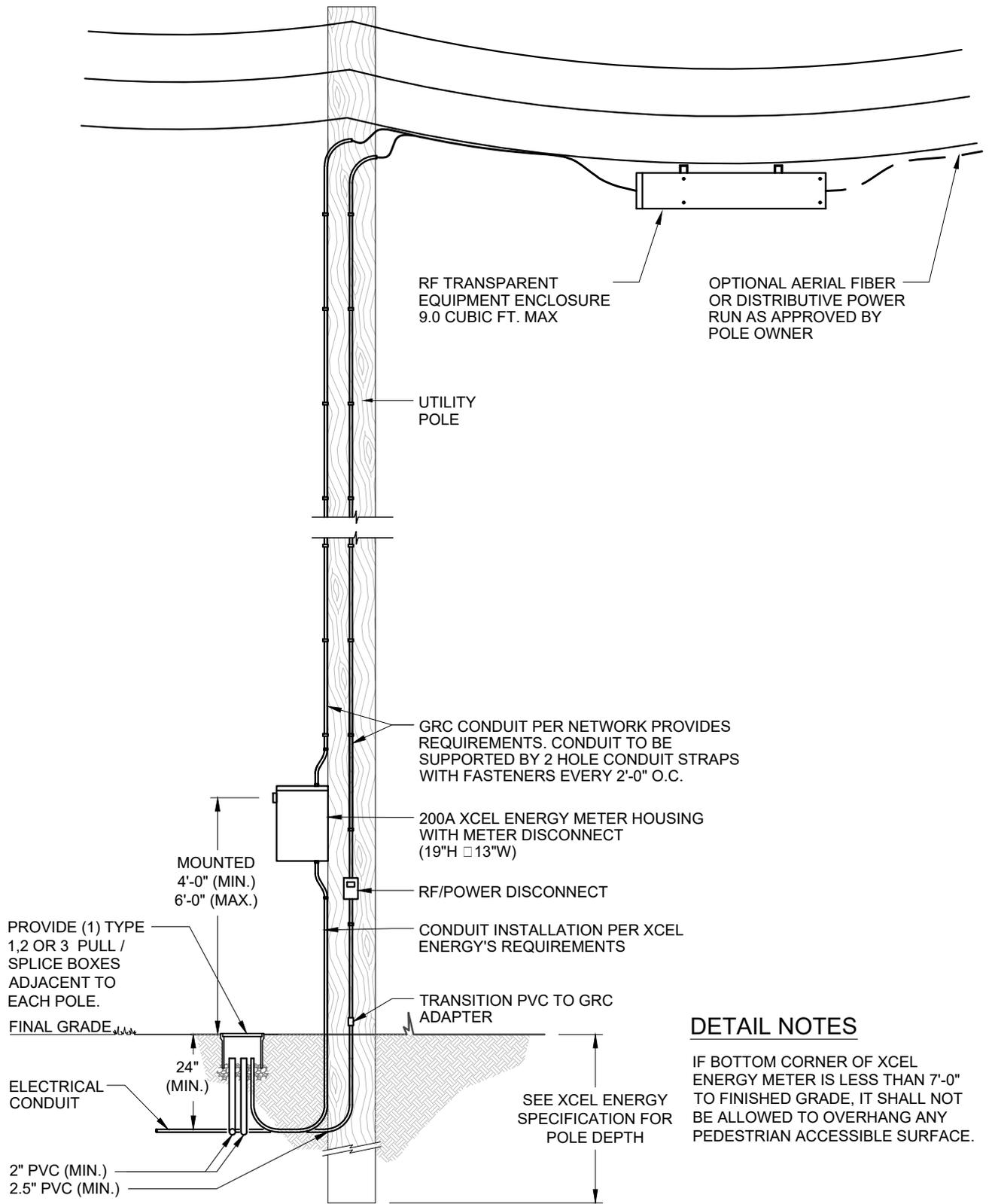


DETAIL NOTES

IF BOTTOM CORNER OF XCEL ENERGY METER IS LESS THAN 7'-0" TO FINISHED GRADE, IT SHALL NOT BE ALLOWED TO OVERHANG ANY PEDESTRIAN ACCESSIBLE SURFACE.

TYPE 1A UTILITY POLE WITH MOUNTED EQUIPMENT SHROUD

	<p>City and County of Denver Department of Public Works</p>	<p>Date: May 2019</p>
	<p>SMALL CELL DE LOYMENT TYPE 1A: UTILITY POLE MOUNTED</p>	<p>Std. Dwg. No. SS-01</p>

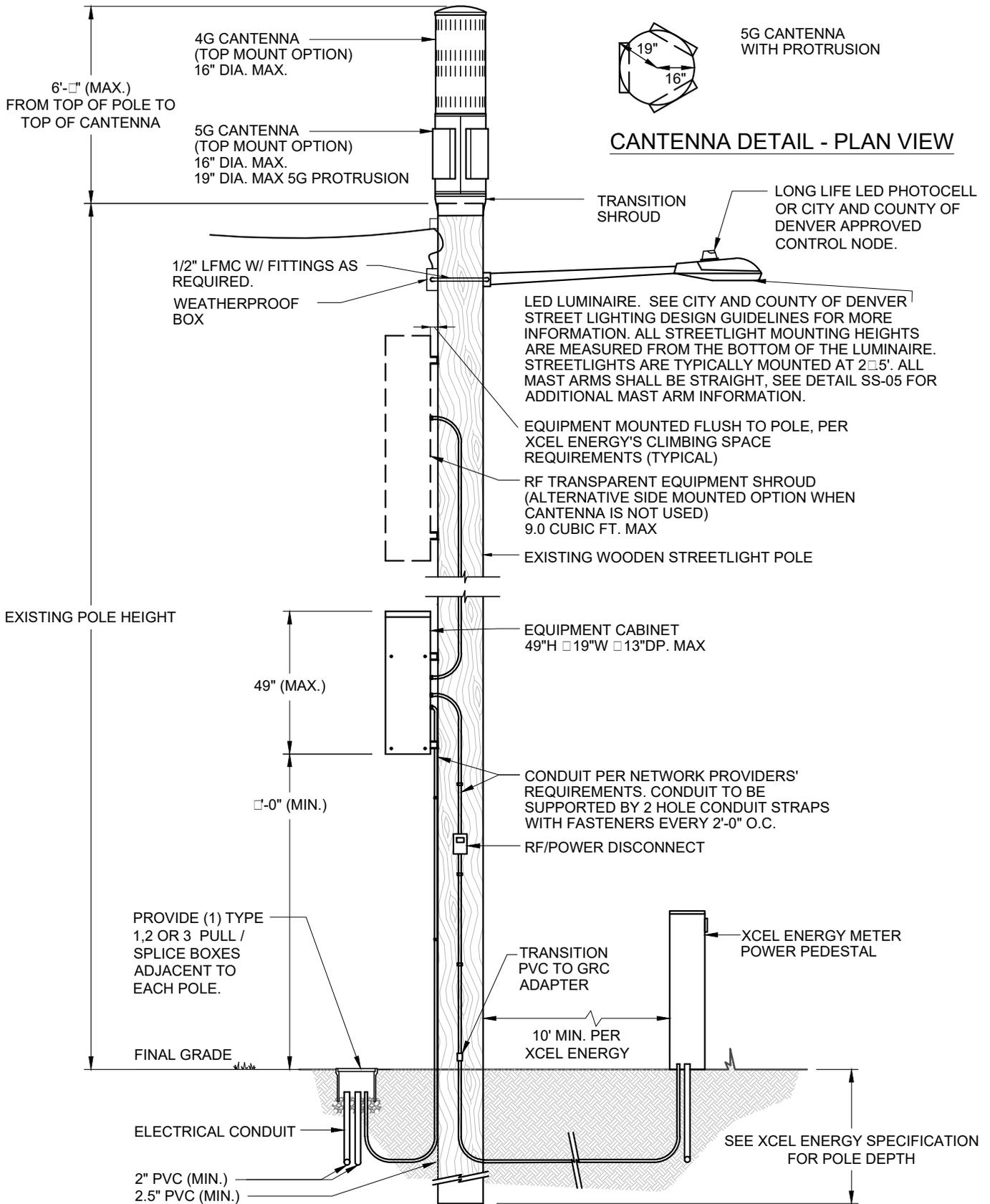


DETAIL NOTES

IF BOTTOM CORNER OF XCEL ENERGY METER IS LESS THAN 7'-0" TO FINISHED GRADE, IT SHALL NOT BE ALLOWED TO OVERHANG ANY PEDESTRIAN ACCESSIBLE SURFACE.

TYPE 1B UTILITY POLE WITH STRAND MOUNTED SHROUD

	<p>City and County of Denver Department of Public Works</p>	<p>Date: May 2019</p>
	<p>SMALL CELL DEPLOYMENT TYPE 1B: UTILITY POLE STRAND MOUNTED</p>	<p>Std. Dwg. No. SS-02</p>



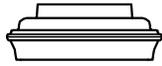
City and County of Denver
Department of Public Works

Date:
May 2019

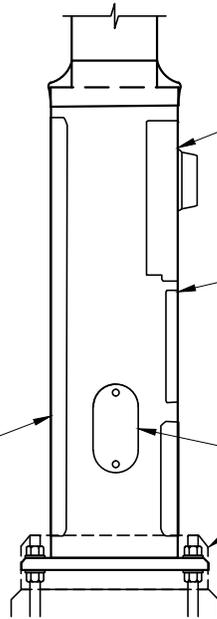
SMALL CELL DEPLOYMENT TYPE 2:
SMALL CELL-STREETLIGHT ON WOODEN POLE

Std. Dwg. No.
SS-03

**POTENTIAL DECORATIVE
TRANSITION SHROUD**



SMALL CELL EQUIPMENT ACCESS DOOR WITH LOCKABLE COVER PER CARRIER REQUIREMENTS.



200A XCEL ENERGY METER HOUSING FOR SMALL CELL ELECTRIC SERVICE RECESSED IN EQUIPMENT CABINET.

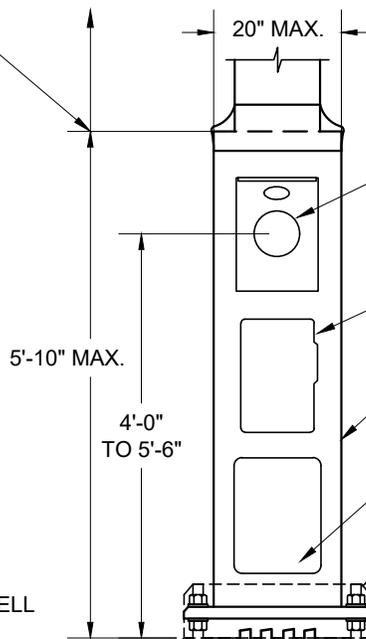
XCEL ENERGY METER DISCONNECT RECESSED IN EQUIPMENT CABINET.

HAND HOLE FOR STREETLIGHT ELECTRICAL ACCESS

OPTIONAL BOLT SHROUD

SIDE VIEW

MEASUREMENT LOCATION FOR RISER POLE



200A XCEL ENERGY METER HOUSING FOR SMALL CELL ELECTRIC SERVICE, RECESSED IN EQUIPMENT CABINET.

XCEL ENERGY METER DISCONNECT RECESSED IN EQUIPMENT CABINET.

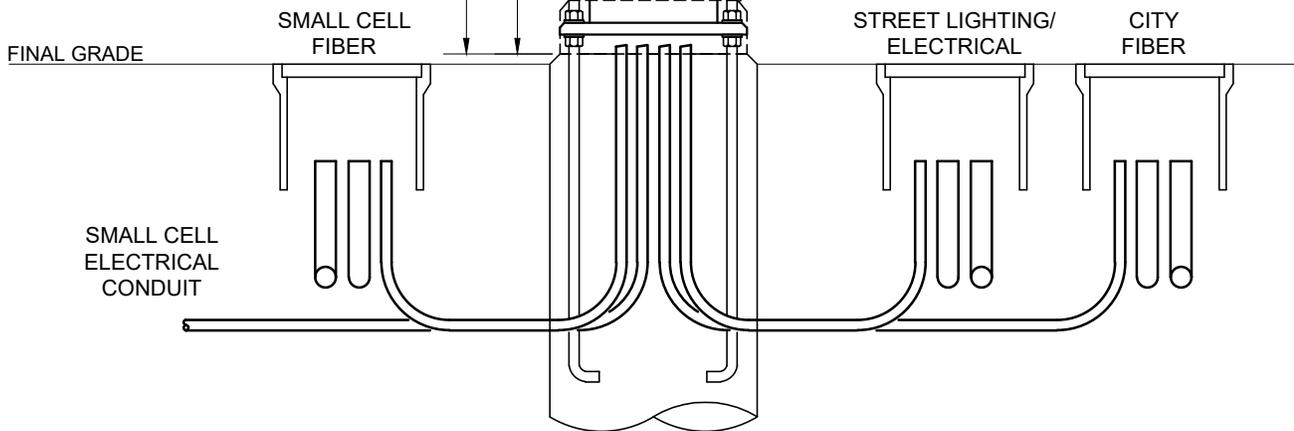
EQUIPMENT CABINET 20" DIA. MAX.

PASSIVE VENTILATION

OPTIONAL BOLT SHROUD

DETAIL NOTES

SPLICE BOX LOCATION MAY VARY. SPLICE BOXES SHOULD BE LOCATED WITHIN HARDSCAPE AREA WHENEVER POSSIBLE. REFER TO DETAILS SS-14 AND SS-15 FOR MORE INFORMATION.



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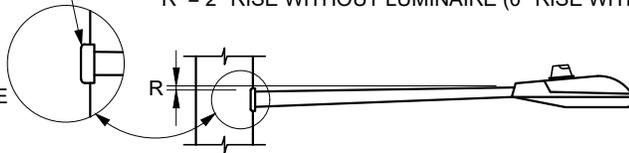
SMALL CELL DEPLOYMENT TYPE 3:
EQUIPMENT CABINET

Date:
May 2019

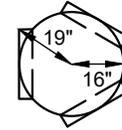
Std. Dwg. No.
SS-04

ARM PLATE SHALL CONFORM TO APPLICABLE AASHTO REQUIREMENTS. XCEL REQUIRES TENON TOP MAST ARM FITS TO A 3" O.D. TENON TOP POLE DIRECTLY WITH NO OTHER PARTS.
 $R = 2^\circ$ RISE WITHOUT LUMINAIRE (0° RISE WITH LUMINAIRE WEIGHT)

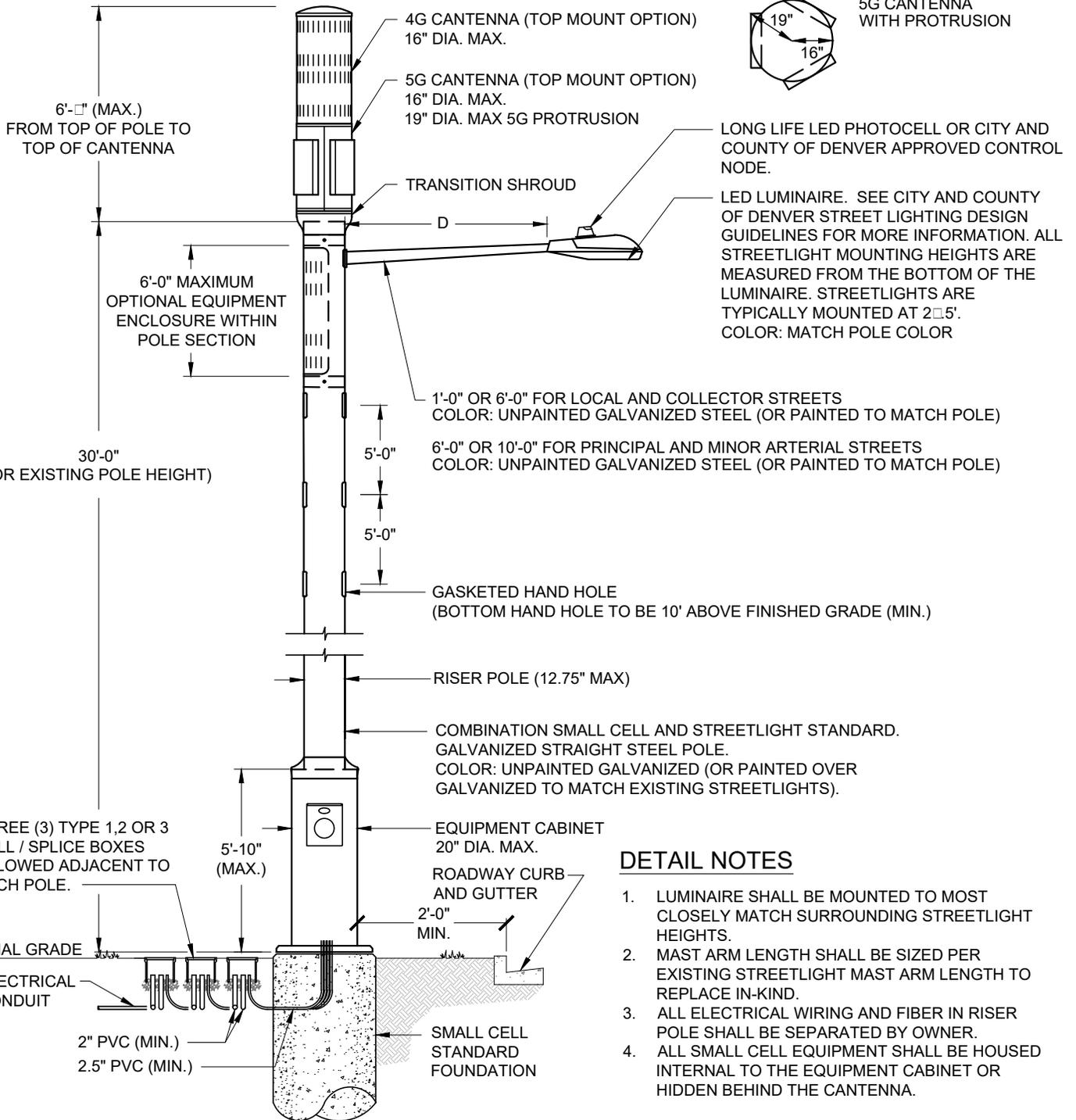
MAST ARM ARE TENON TOP SIDE MOUNT



CANTENNA DETAIL PLAN VIEW



5G CANTENNA WITH PROTRUSION



DETAIL NOTES

1. LUMINAIRE SHALL BE MOUNTED TO MOST CLOSELY MATCH SURROUNDING STREETLIGHT HEIGHTS.
2. MAST ARM LENGTH SHALL BE SIZED PER EXISTING STREETLIGHT MAST ARM LENGTH TO REPLACE IN-KIND.
3. ALL ELECTRICAL WIRING AND FIBER IN RISER POLE SHALL BE SEPARATED BY OWNER.
4. ALL SMALL CELL EQUIPMENT SHALL BE HOUSED INTERNAL TO THE EQUIPMENT CABINET OR HIDDEN BEHIND THE CANTENNA.

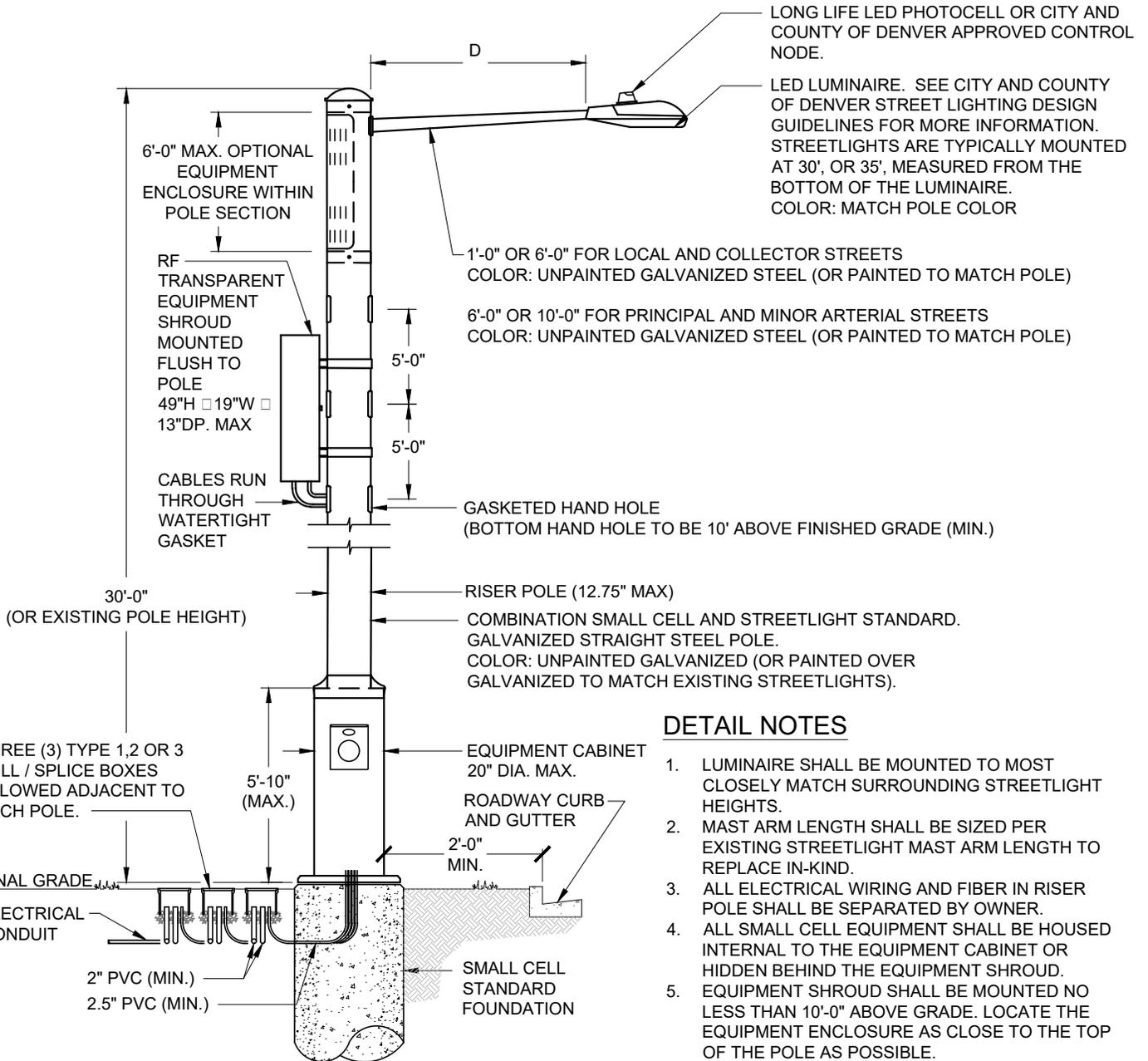
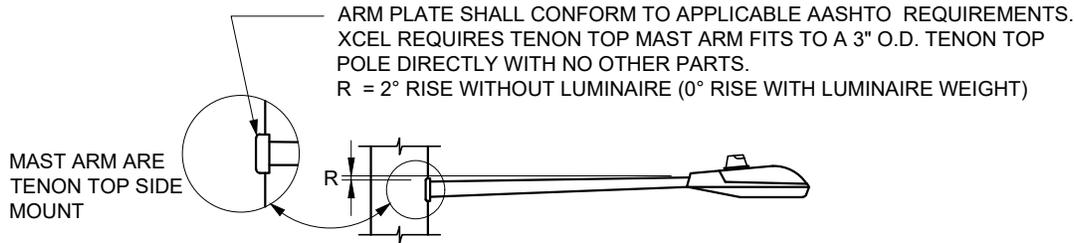


City and County of Denver
 Department of Public Works

Date:
 May 2019

SMALL CELL DEPLOYMENT TYPE 3A:
 COMBINATION POLE WITH CANTENNA

Std. Dwg. No.
 SS-05



DETAIL NOTES

1. LUMINAIRE SHALL BE MOUNTED TO MOST CLOSELY MATCH SURROUNDING STREETLIGHT HEIGHTS.
2. MAST ARM LENGTH SHALL BE SIZED PER EXISTING STREETLIGHT MAST ARM LENGTH TO REPLACE IN-KIND.
3. ALL ELECTRICAL WIRING AND FIBER IN RISER POLE SHALL BE SEPARATED BY OWNER.
4. ALL SMALL CELL EQUIPMENT SHALL BE HOUSED INTERNAL TO THE EQUIPMENT CABINET OR HIDDEN BEHIND THE EQUIPMENT SHROUD.
5. EQUIPMENT SHROUD SHALL BE MOUNTED NO LESS THAN 10'-0" ABOVE GRADE. LOCATE THE EQUIPMENT ENCLOSURE AS CLOSE TO THE TOP OF THE POLE AS POSSIBLE.

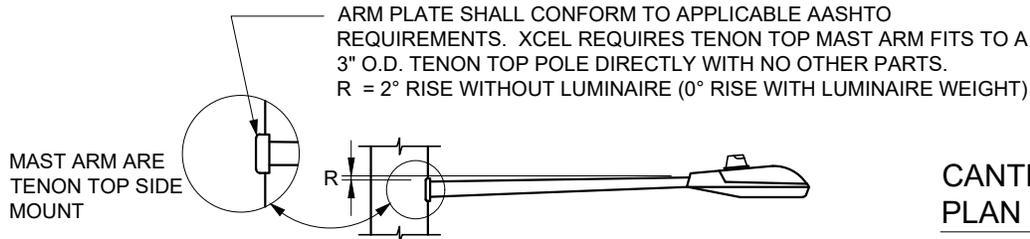


City and County of Denver
 Department of Public Works

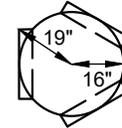
Date:
 May 2019

SMALL CELL DEPLOYMENT TYPE 3B:
 COMBINATION POLE WITH EXTERNAL SHROUD

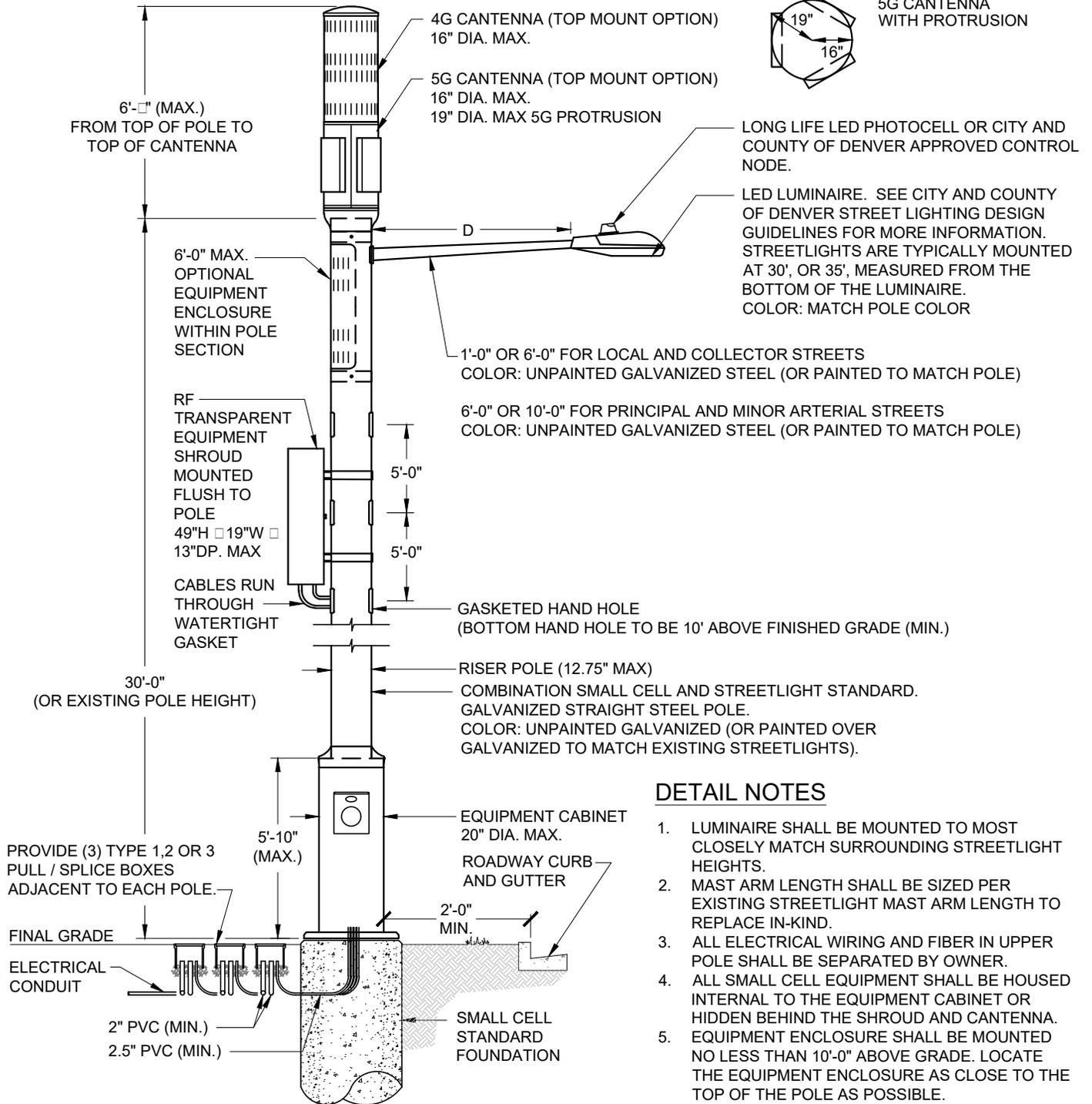
Std. Dwg. No.
 SS-06



CANTENNA DETAIL PLAN VIEW



5G CANTENNA WITH PROTRUSION



DETAIL NOTES

1. LUMINAIRE SHALL BE MOUNTED TO MOST CLOSELY MATCH SURROUNDING STREETLIGHT HEIGHTS.
2. MAST ARM LENGTH SHALL BE SIZED PER EXISTING STREETLIGHT MAST ARM LENGTH TO REPLACE IN-KIND.
3. ALL ELECTRICAL WIRING AND FIBER IN UPPER POLE SHALL BE SEPARATED BY OWNER.
4. ALL SMALL CELL EQUIPMENT SHALL BE HOUSED INTERNAL TO THE EQUIPMENT CABINET OR HIDDEN BEHIND THE SHROUD AND CANTENNA.
5. EQUIPMENT ENCLOSURE SHALL BE MOUNTED NO LESS THAN 10'-0" ABOVE GRADE. LOCATE THE EQUIPMENT ENCLOSURE AS CLOSE TO THE TOP OF THE POLE AS POSSIBLE.

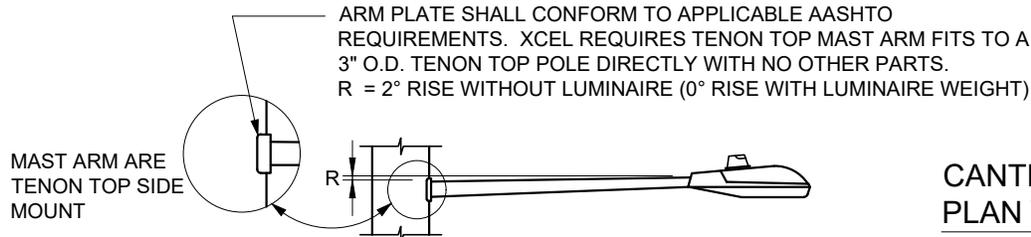


City and County of Denver
Department of Public Works

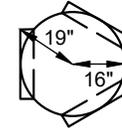
Date:
May 2019

SMALL CELL DEPLOYMENT TYPE 3C: COMBINATION
POLE WITH CANTENNA AND EXTERNAL SHROUD

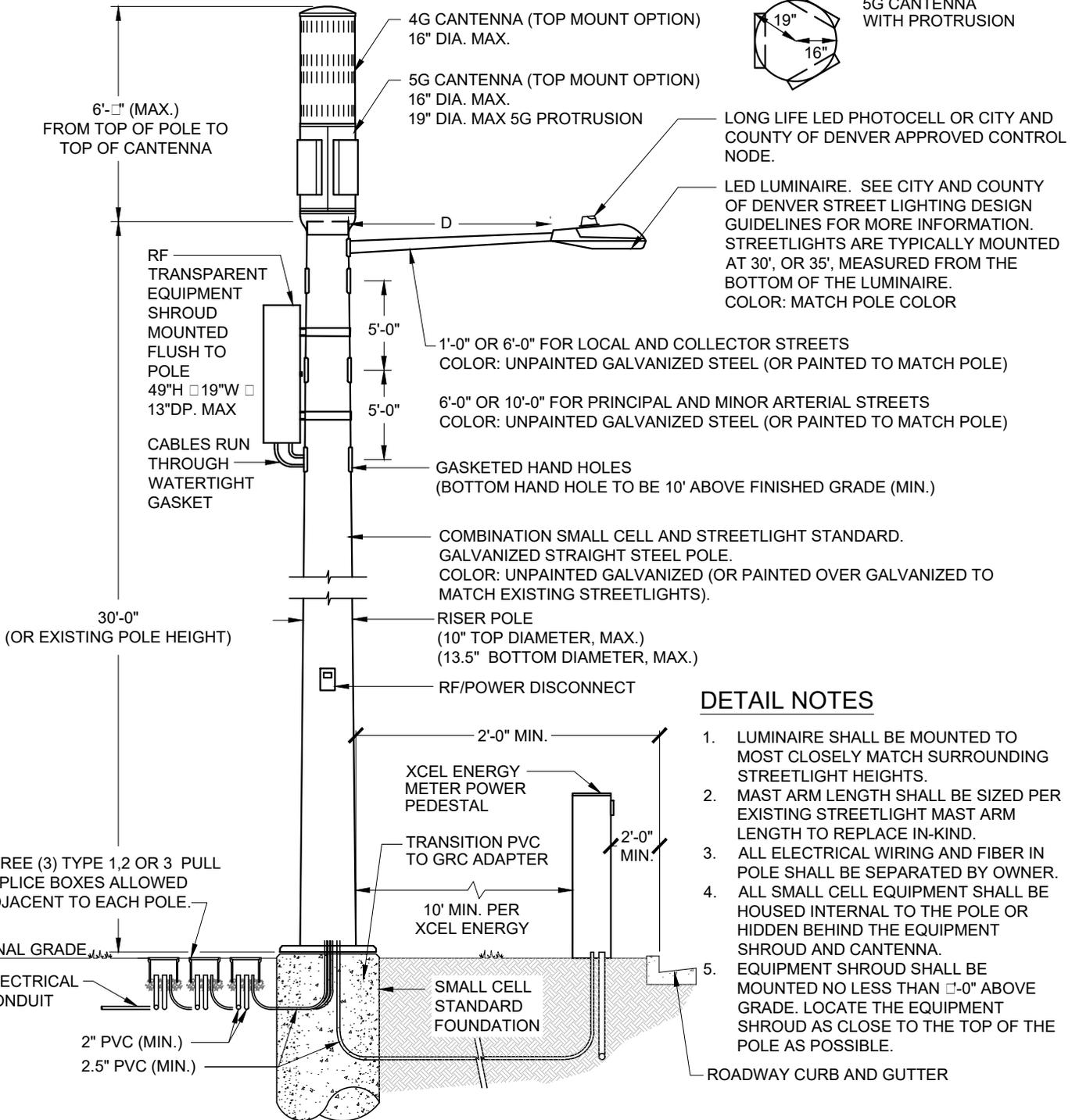
Std. Dwg. No.
SS-07



CANTENNA DETAIL PLAN VIEW



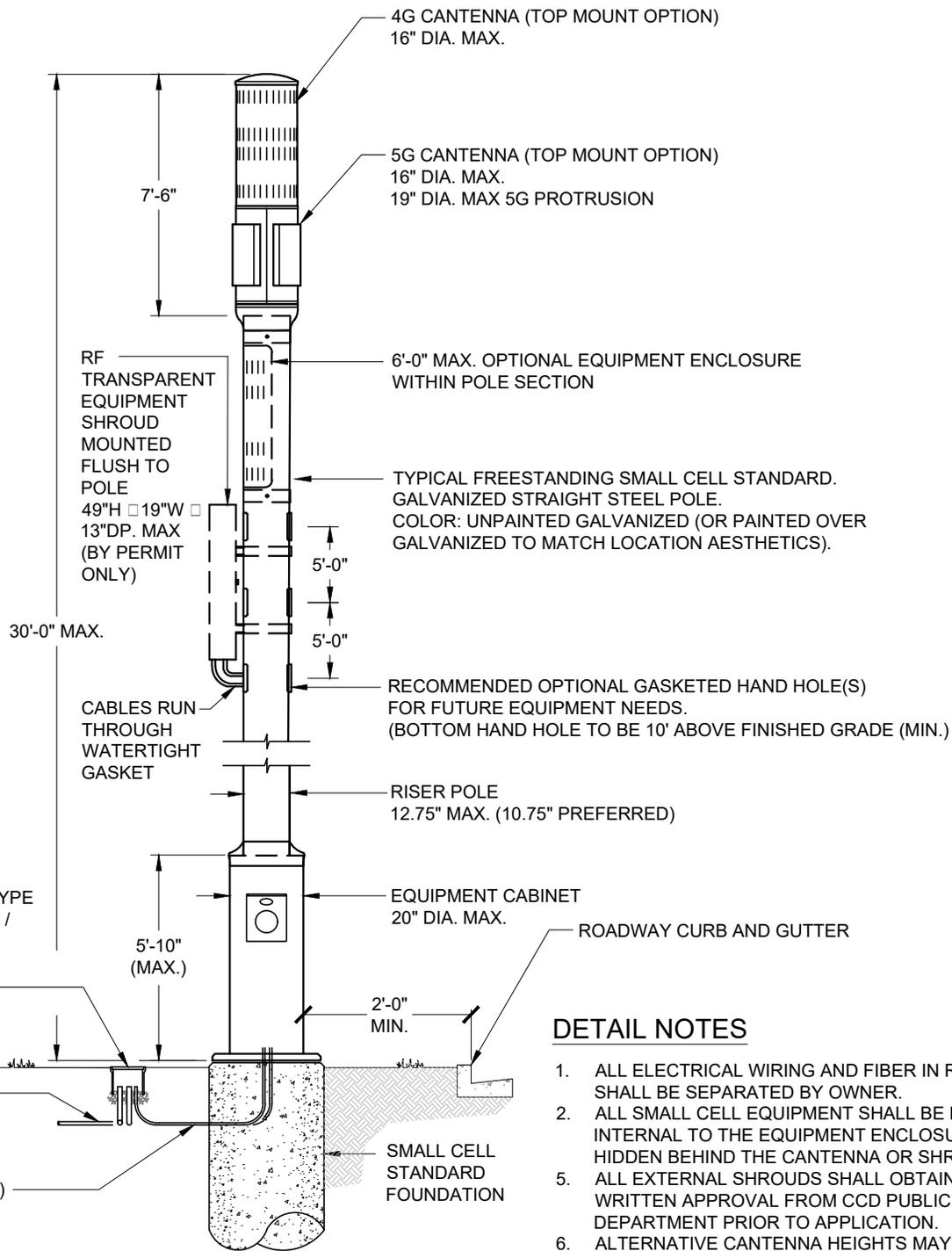
5G CANTENNA WITH PROTRUSION



DETAIL NOTES

1. LUMINAIRE SHALL BE MOUNTED TO MOST CLOSELY MATCH SURROUNDING STREETLIGHT HEIGHTS.
2. MAST ARM LENGTH SHALL BE SIZED PER EXISTING STREETLIGHT MAST ARM LENGTH TO REPLACE IN-KIND.
3. ALL ELECTRICAL WIRING AND FIBER IN POLE SHALL BE SEPARATED BY OWNER.
4. ALL SMALL CELL EQUIPMENT SHALL BE HOUSED INTERNAL TO THE POLE OR HIDDEN BEHIND THE EQUIPMENT SHROUD AND CANTENNA.
5. EQUIPMENT SHROUD SHALL BE MOUNTED NO LESS THAN 4'-0" ABOVE GRADE. LOCATE THE EQUIPMENT SHROUD AS CLOSE TO THE TOP OF THE POLE AS POSSIBLE.

	<p>City and County of Denver Department of Public Works</p>	<p>Date: May 2019</p>
	<p>SMALL CELL DEPLOYMENT TYPE 3D: COMBINATION POLE WITH DIST. POWER, CANTENNA AND EXTERNAL SHROUD</p>	<p>Std. Dwg. No. SS-08</p>



30 FT. STANDARD

DETAIL NOTES

1. ALL ELECTRICAL WIRING AND FIBER IN RISER POLE SHALL BE SEPARATED BY OWNER.
2. ALL SMALL CELL EQUIPMENT SHALL BE HOUSED INTERNAL TO THE EQUIPMENT ENCLOSURE OR HIDDEN BEHIND THE ANTENNA OR SHROUD.
5. ALL EXTERNAL SHROUDS SHALL OBTAIN SPECIFIC WRITTEN APPROVAL FROM CCD PUBLIC WORKS DEPARTMENT PRIOR TO APPLICATION.
6. ALTERNATIVE ANTENNA HEIGHTS MAY BE APPROVED BY THE CITY AND COUNTY OF DENVER PUBLIC WORKS DEPARTMENT AS LONG AS THE TOTAL POLE HEIGHT WITH ANTENNA IS 30'-0" MAXIMUM.
7. ANTENNA HEIGHTS GREATER THAN 7'-6" SHALL OBTAIN SPECIFIC WRITTEN APPROVAL FROM CCD PUBLIC WORKS DEPARTMENT PRIOR TO APPLICATION.

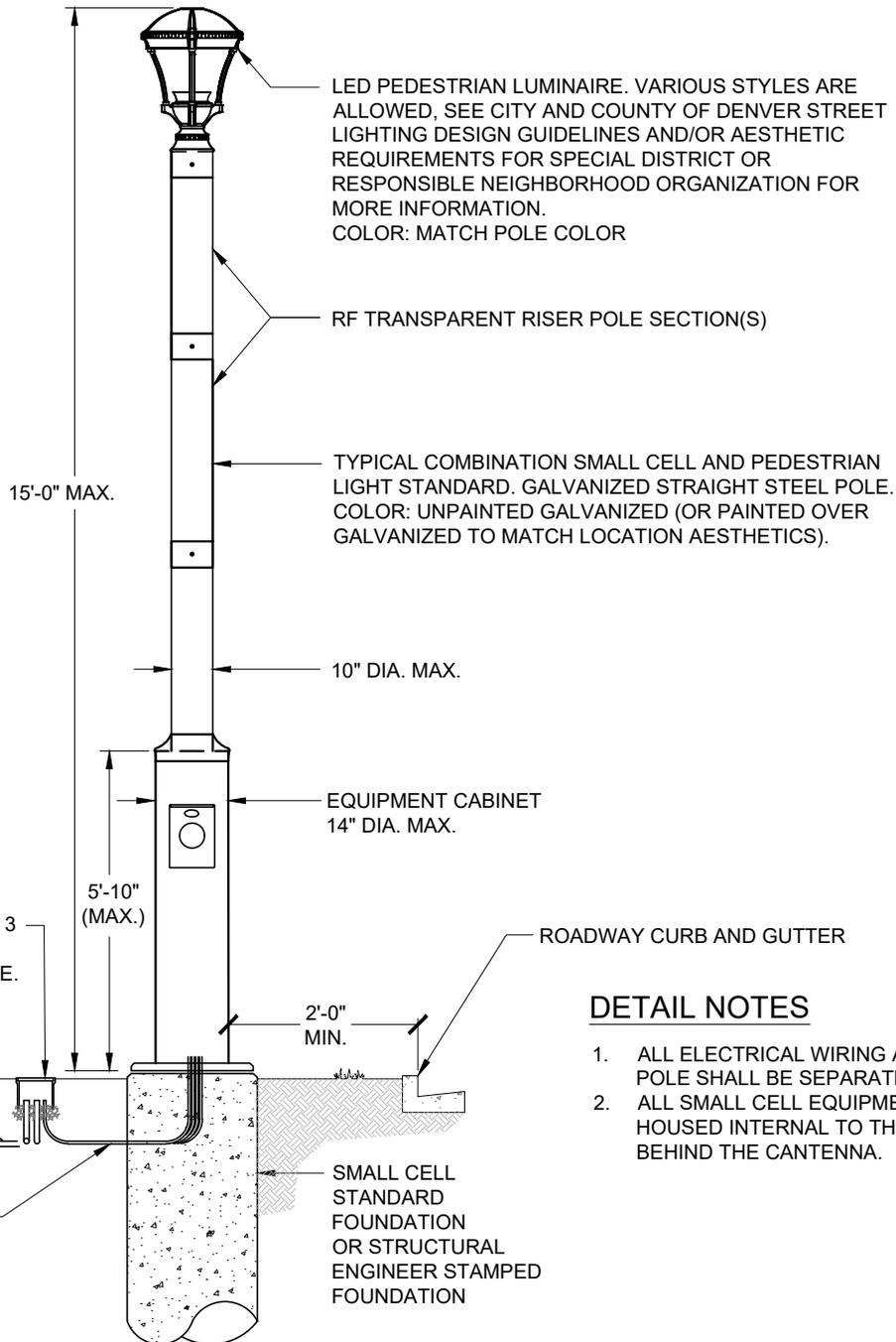


City and County of Denver
Department of Public Works

Date:
May 2019

SMALL CELL DEPLOYMENT TYPE 4: SINGLE-CARRIER
FREESTANDING SMALL CELL

Std. Dwg. No.
SS-09



DETAIL NOTES

1. ALL ELECTRICAL WIRING AND FIBER IN RISER POLE SHALL BE SEPARATED BY OWNER.
2. ALL SMALL CELL EQUIPMENT SHALL BE HOUSED INTERNAL TO THE POLE OR HIDDEN BEHIND THE ANTENNA.



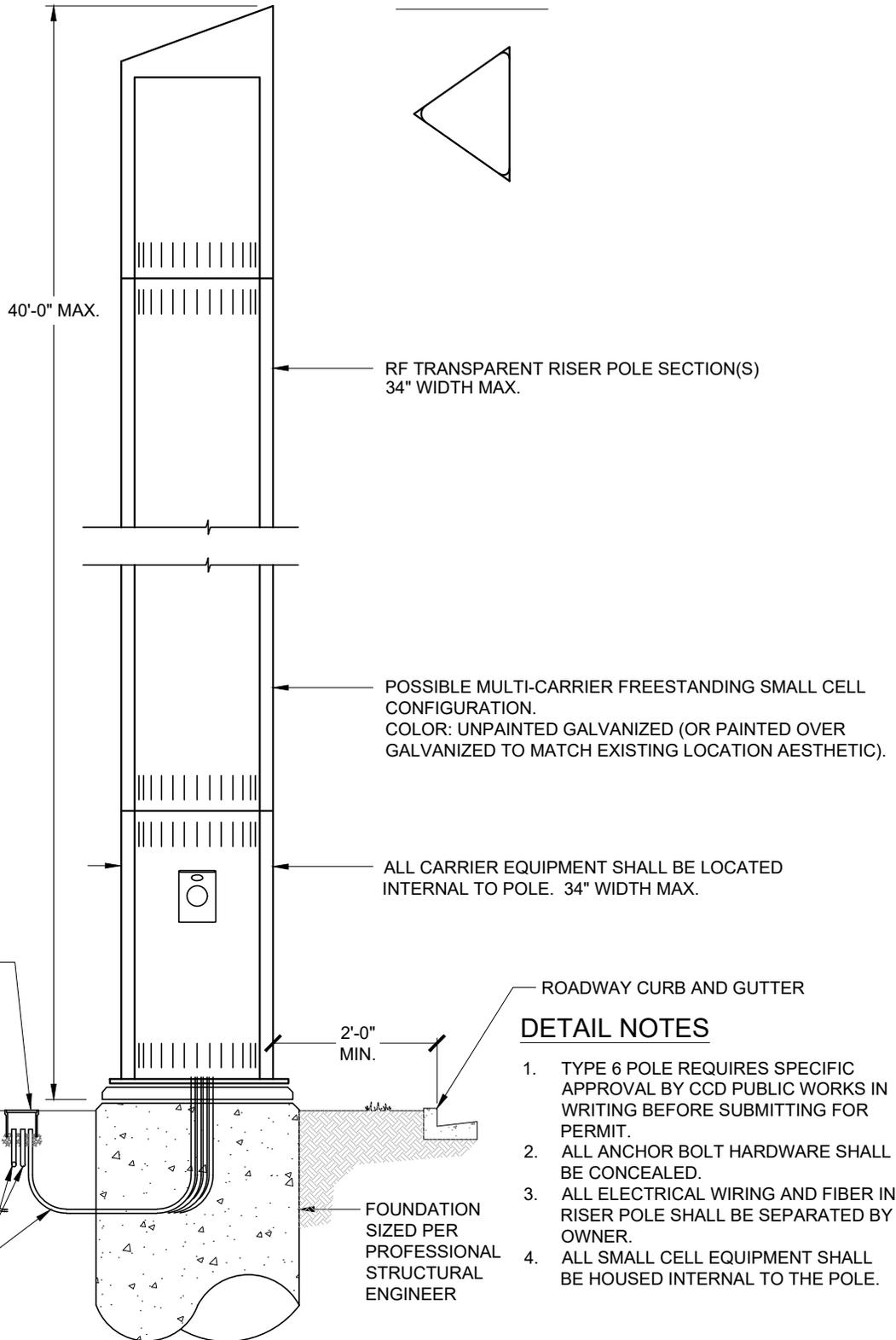
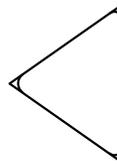
City and County of Denver
Department of Public Works

Date:
May 2019

SMALL CELL DEPLOYMENT TYPE 5: COMBINATION
PEDESTRIAN LIGHT

Std. Dwg. No.
SS-10

PLAN VIEW



DETAIL NOTES

1. TYPE 6 POLE REQUIRES SPECIFIC APPROVAL BY CCD PUBLIC WORKS IN WRITING BEFORE SUBMITTING FOR PERMIT.
2. ALL ANCHOR BOLT HARDWARE SHALL BE CONCEALED.
3. ALL ELECTRICAL WIRING AND FIBER IN RISER POLE SHALL BE SEPARATED BY OWNER.
4. ALL SMALL CELL EQUIPMENT SHALL BE HOUSED INTERNAL TO THE POLE.



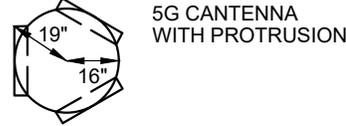
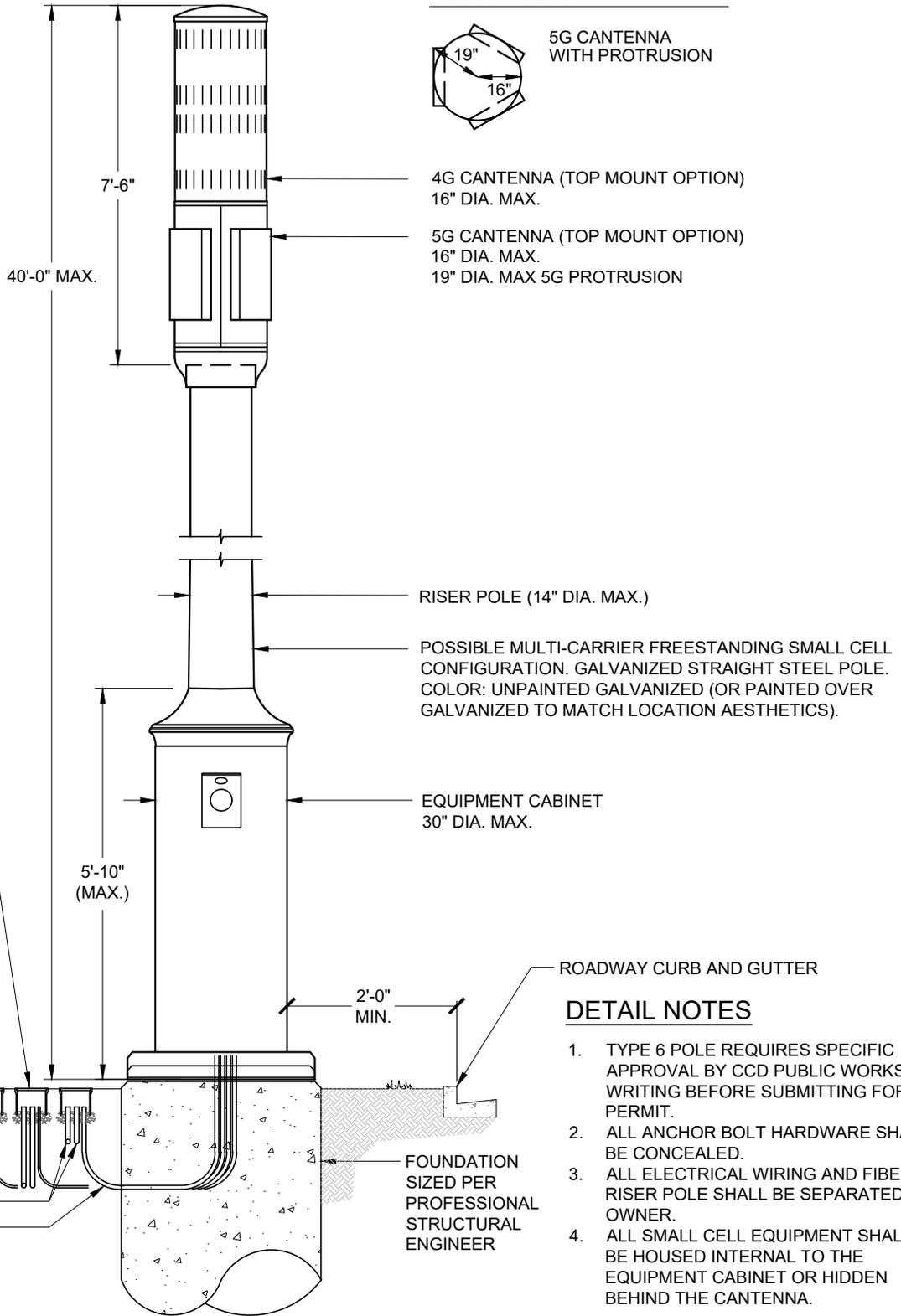
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SMALL CELL DEPLOYMENT TYPE 6A:
MULTI-CARRIER FREESTANDING POLE A

Date:
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SS-11

CANTENNA DETAIL PLAN VIEW



4G CANTENNA (TOP MOUNT OPTION)
16" DIA. MAX.

5G CANTENNA (TOP MOUNT OPTION)
16" DIA. MAX.
19" DIA. MAX 5G PROTRUSION

RISER POLE (14" DIA. MAX.)

POSSIBLE MULTI-CARRIER FREESTANDING SMALL CELL CONFIGURATION. GALVANIZED STRAIGHT STEEL POLE. COLOR: UNPAINTED GALVANIZED (OR PAINTED OVER GALVANIZED TO MATCH LOCATION AESTHETICS).

EQUIPMENT CABINET
30" DIA. MAX.

THREE (3) TYPE 1,2 OR 3 PULL / SPLICE BOXES ALLOWED ADJACENT TO EACH POLE.

FINAL GRADE

ELECTRICAL CONDUIT

2" PVC (MIN.)

2.5" PVC (MIN.)

FOUNDATION SIZED PER PROFESSIONAL STRUCTURAL ENGINEER

ROADWAY CURB AND GUTTER

DETAIL NOTES

1. TYPE 6 POLE REQUIRES SPECIFIC APPROVAL BY CCD PUBLIC WORKS IN WRITING BEFORE SUBMITTING FOR PERMIT.
2. ALL ANCHOR BOLT HARDWARE SHALL BE CONCEALED.
3. ALL ELECTRICAL WIRING AND FIBER IN RISER POLE SHALL BE SEPARATED BY OWNER.
4. ALL SMALL CELL EQUIPMENT SHALL BE HOUSED INTERNAL TO THE EQUIPMENT CABINET OR HIDDEN BEHIND THE CANTENNA.

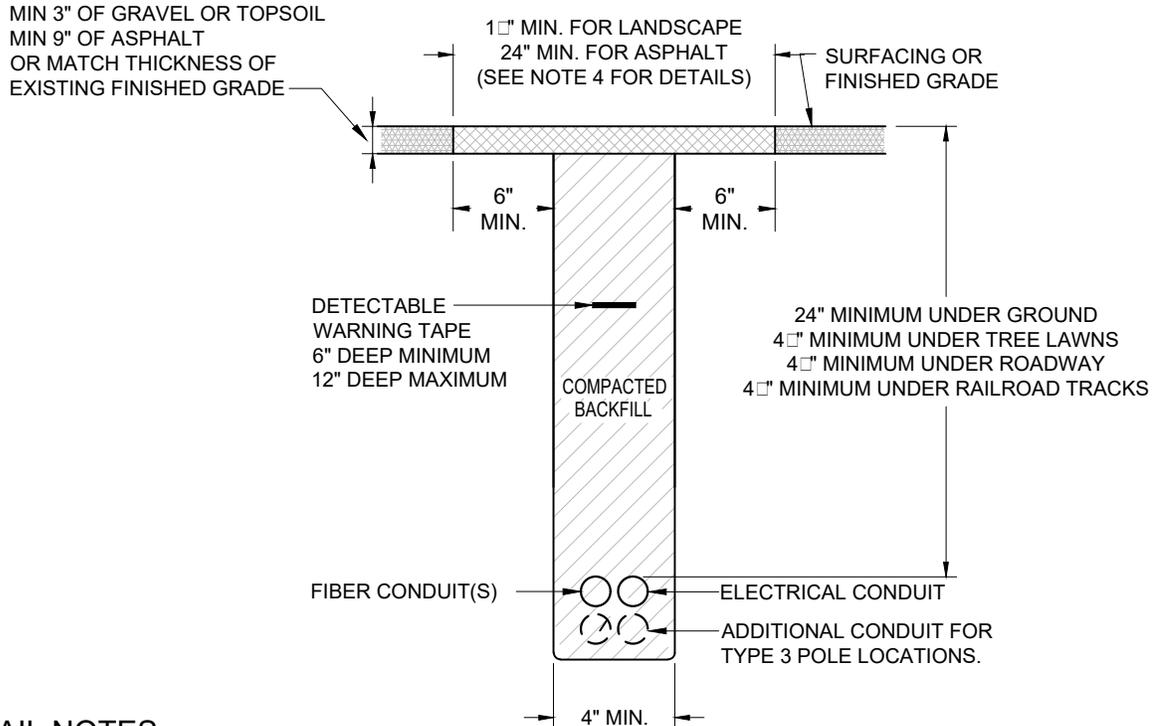


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SMALL CELL DEPLOYMENT TYPE 6B:
MULTI-CARRIER FREESTANDING POLE B

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SS-12



DETAIL NOTES

1. CONTRACTOR SHALL COORDINATE BORING, DRIVING, OR TRENCHING WITH OTHER UNDERGROUND UTILITIES. CONTRACTOR SHALL USE COMMON TRENCHES WHEREVER POSSIBLE.
2. WHENEVER POSSIBLE, CONDUIT OR CABLE SHALL BE INSTALLED BY BORING, DRIVING, OR ANY OTHER ACCEPTABLE MEANS UNDER CONCRETE UNITS. OPEN CUTTING SHALL BE USED ONLY UNDER SPECIAL CIRCUMSTANCES AND ONLY WITH APPROVAL OF PUBLIC WORKS.
3. MINIMUM WIDTH AND TYPE OF RESTORATION TO BE DETERMINED BY PW INSPECTOR, BASED ON CONTRACTOR'S PRE-ACTIVITY PHOTOS, TO MATCH PRE-EXISTING CONDITIONS.
4. SOD REPLACEMENT SHALL BE A MINIMUM OF 1" IN WIDTH. ASPHALT REPLACEMENT SHALL BE A MINIMUM OF 24" IN WIDTH. CONCRETE REPLACEMENT SHALL BE PER THE DEPARTMENT OF PUBLIC WORKS TRANSPORTATION STANDARD DETAILS 12.3.
5. ANY HARDSCAPE (CONCRETE OR PAVERS) SHALL BE REPLACED IN FULL PANELS OR PAVERS OF THE SAME TYPE, COLOR, AND SIZE AS BEFORE.
6. 1-12 AWG LOCATE WIRE AND A NYLON OR POLYESTER PULL TAPE WITH 1,250 LBS TEST STRENGTH AND FOOTAGE MARKINGS IN ALL EMPTY CONDUITS.
7. ALL CONDUIT, LANDSCAPE RESTORATION, ASPHALT RESTORATION, AND CONCRETE RESTORATION MUST BE INSTALLED IN ACCORDANCE WITH THE DEPARTMENT OF PUBLIC WORKS TRANSPORTATION STANDARD DETAILS.
8. SEPARATE CONDUITS SHALL BE PROVIDED, EACH FOR SMALL CELL ELECTRIC CONDUIT AND SMALL CELL CARRIER FIBER.
9. ALL CONDUIT SHALL BE ELECTRONICALLY LOCATABLE.

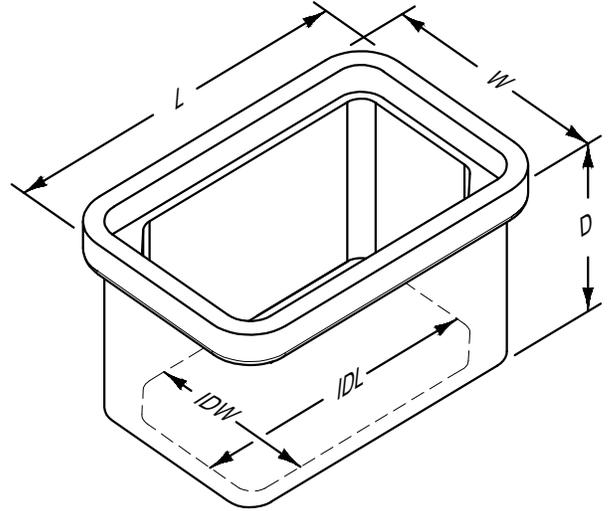
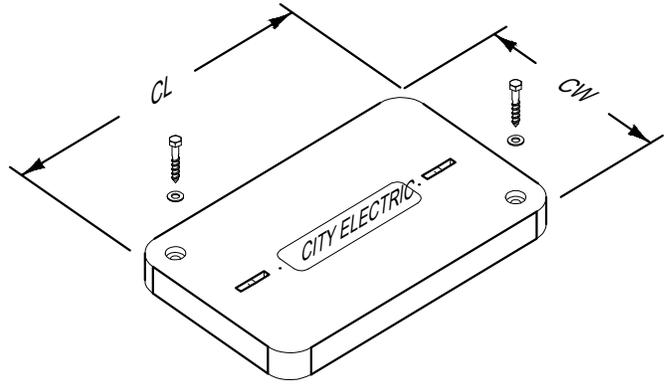


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SMALL CELL DEPLOYMENT: CONDUIT BURIAL DETAIL

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SS-13



**PULL BOX / SPLICE BOX - COMPOSITE
MINIMUM DIMENSIONS**

TYPE 1		TYPE 2		TYPE 3	
L	□ 20"	L	□ 25"	L	□ 32"
W	□ 13"	W	□ 15"	W	□ 19"
D	□ 12"	D	□ 12"	D	□ 12"
IDL	□ 17"	IDL	□ 21"	IDL	□ 2□"
IDW	□ 10"	IDW	□ 11"	IDW	□ 15"
CL	□ 1□"	CL	□ 23"	CL	□ 30"
CW	□ 11"	CW	□ 13"	CW	□ 17"

DETAIL NOTES

BOX COVERS MUST BE POLYMER CONCRETE WITH FIBERGLASS REINFORCEMENT, INCIDENTAL TRAFFIC RATED 22,000 PSI (MINIMUM) LOAD RATING PER ANSI WITH BOLTED COVER. XCEL ENERGY PULL BOX/SPLICE BOX SHALL BE □000 PSI (MINIMUM) LOAD RATING PER ANSI.

1. BOX COVERS SHALL BE LABELED AS FOLLOWS:
 - PULL BOXES CONTAINING STREETLIGHT ELECTRIC SERVICE SHALL BE LABELED "STREETLIGHT"
 - XCEL ENERGY PULL BOXES SHALL BE LABELED "XCEL ENERGY"
 - PULL BOXES CONTAINING CITY FIBER SHALL BE LABELED "CITY FIBER"
 - PULL BOXES CONTAINING SMALL CELL CARRIER FIBER SHALL BE LABELED WITH THE NAME OF THE CARRIER. LABELING MUST BE CAST INTO THE COVER AND NOT A SEPARATE INDEPENDENT TAG.
3. REFER TO N.E.C. ARTICLE 314 "PULL AND JUNCTION BOXES AND CONDUIT BODIES MINIMUM SIZE" FOR BOX SIZE REQUIREMENTS BASED ON CONDUIT AND WIRE SIZES.
4. THE WIRE TERMINATIONS IN THIS BOX SHALL BE MADE USING SUBMERSIBLE INSULATED PEDESTAL LUG CONNECTIONS. PROVIDE ONE MULTI-LUG CONNECTOR FOR EACH PHASE, NEUTRAL AND GROUND CONDUCTOR TO BE SPLICED IN THIS IN-GRADE SPLICE BOX.



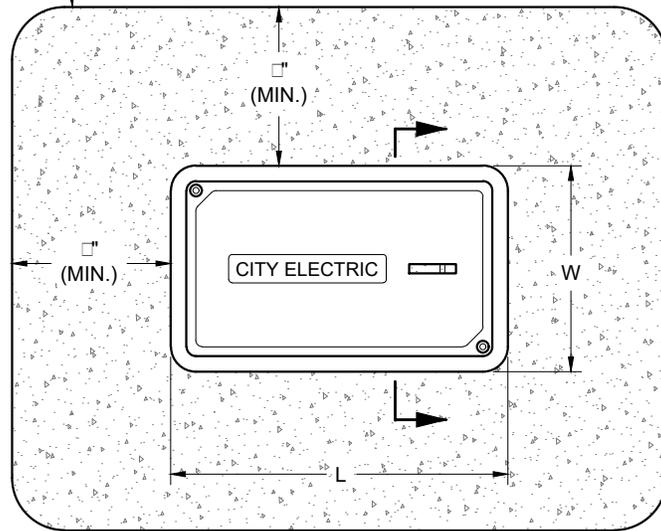
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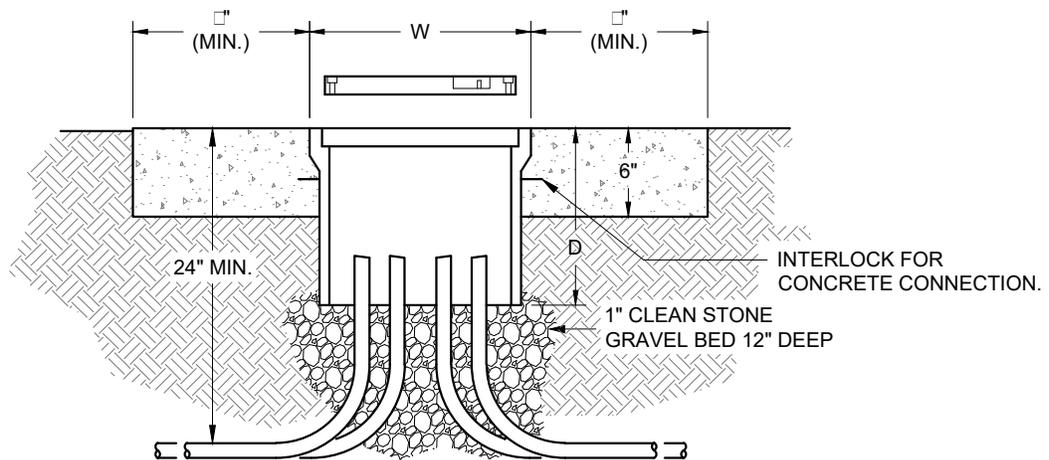
SMALL CELL DEPLOYMENT: PULL BOX / SPLICE BOX
DIMENSIONS

Std. Dwg. No.
SS-14

CONCRETE (CLASS B) SUPPORT RING FOR INSTALLATIONS IN SOFTSCAPE (NOT REQUIRED WHEN EMBEDDED IN CONCRETE SIDEWALK OR OTHER SUITABLE CONCRETE PAD)



PLAN VIEW



SECTION A-A

TYPICAL PULL BOX / SPLICE BOX

DETAIL NOTES

1. ALL PULL OR SPLICE BOXES SHALL BE 22,000 PSI (MINIMUM) INCIDENTAL TRAFFIC RATED PER ANSI. REFER TO SS-15 FOR PULL BOX SIZE REQUIREMENTS.
2. REFER TO SS-17 TO SS-19 FOR GROUNDING DETAILS.
3. ALL PULL BOXES SHOULD BE LOCATED ADJACENT TO EACH OTHER IN HARDSCAPE WHENEVER POSSIBLE.



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SMALL CELL DEPLOYMENT:
IN-GRADE PULL BOX / SPLICE BOX

Std. Dwg. No.
SS-15

GENERAL NOTES:

1. REFER TO DETAIL SS-1 FOR TYPICAL SMALL CELL ELECTRICAL DETAIL NOTES.
2. CITY FIBER AND STREETLIGHT ELECTRICAL SPLICE BOXES MAY NOT BE REQUIRED FOR TYPE 1, TYPE 2, TYPE 4, OR TYPE 6 SMALL CELL INSTALLATIONS.

TOP OF FOUNDATION SHALL BE 3" ABOVE ADJACENT SOFTSCAPE WITH 3" CHAMFER TOP EDGE, XCEL REQUIRES 4" TO 6" ABOVE SOFTSCAPE.

TYPICAL PULL BOX PER DETAIL SS-14.

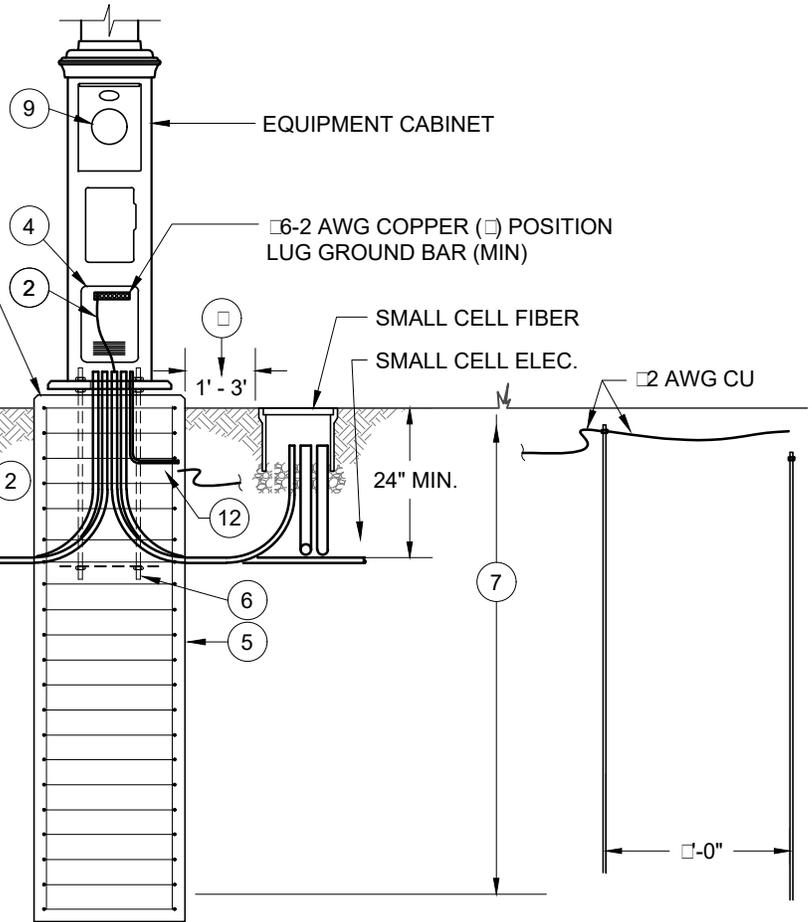
FINAL GRADE

CITY FIBER
STREETLIGHT ELEC.

2" PVC (MINIMUM)
CONDUITS IN AND OUT.

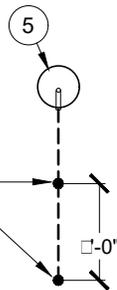
2.5" PVC (MINIMUM), CONNECT TO CIRCUIT AS DESIGNATED ON PLANS.

5/8" DIA. X 10'-0" LG. COPPER CLAD DRIVEN GROUND ROD IN SPLICE BOX 6" (MIN.) AWAY FROM CONCRETE BASE (1' MIN. - 3' MAX. FOR XCEL). EXOTHERMIC WELD OR UNDERGROUND RATED LUG CONNECT CONDUCTOR TO GROUND ROD.



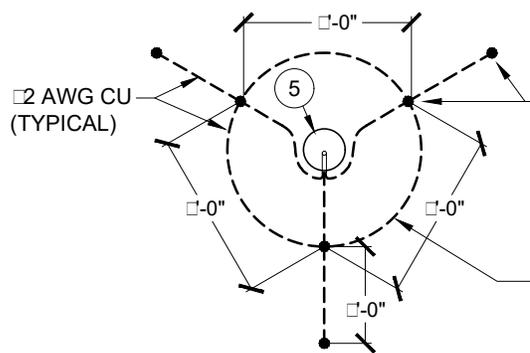
ELEVATION SECTION VIEW

5/8" DIA. X 10'-0" LG. COPPER CLAD DRIVEN GROUND ROD (TYPICAL OF 2) 6" (MIN.) AWAY FROM OTHER GROUND RODS. EXOTHERMIC WELD 2 AWG CU CONDUCTOR TO GROUND ROD.



**11 GROUNDING OPTION 1
LINEAR GROUNDING
PLAN VIEW**

5/8" DIA. X 10'-0" LG. COPPER CLAD DRIVEN GROUND ROD (TYPICAL OF 6) 6" (MIN.) AWAY FROM OTHER GROUND RODS. EXOTHERMIC WELD 2 AWG CU CONDUCTOR TO GROUND ROD.



**10 GROUNDING OPTION 2
RADIAL GROUNDING WITH INNER RING
PLAN VIEW**



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SMALL CELL DEPLOYMENT: SMALL CELL ELECTRICAL
DETAIL IN SOFTSCAPE

Date:
May 2019

Std. Dwg. No.
SS-16

ELECTRICAL FOUNDATION DETAIL NOTES

- ① BOND RACEWAY GROUND TO GROUND ROD IN ELECTRICAL PULL BOXES / SPLICE BOXES.
- ② BOND (1 #4 SOFT DRAWN BARE CU) TO GROUND ROD IN ELECTRICAL PULL BOXES / SPLICE BOXES AND GROUNDING LUG IN EQUIPMENT CABINET HAND HOLE. XCEL REQUIRES 1 #4 CU.
- ③ PROVIDE 3-TERMINAL SUBMERSIBLE UNDERGROUND RATED LUG CONNECTORS TO FIT #14AWG - #4AWG COPPER WIRE, BY BURNDY OR ILSCO NIMBUS OR APPROVED EQUAL. MAXIMUM OF (5) REQUIRED OR (1) FOR EACH CONDUCTOR IN HOME RUN. XCEL REQUIRES 4-LUG TERMINAL FOR HOT CONDUCTORS AND 6-LUG TERMINAL FOR NEUTRAL/GROUND CONDUCTORS, 3-CONNECTIONS MAX. XCEL ALSO REQUIRES #12 AWG, 350 KCMIL CU.AL.
- ④ AT EACH EQUIPMENT CABINET HAND HOLE, PROVIDE A SUBMERSIBLE, WATERPROOF, IN-LINE FUSE HOLDER BY EATON OR APPROVED EQUAL WITH FNQ-R 15A FUSE FOR EACH HOT AND A SUBMERSIBLE, WATERPROOF CONNECTOR ON NEUTRAL (IF REQUIRED).
- ⑤ SMALL CELL FOUNDATION EMBEDMENT DEPTH, DIMENSIONS AND REINFORCEMENT SHALL BE PER SS-21 THROUGH SS-24 OR AS DESIGNED BY A STRUCTURAL ENGINEER LICENSED IN THE STATE OF COLORADO.
- ⑥ ANCHOR BOLT CIRCLE SHALL BE 24" AND CENTERED ON FOUNDATION WITH AN ANCHOR BOLT TEMPLATE.
- ⑦ DEPTH OF FOUNDATION PER SS-20 THROUGH SS-21 OR AS DESIGNED BY A STRUCTURAL ENGINEER LICENSED IN THE STATE OF COLORADO.
- ⑧ XCEL REQUIRES THE CLOSEST EDGE OF PULL BOX SHALL BE 1' TO 3' FROM FOUNDATION EXCEPT WHEN FIELD CONDITIONS DICTATE OTHERWISE.
- ⑨ XCEL METER SHALL BE PROPERLY GROUNDED PER N.E.S.C. CURRENT ADDITION.
- ⑩ RADIAL GROUNDING OPTION: BOND (1 #2 SOFT DRAWN BARE CU) TO GROUND ROD RING WITH (6) 5/8" #10'-0" GROUND RODS IN RADIAL DESIGN WITH LOOP RING ON INSIDE (3) RODS. EXOTHERMIC WELD CONDUCTOR TO EACH ROD.
- ⑪ LINEAR GROUNDING OPTION: BOND (1 #2 SOFT DRAWN BARE CU) TO (2) 5/8" #10'-0" GROUND RODS IN LINEAR ARRANGEMENT . EXOTHERMIC WELD CONDUCTOR TO EACH ROD.
- ⑫ PROVIDE 3/4" GRC SLEEVE IN FOUNDATION FOR GROUNDING CONDUCTORS.

GENERAL NOTE

FOUNDATION DETAILS ARE INCLUDED ONLY TO SHOW ELECTRICAL COMPONENTS. REFER TO SS-20 THROUGH SS-23 FOR STRUCTURAL REQUIREMENTS.

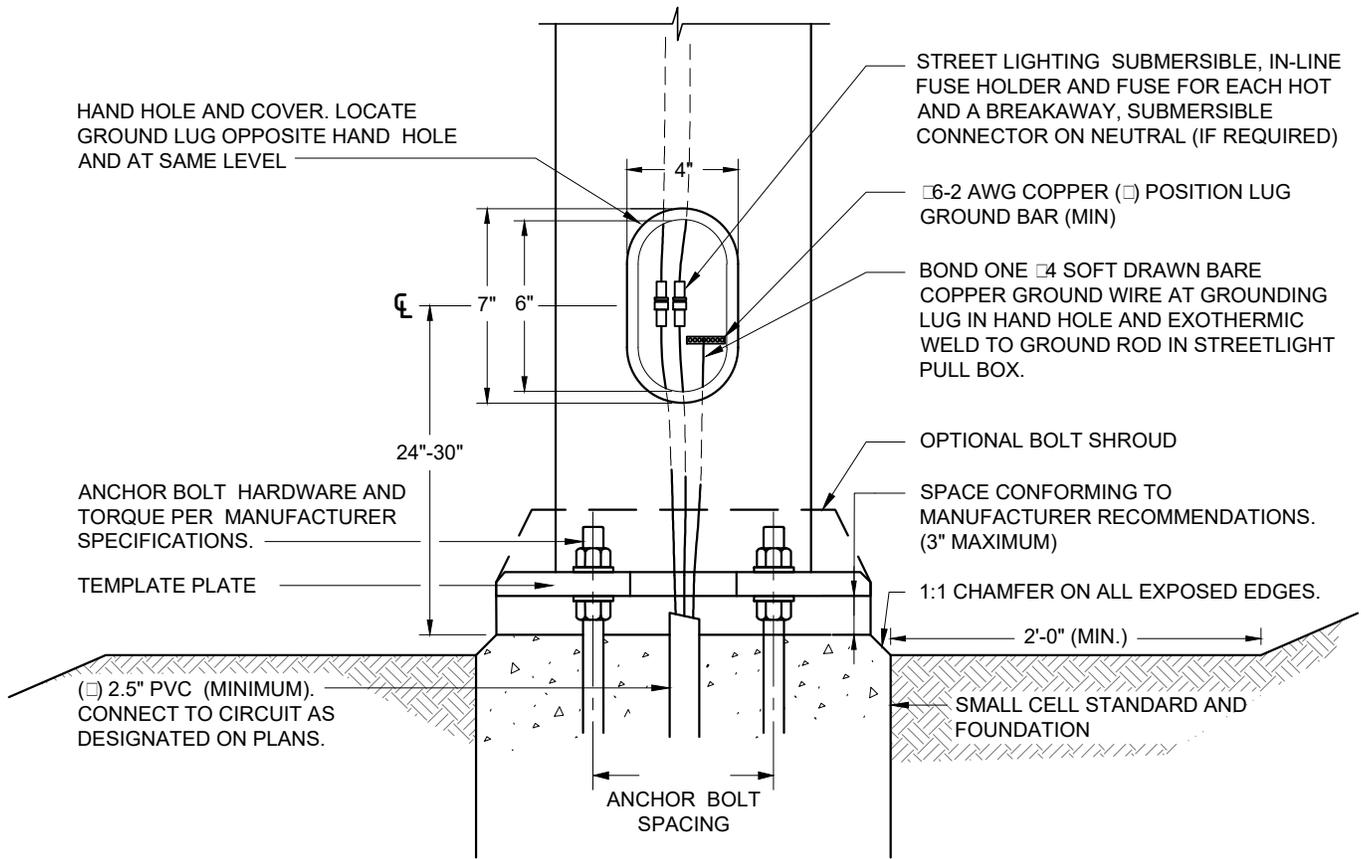


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SMALL CELL DEPLOYMENT: SMALL CELL ELECTRICAL
DETAIL NOTES

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May 2019

Std. Dwg. No.
SS-18



TYPICAL BASE DETAIL

NOTES

1. ONLY FOR USE OUTSIDE OF MINIMUM CORNER OR ROADSIDE CLEAR ZONES OR IN PROTECTED INSTALLATIONS.
2. SMALL CELL STANDARD FOUNDATIONS SHALL BE PRECAST CONCRETE.
3. ALL CONDUCTORS SHALL BE SIZED IN CONFORMANCE WITH N.E.C. REQUIREMENTS 3/C COPPER 12 AWG CABLE MINIMUM.
4. ALL EQUIPMENT SHALL BE LOCATED INTERNAL TO THE EQUIPMENT CABINET OR RECESSED IN THE EQUIPMENT CABINET TO MEET UTILITY REQUIREMENTS.
5. EQUIPMENT CABINET SHALL BE SIZED TO HANDLE THE EQUIPMENT REQUIRED BY THE OWNER.
6. EQUIPMENT SHALL BE INSTALLED IN SEPARATED COMPARTMENTS WITH LOCKABLE ACCESS COVER PER OWNER REQUIREMENTS.
7. ANCHOR BOLT CIRCLE SHALL BE 24" AND CENTERED ON FOUNDATION. USE ANCHOR BOLT TEMPLATE.

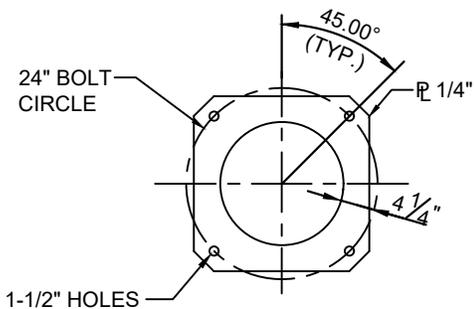


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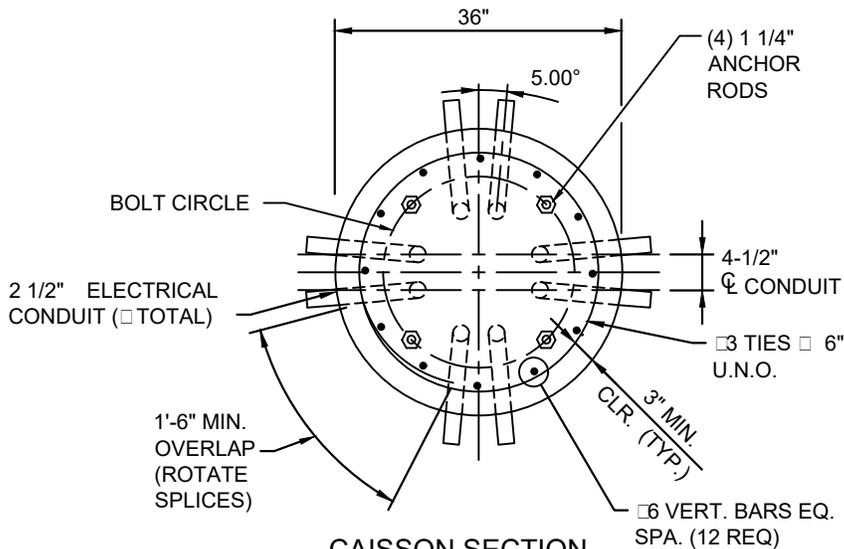
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SMALL CELL DEPLOYMENT: POLE BASE STANDARD

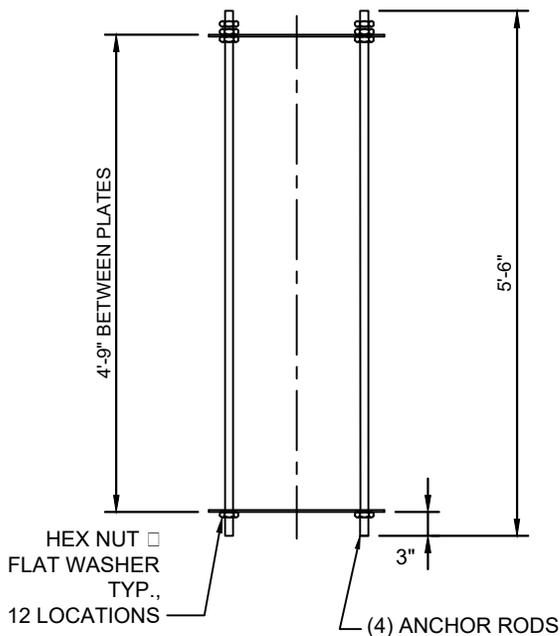
Std. Dwg. No.
SS-19



TEMPLATE/EMBEDMENT PLATE PLAN

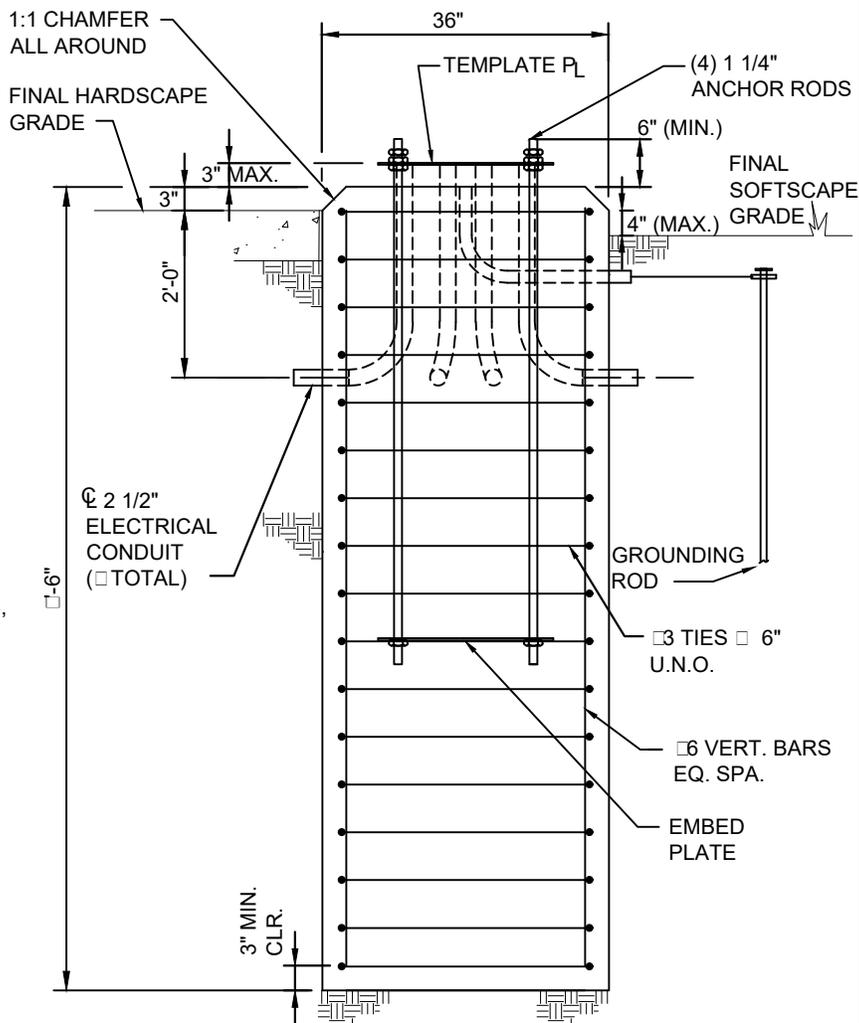


CAISSON SECTION
(TEMPLATE P_L NOT SHOWN)



ANCHOR BOLT DETAIL

1 1/4" ANCHOR BOLTS ASTM A193 GRADE B AND SHALL BE GALVANIZED □/HEAVY NUTS, LEVELING NUTS, AND ASTM F436 HARDENED STEEL WASHERS



CAISSON FOUNDATION DETAIL

NOTES:

- 1) REFER TO SS-22 □ SS-23 FOR GENERAL STRUCTURAL NOTES.
- 2) REFER TO ELECTRICAL DETAILS FOR CONDUIT, ELECTRICAL, AND GROUNDING REQUIREMENTS.
- 3) POLE HEIGHTS GREATER THAN 40'-0" REQUIRE FOUNDATION DESIGN BY CONTRACTOR.

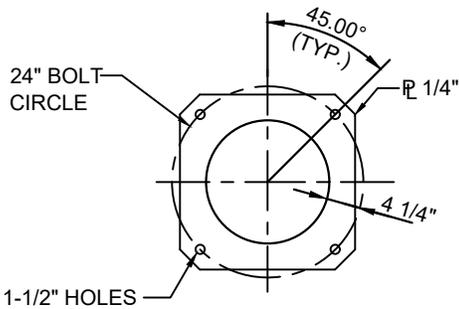


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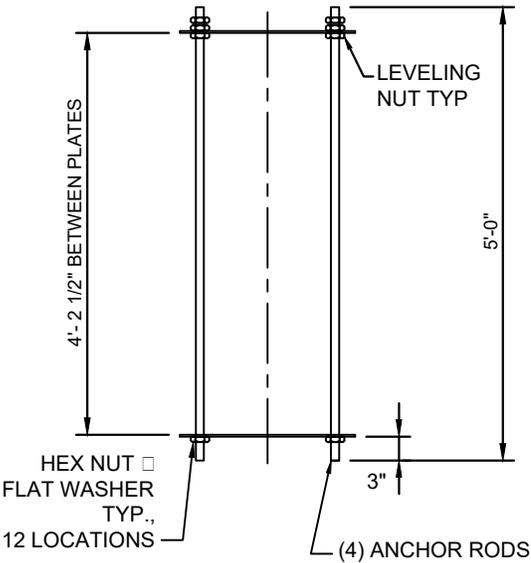
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SMALL CELL DEPLOYMENT:
PIER FOUNDATION

Std. Dwg. No.
SS-20

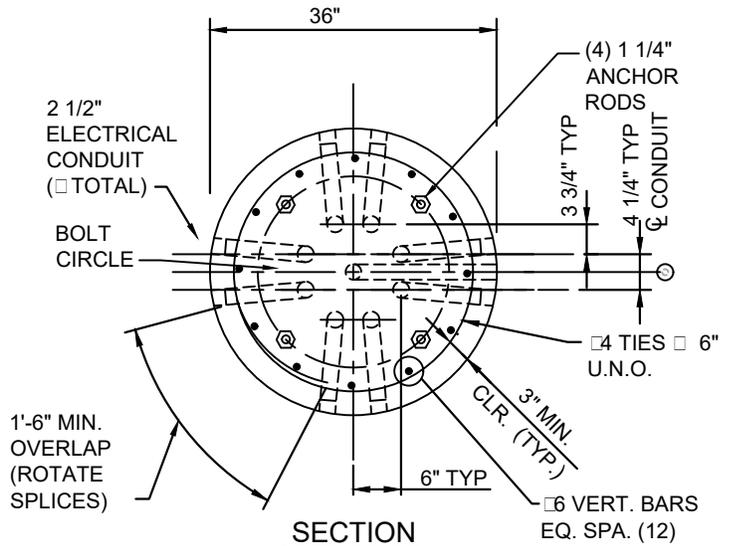


TEMPLATE/EMBEDMENT PLATE PLAN

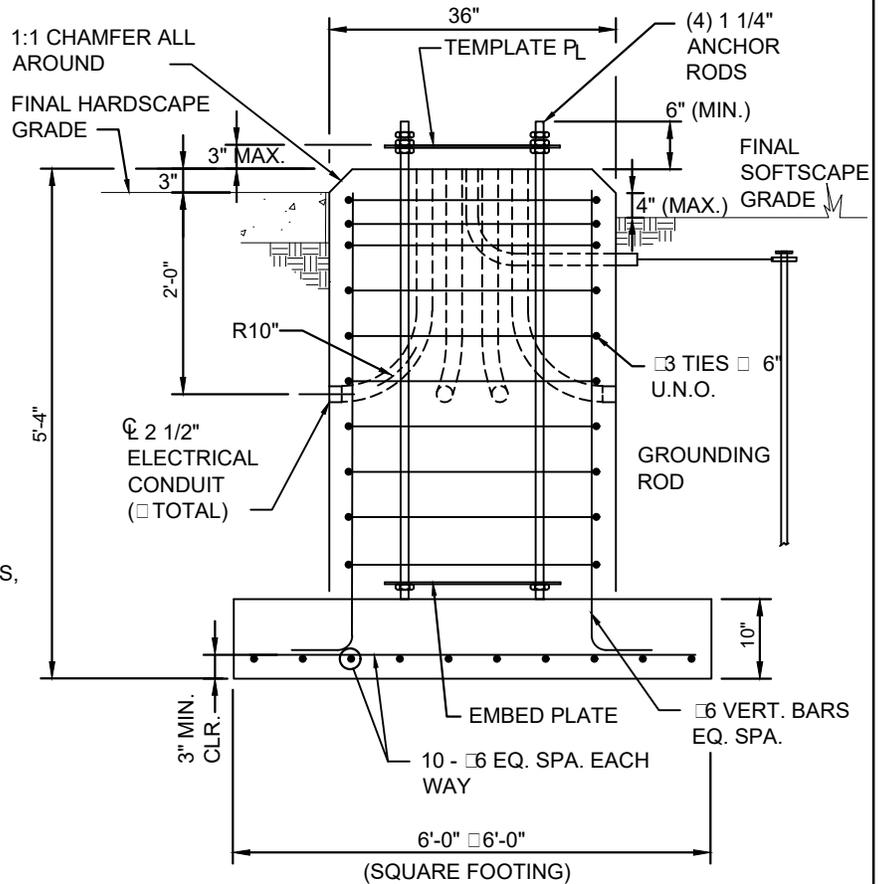


ANCHOR BOLT DETAIL

1 1/4" ANCHOR BOLTS ASTM A193 GRADE B AND SHALL BE GALVANIZED □/HEAVY NUTS, LEVELING NUTS, AND ASTM F436 HARDENED STEEL WASHERS



SECTION



FOUNDATION DETAIL

NOTES:

- 1) REFER TO SS-22 □ SS-23 FOR GENERAL STRUCTURAL NOTES.
- 2) REFER TO ELECTRICAL DETAILS FOR CONDUIT, ELECTRICAL, AND GROUNDING REQUIREMENTS.
- 3) POLE HEIGHTS GREATER THAN 40'-0" REQUIRE FOUNDATION DESIGN BY CONTRACTOR.



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SMALL CELL DEPLOYMENT:
SPREAD FOOTING FOUNDATION

Std. Dwg. No.
SS-21

GENERAL STRUCTURAL NOTES:

1. DESIGN INFORMATION AND GENERAL REQUIREMENTS

1.1. CODES AND DESIGN GUIDELINES

- A. 2015 INTERNATIONAL BUILDING CODE, WITH CITY COUNTY OF DENVER (CCD) AMENDMENTS
- B. TIA-222-G, STRUCTURAL STANDARD FOR ANTENNA SUPPORTING STRUCTURES AND ANTENNAS WITH EXCEPTION OF CCD REQUIREMENTS FOR FROST DEPTH.
- C. AASHTO LRFD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES, AND TRAFFIC SIGNALS, FIRST EDITION WITH LATEST INTERIMS
- D. AMERICAN CONCRETE INSTITUTE (ACI) BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE 318-14.
- E. CITY COUNTY OF DENVER STREET LIGHTING DESIGN GUIDELINES, MARCH 2017 OR LATEST EDITION.

1.2. LOADS

- A. WIND LOAD SHALL BE 115 MPH ULTIMATE BASED ON ASCE 7-10 SPECIAL WIND REGION.
- B. MAXIMUM DEAD LOAD AT TOP OF FOUNDATION (INCLUDING POLE, POLE BASE, LUMINAIRES, CANTENNA AND EQUIPMENT) IS ASSUMED TO BE 2600 LBS.
- C. TYPICAL RISK CATEGORY WITH MEAN RECURRENCE INTERVAL 700 YRS (AASHTO)
- D. STRUCTURE CLASS II (TIA)

1.3. GEOTECHNICAL

- A. THE FOLLOWING SOIL PARAMETERS WERE USED FOR STANDARD FOUNDATION DESIGN:
 - 1. LOOSE GRANULAR SOIL WITH A UNIT WEIGHT OF 110 PCF AND A 25 DEGREE ANGLE OF INTERNAL FRICTION (PHI ANGLE).
 - 2. SOFT COHESIVE SOIL WITH A UNIT WEIGHT OF 110 PCF AND A UNIT COHESION OF 500 PSF.
 - 3. PIER AND FOOTING FOUNDATION: COMPACTED FOUNDATION SOIL NET ALLOWABLE BEARING CAPACITY OF 1500 PSF WAS USED FOR DESIGN.
- B. CONTACT THE CCD PROJECT REPRESENTATIVE IF ANY OF THE FOLLOWING SOIL CONDITIONS ARE ENCOUNTERED DURING DRILLING/EXCAVATION:
 - 1. THE SOIL HAS A HIGH ORGANIC CONTENT, VOIDS, DELETERIOUS SOILS OR CONSISTS OF SATURATED SOILS.
 - 2. THE SITE WON T SUPPORT THE WEIGHT OF THE DRILLING RIG.
 - 3. THE FOUNDATION SOILS ARE NOT HOMOGENEOUS.
 - 4. FIRM BEDROCK IS ENCOUNTERED.

1.4. MISCELLANEOUS

- A. CONTRACTOR SHALL VERIFY ALL DIMENSIONS, ELEVATIONS, AND EXISTING CONDITIONS PRIOR TO PROCEEDING WITH THE WORK.

2. FOUNDATION NOTES

2.1. GENERAL

- A. HYBRID STANDARD FOUNDATIONS SHALL BE DRILLED CONCRETE CAISSON FOUNDATIONS. THE PIER AND FOOTING FOUNDATION DETAILS PRESENTED IN THESE GUIDELINES PRESENT AN ALTERNATIVE FOUNDATION TYPE THAT MAY BE PROPOSED BY THE CONTRACTOR WITH APPROVAL OF THE CITY COUNTY OF DENVER.
- B. CAISSON OR PIER AND FOOTING FOUNDATION TYPES MAY BE PROVIDED AS CAST-IN-PLACE CONCRETE OR PRECAST CONCRETE CONSTRUCTION ELEMENTS AT THE OPTION OF THE CONTRACTOR.

2.2. EARTHWORK

- A. DESIGN, FURNISH, AND LEVEL ALL TEMPORARY SHEETING, SHORING, AND DRAINAGE TO MAINTAIN THE EXCAVATION AND PROTECT SURROUNDING STRUCTURES AND UTILITIES.
- B. CAISSON FOUNDATIONS:
 - 1. CAISSONS SHALL BE PLACED AGAINST UNDISTURBED EARTH WITH THE DRILLED HOLE MATCHING THE OUTER DIAMETER OF A CAST-IN-PLACE CAISSON.
 - 2. PRECAST CAISSON FOUNDATIONS SHALL BE DRILLED AT A DIAMETER NO LARGER THAN THE OUTER DIAMETER OF THE CAISSON PLUS 6 INCHES.
 - 3. OVER EXCAVATED AREAS OF THE PRECAST CAISSON SHALL BE BACKFILLED USING A LEAN CONCRETE SLURRY (FLOWABLE FILL) WITH A MINIMUM COMPRESSIVE STRENGTH OF 200 PSI.
- C. PIER AND FOOTING FOUNDATIONS:
 - 1. THOROUGHLY COMPACT BOTTOM OF FOOTINGS PRIOR TO PLACING ANY CONCRETE.
 - 2. BACKFILL SHALL BE COMPACTED TO 95% STANDARD PROCTOR.
 - 3. PRECAST PIER AND FOOTING FOUNDATIONS SHALL BE EXCAVATED SO THAT THE BOTTOM SURFACE IS LEVEL AND COMPACTED TO PROVIDE THE REQUIRED BEARING CAPACITY OF THE UNDISTURBED SOIL.

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	SMALL CELL DEPLOYMENT: GENERAL FOUNDATION STRUCTURAL NOTES	Std. Dwg. No. SS-22

GENERAL STRUCTURAL NOTES (CONTINUED):

2.3. CAST-IN-PLACE (CIP) OR PRECAST CONCRETE

- A. CONCRETE CONSTRUCTION SHALL BE IN ACCORDANCE WITH ACI 301 SPECIFICATIONS FOR STRUCTURAL CONCRETE .
- B. CONCRETE MIX DESIGN TO BE IN ACCORDANCE WITH ACI 318 CHAPTER 26 AND THE SPECIFICATIONS INCLUDED IN THESE GUIDELINES.
- C. CONCRETE SHALL BE CLASS B WITH A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4500 PSI.
- D. MAXIMUM SLUMP PRIOR TO THE ADDITION OF SUPER PLASTICIZER ADMIXTURES SHALL BE 3 INCHES.
- E. NO CALCIUM CHLORIDE ADMIXTURES OR OTHER AGGREGATES CONTAINING CHLORIDES SHALL BE USED IN ANY CONCRETE.
- F. COARSE AGGREGATE FOR NORMAL WEIGHT CONCRETE SHALL CONFORM TO ASTM C33 SIZE #57.
- G. COLD WEATHER PLACEMENT SHALL COMPLY WITH ACI 306.1.
- H. HOT WEATHER PLACEMENT SHALL COMPLY WITH ACI 305R.

2.4. REINFORCEMENT

- A. REINFORCING STEEL SHALL CONFORM TO ASTM A615, GRADE 60.
- B. BARS SHALL BE SECURELY HELD IN ACCURATE POSITION BY SUITABLE ACCESSORIES, TIE BARS, SUPPORT CHAIRS, ETC.
- C. HOOK LENGTHS SHALL BE A MINIMUM 12 BAR DIAMETERS.
- D. CONCRETE COVER FOR REINFORCING SHALL BE AS FOLLOWS:
 - 1. CONCRETE CAST AGAINST EARTH: 3 INCHES.
 - 2. CONCRETE (CIP OR PRECAST) TO BE IN CONTACT WITH GROUND OR WEATHER: 2 INCHES.

2.5. ANCHOR BOLTS, ANCHOR EMBED PLATE, NUTS AND WASHERS SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM A153.

2.6. ALL FOUNDATIONS SHALL HAVE GROUNDING IN CONFORMANCE WITH THE NEC.



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SMALL CELL DEPLOYMENT:
GENERAL FOUNDATIO STRUCTURAL NOTES, CONTINUED

Std. Dwg. No.
SS-23



B SPECIFICATIONS

The following sections describe in detail the pole structural and specifications expected for small cell infrastructure placed in the public rights of way (ROW) of the City and County of Denver (CCD). All work completed in the ROW must be in accordance with the CCD Public Works Transportation Standards and Engineering Details.

B.1 Small Cell Pole

Description

This work consists of furnishing and installing foundations, small cell poles, conduit, junction boxes, cable, wiring, and incidental materials for small cell installation in accordance with these specifications and in conformance with the details, lines, grades, and locations shown on the plans.

Materials

Small Cell materials shall conform to Small Cell and Electrical Materials.

- a) *Foundations.* Concrete bases and equipment pads shall be pre-cast or cast-in-place concrete per CCD standard to meet ACI 318. A complete foundation includes the concrete, reinforcing steel, anchor bolts, leveling nuts, conduit stubs, ground rod and wire, excavation and backfill, restoration, accessories as required to provide a complete unit. Banner arm (if required) wind loading shall be incorporated into small cell standard structural design.
- b) *Small Cell Standard.* A complete small cell standard includes the metal riser pole, mounting bracket, mast arm(s) if required, cantenna, equipment cabinet, grounding system, and all hardware. The riser pole shall have six (6) handholes at the top to maintain streetlight electrical service and provide weatherproof, gasketed access points for conduits to exit the standard. An optional handhole shall be provided at the bottom of the riser pole if fiber and electrical service cannot be accessed from the equipment cabinet.

Pole and mast arm or arms shall be the type and size shown on the plans.

- c) *Conduit.* Conduit includes conduit, trenching, backfill, jacking, augering, fittings, drainage tees, sealing, restoration, and accessories as required to provide a complete installation.

- d) *Electrical Warning Tape.* Detectable electrical warning tape shall consist of pre-manufactured non-adhesive polyethylene material that is unaffected by acids, alkalines, and other soil components. The color of the tape shall be red, and it shall be, at a minimum, 3.5 mils thick and 6 inches wide. Its tensile strength shall be 2,500 psi lengthwise.

The electrical tape shall include the following identification printed in black letters continuously along the length of the tape: "CAUTION BURIED ELECTRIC LINE BELOW".

The identification note and color of tape shall conform to the requirements of the "American Public Works Association (APWA) Uniform Color Codes (Red) – Electrical Power Lines, Cables, Conduit and Lighting Cables."

- e) *Conductors.* Conductor includes control wiring, luminaire wiring, main circuit wiring, ground wiring, service entrance wiring, pulling, splicing, connections, testing, and all other wiring necessary for a complete installation.
- f) *Pull boxes.* Pull box includes pull box, cover with bolts, excavation, gravel base, backfill, sealing, restoration, and accessories as required to provide a complete installation.
- g) *Materials List.* At the preconstruction conference the Contractor shall submit to a list of all materials and equipment to be incorporated into the work. The Contractor shall include the following items on the list:
- a. Small cell standards
 - b. Pull Box
 - c. Fuse holders
 - d. Conductors
 - e. Conduit
 - f. Wireless Lighting Control and Monitoring System
 - g. Small cell foundations
 - h. Equipment pads
 - i. All other items required for a complete installation

CCD will return lists that are incomplete or that include unacceptable materials to the Contractor for correction and re-submission.

The Contractor shall not order materials or equipment until CCD and the party or agency responsible for maintenance have reviewed and approved the materials and equipment list. CCD's approval of the list shall not relieve the Contractor responsibility for the proper functioning of the completed installation.

- h) *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 Contractor, and this support shall be made available from factory certified personnel or factory certified installers at no additional charge to CCD.

General

All work shall conform to these specifications and the National Electrical Code (NEC) when the small cell pole is owned by CCD or the Carrier, or the National Electrical Safety Code (NESC) when the small cell pole is owned by Xcel Energy.

The Contractor and/or Applicant shall keep fully informed of and comply with all Federal, State, and local laws, ordinances, and regulations, and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which may affect those engaged or employed on the work, or affect the conduct of the work. The Contractor and/or Applicant shall protect and indemnify CCD and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order or decree, whether by the Contractor and/or Applicant, the subcontractors, suppliers of materials or services, or their employees.

Each system shall be installed as shown on the plans or as designated. The Contractor and/or Applicant shall furnish and install all incidentals necessary to provide a complete working unit or system.

Concrete Foundation Pads and Small Cell Standard Foundations.

Foundations shall be installed as shown on the plans, complete with grounding. The Contractor and/or Applicant shall test and report soil conditions to CCD as necessary to ensure proper installation of foundations. Foundations shall be installed at the final grade.

All anchor bolts shall be positioned by means of steel templates. The center of the template shall coincide with the center of the foundation. Anchor bolt size and 24-inch bolt circle shall accommodate a 20-inch equipment cabinet per manufacturer's requirements.

All small cell standard foundations shall be as detailed.

Conduits shall be properly positioned and anchored before the concrete is placed.

Coordinate the base setback and orientation with CCD.

All foundations shall have ground rods conforming to the NEC or NESC. All foundations on structures shall be grounded to the structural steel by a method that is in accordance with the NEC or NESC and which is approved by CCD.

Small Cell Standards

Poles, equipment cabinets, and bolts shall be galvanized steel. Galvanizing will be performed in accordance with ASTM 123 and meet the following galvanization and paint requirements.

1. Galvanizing will be SSPC-SP1 Solvent wiped where needed and the Galvanizing will receive a sweep blast to a uniform dull appearance. Any areas of fracture will be repaired. Any excess zinc build up should be blended to no higher than the height of a dime with no thick edges or areas that may cause paint entrapment potentially leading to a premature coating failure.

The first epoxy coat typically should be applied within 120-180 minutes of abrasive blasting. Items shall be cleaned free of blast debris before coating. Compressed air should be used to clean items; items should be free of Oil, residue, and any other contaminates/debris.

- Epoxy Primer Gray- B107989EA80K-A
- Impact Resistance Direct 100 IN/LBS @ 2.0-3.0 Mils (ASTM D2794)
- Impact Resistance Indirect- 100 IN/LBS @ 2.0-3.0 Mils (ASTM D2794)
- Cross- Hatch Adhesion 5B (ASTM D3359)
- Conical Mandrel 1/8" (ASTM D522)
- Pencil Hardness 2H (ASTM D3363)
- Specific Gravity 1.58 +/- 0.05 G/ML
- Theoretical Coverage 121.63 ft²/LB @ 1.0 Mil
- 60 percent gloss 75-85 (ASTM D523)

The Epoxy prime coat shall be applied on poles for a DFT Average of 5.0 Mils for the bottom eight feet, 3.0 Mils DFT above that. Arms have the epoxy prime applied for a 3.0 mil DFT. DFT readings shall be taken in accordance with SSPC-PA2.

Top coat to be applied for a DFT of 3.0 mils average unless noted otherwise.

Aerosol touch up should be used for coverage on areas that were masked by a hanging device (Hanging hook or chain, etc) or used to repair small scratches or imperfections.

Poles shall be set plumb, and centered, on the small cell standard foundation using leveling nuts when installed.

Defects and scratches on painted, powder-coated, or anodized poles shall be primed and painted with a color-matched paint to match undamaged pole sections. Defects and scratches on galvanized poles shall be re-galvanized in the field.

Stainless steel mounting hardware shall be used to mount luminaires, mast arms, access doors, antenna, equipment cabinet, and other hardware to the poles. Apply an approved zinc-based anti-seize compound to all mounting hardware prior to assembly.

Banner arms (if required) shall be incorporated into small cell standard structural design.

Conduit

The electrical conduit system shall be installed in accordance the following:

In the conduit system, the locations of conduit, junction boxes, and expansion joints shown on the plans are approximate. Actual locations shall be established during construction. The conduit system shall be located to avoid interference with known present or known construction installations. All underground conduit runs and conduit risers on poles shall be installed as needed even though they may not be shown on the plans.

All conduit shall be installed within the public Right of Way and shall be at least two-inch (2" minimum) inside diameter unless otherwise designated on the plans. The Contractor and/or Applicant may use larger conduit than specified. If larger conduit is used, it shall be for the entire run from outlet to outlet. Reducer couplings shall not be used. Larger conduits shall be sized to accommodate the constraints established by the hole in the pole anchor base plate.

Conduit terminating in standards or pedestals shall extend approximately two inches past the foundations and shall slope toward the junction box opening. Conduit entering pull boxes shall terminate two inches inside the box wall and two to five inches above the bottom, and shall slope toward the top of the box to facilitate pulling of conductors. Conduit entering through the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduits shall enter from the direction of the run.

The ends of all conduits, whether shop or field cut, shall be reamed to remove burrs and rough edges. Cuts shall be made square and true so that the ends will butt or come together for their full circumference.

Non-metallic conduit shall be cut with a hacksaw or other approved tool. Non-metallic conduit connections shall be the solvent-weld type.

Conduit connections at junction boxes shall be tightly secured and waterproofed. All conduit ends shall be sealed with duct seal after installation of wiring. The duct seal shall be rated for outdoor use.

When specified, conduit shall be installed under existing pavement by boring operations. Where plans show that existing pavement is to be removed, jacking the conduit is not required. Jacking or drilling pits shall maintain a minimum of two feet clear of the edge of pavement. Water shall not be used as an aid in the jacking or drilling operations.

Trenching shall be in conformance with CCD standards. Backfill shall be per CCD standards.

Detectable red electrical warning tape shall be installed between six inches and 12 inches below finished grade for all underground conduit runs.

Underground conduit shall be buried a minimum of two feet below finished grade. There shall be no sag between boxes. Conduit within the public ROW shall be in conformance with CCD standards.

Junction Boxes shall be placed at conduit ends, at all locations where conduit bends in a single run would equal 360° or greater per NEC requirements, and at all other locations shown on the plans. The Contractor may install additional pull boxes to facilitate the work.

Excavate minimum 24 inches below base depth of each junction box, backfill and compact with 1" clean stone gravel to permit draining of water.

Placement and setback of the junction boxes shall be coordinated with CCD.

Unless otherwise shown on the plans or directed by CCD, junction boxes shall be installed so that the covers are level with the sidewalk grade. Covers shall be flush with the surrounding finished ground when no grade is established.

Where a conduit stub-out is called for on the plans, a sweeping elbow shall be installed in the direction indicated. All conduit stub outs shall be capped.

Wiring

All wiring shall be copper, 600 Volt rated, Type: Conform to the applicable UL and ICEA Standards for the use intended. Copper conductors with 600-volt insulation unless otherwise specified or noted on the drawings. Stranded conductors for No. 8 and larger, with the exception of the ground rod conductor shall be #6 AWG solid, bare, copper.

Aluminum Conductors shall be prohibited unless required by Xcel Energy.

Insulation: Type THWN/THHN insulation minimum unless otherwise specified or noted on the drawings.

Size: No. 12 minimum unless otherwise specified or noted on the drawings. Not less than NEC (NESC if Utility owned) requirements for the system to be installed.

Color Coding: Phase, neutral and ground conductors color-coded in accordance with NEC (NESC if Utility owned). Connect all Conductors of the same color to the same phase conductor as follows:

208Y/120V-3PH-4W Color coding shall be:

- 1) Phase = Black
- 2) Phase = Red
- 3) Phase = Blue
- 4) Neutral = White
- 5) Ground = Green

120/240V-1PH-3W Color coding shall be:

- 1) Line 1 = Black
- 2) Line 2 = Red
- 3) Neutral = White
- 4) Ground = Green

Unless otherwise authorized, the multiple system of electrical distribution shall be used. Conductors of the size and material specified shall be installed for control wiring, luminaire wiring, small cell equipment wiring, CCD IOT wiring, main circuit wiring, ground wiring, service entrance wiring, and all other wiring necessary for a complete installation.

Conductors shall be sized to prevent a voltage drop of more than three percent per feeder run. All conductors shall be installed in conduit.

All power and lighting circuits shall include an insulated green grounding conductor.

A complete grounding system shall be installed for the entire small cell installation. Grounding shall consist of ground cables, conduits, grounding rods, wire or strap, and ground fittings, as required by the NEC (or NESC if Utility owned).

Type THWN conductors shall be used for all underground conduit runs. Leave sufficient lengths of branch conductors to allow conductor splices to be extracted from pole base for maintenance. Type XHHW shall be used for the service entrance conductors.

Extend three conductor SOW cable feeder leads to the luminaires from the cables in the pole base.

Install in-the-line fuses on each feeder lead. Leave sufficient lengths of feeder conductors to allow fuses and conductors to be extracted from pole base for maintenance.

Provide a No. 6 AWG solid, bare, copper wire connection to ground rod with ample length to allow connection to small cell standard, and system ground conductor.

Attach grounding conductor to the energy suppliers neutral at the service point. Terminate grounding conductor with less than 25 ohms ground reference at the service point. If ground resistance is greater than

25 ohms, add additional ground rod(s) or other ground reference bond to bring the resistance to under 25 ohms resistance to earth. Provide ground rods elsewhere as shown on the drawings.

Butt splices within the bases are not acceptable.

At each pole, provisions shall be made for convenient sectionalizing of the circuits. This shall be done by providing ample length (18 to 24 inches) of branch conductor ends and performing splices using submersible type (Burndy Uni-tap connectors or an approved equal). Wire nuts are not an acceptable method for splicing. Splicing shall only be performed within the pole bases and splice boxes where applicable.

Separation of service shall be provided within the pole by conduit or dividers. Electrical wiring and fiber shall be separated by Owner within.

Testing (City Owned and/or City Contract Only)

Prior to final acceptance, the Contractor and/or Applicant shall demonstrate to CCD's satisfaction that all electrical and lighting equipment installations are in proper working condition. Temporary power and all cable connections required for testing shall be provided by the Contractor and/or Applicant.

The Contractor and/or Applicant shall perform grounding tests to show ground resistance of 25 ohms or less.

As-built Drawings and O&M Manual (City Owned and/or City Contract Only)

Contractor shall supply accurate as-built drawings of the project to CCD. Drawings shall indicate location and setback of conduit, control center with meter, and utility service point, and pole locations along the roadway measured from a reliable location.

The Contractor shall collect, gather and assemble into one book the installation details, instructions, schematics of actual equipment and operations directions supplied by the manufacturer with all equipment. Final acceptance of the work will be withheld until such data has been presented complete to CCD. The manual shall be available for instruction of operations and maintenance of the equipment and systems.

Method of Measurement (City Owned and/or City Contract Only)

Concrete bases and equipment pads will be measured by the actual number installed and accepted.

Small cell standards will be measured by the number of small cell standards installed and accepted. Measure each type separately as described on the Plans.

Luminaires will be measured by the number of luminaires installed. Measure each type separately as described on the Plans.

Conduit will be measured by the linear foot in place. Measure each type separately.

Wiring will be measured by the linear foot in place. Measure each type separately.

Basis of Payment (City Owned and/or City Contract Only)

The accepted quantities will be paid for at the contract unit price for each of the pay items listed on the plans and as they appear in the bid schedule. All associated work items will be considered incidental.

Table B-1: Example Pay Items and Units

Pay Item	Pay Unit
Small Cell Standard Metal (___ foot)	Each
Luminaire (Type)(LED)(Lumens)	Each
Luminaire (Type)(LED) Special	Each
___ Inch Electrical Conduit	Linear Feet
___ Inch Electrical Conduit (Plastic)	Linear Feet
___ Inch Electrical Conduit (Bored)	Linear Feet
Wiring	Linear Feet
Lighting Control Center	Each
Secondary Service Pedestal	Each
Pull Box	Each
Standard Foundation	Each
Concrete Foundation Pad	Each

When the Contractor and/or Applicant, at his/her option, installs larger conduit than specified, it will be paid for at the original contract price for the size specified.

The following items will not be measured and paid for separately, but shall be included in the work:

- 1) Soil testing for foundations.
- 2) Pull wire, weatherheads, and adaptors and expansion joints for conduit
- 3) Additional pull boxes installed at the Contractor’s and/or Applicant’s option.
- 4) Saw cutting; trenching; excavation; backfill; jacking; drilling pits; underground electrical warning tape; removal and replacement of pavement, sidewalks, gutters, and all other work necessary to complete conduit installation.
- 5) Electrical conductor tagging.
- 6) Testing of the installation, including temporary power and all required cable connections.

END OF SECTION

B.2 Small Cell Materials

General

Materials shall be of a standard line from a name brand manufacturer or as specified in this document. Electrical material shall be listed by the Underwriters' Laboratories, Inc. (UL), and shall conform to the National Electrical Code (NEC) when the streetlights are owned by CCD, or the National Electrical Safety Code (NESC) when the streetlights are owned by the Xcel Energy.

Material shall be the same as, or compatible with, that used and accepted by the agency responsible for maintenance.

CCD may inspect all lighting material and all electrical materials and all other materials and accept or reject them at the project site. Samples may be taken or manufacturer's certifications may be accepted in lieu of samples.

Concrete Bases and Concrete Equipment Pads

Concrete shall be Class B.

Anchor bolts shall be designed as shown in CCD standard detail SS-22. The threaded ends of the anchor bolts, the nuts, and the washers shall be galvanized in accordance with ASTM A193.

Reinforcing steel shall conform to CCD standard detail SS-22.

Small Cell Standards

- a) *General.* All structural components of small cell standard, base, equipment cabinet, couplers, anchor bolts, luminaires, cantenna, and other attachments to be used shall be designed for a minimum of 115 MPH wind velocity, in accordance with AASHTO's *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, TIA-222 rev G and ASC 710 with IBC 2012 (or latest standard). Foundations shall meet ACI 318-14.
- b) *Metal Small Cell Standards.* Metal small cell standards shall be fabricated of steel unless otherwise approved by CCD. Whenever Small Cell Standard Metal is specified, the Contractor and/or Applicant shall furnish internally and externally galvanized steel. The Contractor and/or Applicant may furnish aluminum small cell standards if CCD gives approval. Material type and shape of small standards shall be the same throughout the design district, unless otherwise approved by CCD.

All standards shall have weatherproof cable-entrance grommets located in conformity with the type of mounting used. Metal surfaces shall be free of imperfections marring the appearance and of burrs or sharp edges that might damage the cable.

All metal poles shall be straight and shall be supplied with pole caps when applicable.

All steel poles, equipment cabinets, mast arms, base flanges, and all other steel hardware shall be hot-dip galvanized in accordance with ASTM A 123. Units on which the spelter coating has been damaged shall be repaired as provided in AASHTO M 36, or other approved method.

Base flanges for steel poles shall have continuous welds both inside and outside, unless otherwise permitted. Base flanges inserted into the pole and bonded shall meet the requirements for materials and strength stated herein.

Each metal standard shall be wired with a breakaway fused connector of proper capacity rating. The fused connector shall be located in the equipment cabinet. If the small cell standard has no equipment cabinet, the fused connector shall be located in the pole at the hand hole.

All equipment cabinets or bases shall have vandal resistant, removable access doors.

Hardware used with steel standards shall be either cadmium plated steel, hot dip galvanized steel, or stainless steel.

Conduit

Unless otherwise specified, conduit shall be rigid non-metallic electrical conduit currently recommended and approved by Underwriters' Laboratories, Inc. for the proposed use conforming to ASTM-F 441 schedule 80, or bored HDPE. Fittings shall be the type used outside the conduit and PVC cement welded. Submersible fittings shall connect the conduit in a manner that makes the joints watertight.

All in-grade Pull Boxes shall be polymer concrete, bottomless and 22,000 PSI (minimum) tier 22 rated bolted covers. 13 inches by 24 inches and 18 inches deep manufactured by Quazite; Cat. # PG1324BA18, unless otherwise noted on the plans. Covers shall be Cat. # PG1324HH00 with stainless steel bolts and the splice box label molded into the top.

Wiring

Conductors shall be standard copper with 600-volt insulation, type THWN or XHHW for underground installation in conduit, and for aboveground installation within poles and service cabinets. The size and type shall be as shown on the plans.

Fuses

Each luminaire in the 120-volt system shall be fused with one 6-amp fuse. Fuse connectors shall be installed in the phase wires of their respective circuits at the pull box located adjacent to the small cell standards or in the pole base. The fuses shall be mounted in inline single-pole molded fuse connector/holders. The fuse holders shall be a Duraline-16998, or approved equal. Fuses shall be of the breakaway type. The Contractor shall provide sufficient excess conductor length to allow withdrawal of the connected fuse holder. The grounding wires shall not be fused. Fuses and fuse holders shall be "UL" listed and shall be installed in such a manner that the fuse stays with the load side when holder is separated. In addition, the Contractor shall form loops in the leads on each side of the fuse holders and so position the fuse holders so that they may be easily removed or inserted through the opening at top of pull box.

Secondary Service Pedestals

The service cabinet shall include all equipment necessary to connect to Xcel Energy's point of service.

All-In-One commercial meter/power pedestal and non-metered/power pedestals shall meet or exceed CCD Standards.

END OF SECTION

B.3 Moisture and Density Control

Construction of Moisture and Density Control Areas

Maximum dry density of all soil types encountered or used will be determined in accordance with AASHTO T 99, AASHTO T 180, or a modification thereof.

The amount of water to be used in compacting A-2-6, A-2-7, A-4, and A-6 through A-7 soils shall not deviate from optimum on the dry side by more than two percentage points as determined by AASHTO T 99, T 180, or a modification thereof, as designated in the Contract. A-4 soils which are unstable at the above moisture content shall be compacted at a lower moisture content to the specified density. The amount of water used in compacting all other soils shall be as required to obtain the percent relative compaction required.

Table B-2: Soil Compaction

Soil Classifications (AASHTO M 145)	AASHTO T 99			AASHTO T 180		
	Minimum	Relative	Compaction	Minimum	Relative	Compaction
	(Percentage)			(Percentage)		
A-1	100			95		
A-3	100			95		
A-2-4	100			95		
A-2-5	100			95		
All Others	95			90		

The percent of relative compaction specified shall be equal to or greater than minimum values as shown in the table above for the various classes of soil and type of compaction.

END OF SECTION

B.4 Structural Concrete

Description

This work consists of furnishing and placing portland cement in accordance with these specifications and in conformity with the lines, grades and dimensions as shown on the plans.

Classification

The classes of concrete shown in Table B-3 shall be used when specified in the approved plans.

Table B-3: Concrete Table

Concrete Class	Required Field Compression Strength (psi)	Cementitious Material Content: Minimum or Range (lbs/yrds ³)	Air Content: % Range (Total)	Water/Cementitious Material Ratio: Maximum or Range
B	4500 at 28 Days	N/A	5 – 8	0.45
D	4500 at 28 Days	615 to 660	5 – 8	0.45
H	4500 at 56 Days	580 to 640	5 – 8	0.38 to 0.42
P	4500 at 28 Days	660	4 – 8	0.44

Class B concrete is an air entrained concrete for general use. Class D, H or P concrete may be substituted for Class B concrete. Additional requirements are: The coarse aggregate shall have a nominal maximum size of 1½ inches or smaller.

Sulfate Resistance.

The Contractor shall provide protection against sulfate attack on concrete structures by providing concrete manufactured according to the requirements of Table B-4. The sulfate exposure for all concrete shall be Class 2 unless otherwise specified on the plans. A higher level of requirements may be used for a lower level of exposure.

If the Contractor provides test reports that show another class of exposure exists at a structure location, then CCD may accept a concrete mix for that location that meets the corresponding sulfate protection requirements.

Table B-4: Concrete Sulfate Protection Requirements

Severity of Sulfate Exposure	Water-Soluble Sulfate (SO ₄) in Dry Soil, Percent	Sulfate (SO ₄) in Water, Ppm	Maximum Water to Cementitious Material Ratio	Cementitious Material Requirements
Class 0	0.00 to 0.10	0 to 150	0.45	Class 0
Class 1	0.11 to 0.20	151 to 1500	0.45	Class 1
Class 2	0.21 to 2.00	1501 to 10,000	0.45	Class 2
Class 3	2.01 or greater	10,001 or greater	0.40	Class 3

Cementitious material requirements are as follows:

- a) Class 0 requirements for sulfate resistance shall be one of the following:
 - a. ASTM C 150 Type I, II or V
 - b. ASTM C 595 Type IP, IP(MS) or IP(HS)
 - c. ASTM C 1157 Type GU, MS or HS
 - d. ASTM C 150 Type III cement if it is allowed, as in Class E concrete
- b) Class 1 requirements for sulfate resistance shall be one of the following:
 - a. ASTM C 150 Type II or V; Class C fly ash shall not be substituted for cement
 - b. ASTM C 595 Type IP(MS) or IP(HS); Class C fly ash shall not be substituted for cement.
 - c. ASTM C 1157 Type MS or HS; Class C fly ash shall not be substituted for cement.
 - d. When ASTM C 150 Type III cement is allowed, as in Class E concrete, it shall have no more than 8 percent C3 A. Class C fly ash shall not be substituted for cement
- c) Class 2 requirements for sulfate resistance shall be one of the following:

- a. ASTM C 150 Type V with a minimum of a 20 percent substitution of Class F fly ash by weight
 - b. ASTM C 150 Type II or III with a minimum of a 20 percent substitution of Class F fly ash by weight. The Type II or III cement shall have no more than 0.040 percent expansion at 14 days when tested according ASTM C 452
 - c. ASTM C 1157 Type HS; Class C fly ash shall not be substituted for cement.
 - d. ASTM C 1157 Type MS plus Class F fly ash where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C 1012
 - e. A blend of portland cement meeting ASTM C 150 Type II or III with a minimum of 20 percent Class F fly ash by weight, where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C 1012.
 - f. ASTM C 595 Type IP(HS); Class C fly ash shall not be substituted for cement.
- d) Class 3 requirements for sulfate resistance shall be one of the following:
- a. A blend of portland cement meeting ASTM C 150 Type II, III, or V with a minimum of a 20 percent substitution of Class F fly ash by weight, where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C 1012.
 - b. ASTM C 1157 Type HS having less than 0.10 percent expansion at 18 months when tested according to ASTM C 1012. Class C fly ash shall not be substituted for cement
 - c. ASTM C 1157 Type MS or HS plus Class F fly ash where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C 1012.
 - d. ASTM C 595 Type IP(HS) having less than 0.10 percent expansion at 18 months when tested according to ASTM C 1012. Class C fly ash shall not be substituted for cement.
 - e. When fly ash is used to enhance sulfate resistance, it shall be used in a proportion greater than or equal to the proportion tested in accordance to ASTM C1012, shall be the same source and it shall have a calcium oxide content no more than 2.0 percent greater than the fly ash tested according to ASTM 1012.

Proportioning

The Contractor shall submit a Concrete Mix Design for each class of concrete being placed on the project. Concrete shall not be placed on the project before the Concrete Mix Design Report has been reviewed and approved by CCD. The Concrete Mix Design will be reviewed and approved following the procedures of CP 62. The Concrete Mix Design will not be approved when the laboratory trial mix data are the results from tests performed more than two years in the past or aggregate data are the results from tests performed more than two years in the past. The concrete mix design shall show the weights and sources of all ingredients including cement, pozzolan, aggregates, water, additives and the water to cementitious material ratio (w/cm). When determining the w/cm, the weight of cementitious material (cm) shall be the sum of the weights of the cement, fly ash and silica fume.

The laboratory trial mix data shall include results of the following:

- a) AASHTO T 119 (ASTM C 143) Slump of Hydraulic Cement Concrete.
- b) AASHTO T 121 (ASTM C 138) Weight per Cubic Foot, Yield, and Air Content (Gravimetric) of Concrete.
- c) AASHTO T 152 (ASTM C 231) Air Content of Freshly Mixed Concrete by the Pressure Method
- d) ASTM C 39 Compressive Strength of Cylindrical Concrete Specimens shall be performed with at least two specimens at 7 days and three specimens at 28 days. Three additional specimens tested at 56 days shall be required for Class H concrete.
- e) Class H concrete shall include a measurement of permeability by ASTM C 1202 Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
- f) Class H concrete shall include a measurement of cracking by AASHTO T334 Standard Practice for Estimating the Cracking Tendency of Concrete. The sample shall be cured at a temperature of 65 to 75 °F and relative humidity not exceeding 40 percent.
- g) Class P concrete shall include AASHTO T 97 (ASTM C 78) Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading) performed with at least two specimens at seven days and four specimens at 28 days. The Contractor shall provide maturity meters and all necessary wires and connectors.

The Contractor shall be responsible for the placement and maintenance of the maturity meters and wires. Placement shall be as directed by CCD.

The maximum slump of the delivered concrete shall be the slump of the approved concrete mix design plus 1½ inch. The laboratory trial mix must produce an average compressive strength at least 115 percent of the required field compressive strength.

The laboratory trial mix shall have a relative yield of 0.99 to 1.02. If the produced concrete does not have a relative yield of 0.99 to 1.02 for two consecutive yield determinations, concrete production shall cease and the Contractor shall present a plan to correct the relative yield to CCD.

Aggregate data shall include the results of the following:

- a) AASHTO T 11 (ASTM C 117) Materials Finer Than 75 um (No. 200) Sieve in Mineral Aggregates by Washing.
- b) AASHTO T 19 (ASTM C 29) Unit Weight and Voids in Aggregate.
- c) AASHTO T 21 (ASTM C 40) Organic Impurities in Fine Aggregate for Concrete.
- d) AASHTO T 27 (ASTM C 136) Sieve Analysis of Fine and Coarse Aggregates.
- e) AASHTO T 84 (ASTM C 128) Specific Gravity and Absorption of Fine Aggregate.
- f) AASHTO T 85 (ASTM C 127) Specific Gravity and Absorption of Coarse Aggregate.
- g) AASHTO T 96 (ASTM C 131) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- h) AASHTO T 104 (ASTM C 88) Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
- i) CP 37 Plastic Fines in Graded Aggregates and Soils by use of the Sand Equivalent Test
- j) ASTM C 535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- k) ASTM C1260 Determining the Potential Alkali Reactivity of Aggregates (Accelerated Mortar-Bar Method). When an aggregate source is known to be reactive, ASTM C1567 results may be submitted in lieu of ASTM C1260 results.

Any aggregate tested by ASTM C1260 with an expansion of 0.10 percent or more, or that is known to be reactive, shall not be used unless mitigative measures are included in the mix design.

Test results from ASTM C1293 Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction may be substituted for ASTM C1260 test results. The ASTM C1293 test shall be run on an individual source of aggregate. The ASTM C1293 test shall not use fly ash or slag as part of the cementitious material content. Any aggregate source tested by ASTM C1293 with an expansion greater than or equal to 0.04 percent at one year shall not be used unless mitigative measures are included in the mix design.

Mitigative measures shall be tested using ASTM C1567 and exhibit an expansion less than 0.10 percent by one of the following methods:

- a) Combined Aggregates. The mix design sources of aggregates, cement and mitigative measures shall be tested. The proportions of aggregates, cement and mitigative measures shall be those used in the mix design.
- b) Individual Aggregates. Each source and size of individual aggregates shall be tested. The source of cement and mitigative measures shall be those used in the mix design. The highest level of mitigative measures for any individual aggregate shall be the minimum used in the mix design.

The Concrete Mix Design Report shall include Certified Test Reports showing that the cement, fly ash and silica fume meet the specification requirements and supporting this statement with actual test results. The certification for silica fume shall state the solids content if the silica fume admixture is furnished as slurry.

For all concrete mix designs with ASTM C595 or C1157 cements, the total pozzolan content shall not exceed 30 percent by weight of the cementitious material content.

When the Contractor's use of fly ash results in any delay, necessary changes in admixture quantities or source, or unsatisfactory work, the cost of such delays, changes, or corrective actions shall be borne by the Contractor.

The Contractor shall submit a new Concrete Mix Design Report meeting the above requirements when a change occurs in the source, type, or proportions of cement, fly ash, silica fume or aggregate. When a change occurs in the source of approved admixtures, the Contractor shall submit a letter stamped by the

Concrete Mix Design Engineer approving the changes to the existing mix design. The change will be approved by CCD prior to use.

The use of approved accelerating, retarding or hydration stabilizing admixtures to existing mix designs will be permitted at the discretion of CCD when documentation includes the following:

- a) Manufacturer's recommended dosage of the admixture
- b) A letter stamped by the Concrete Mix Design Engineer approving the changes to the existing mix design.

Unless otherwise permitted by CCD, the product of only one type of hydraulic cement from one source of any one brand shall be used in a concrete mix design.

Review and approval of the Concrete Mix Design by CCD does not constitute acceptance of the concrete. Acceptance will be based solely on the test results of concrete placed on the project.

Batching

Measuring and batching of materials shall be done at a batching plant in accordance with AASHTO M 157.

The Contractor shall furnish a batch ticket (delivery ticket) with each load for all classes of concrete. Concrete delivered without a batch ticket containing complete information as specified shall be rejected. The Contractor shall collect and complete the batch ticket at the placement site and deliver all batch tickets to CCD on a daily basis. CCD shall have access to the batch tickets at any time during the placement. The following information shall be provided on each batch ticket:

- a) Supplier's name and date
- b) Truck number
- c) Project number and location
- d) Concrete class designation and item number
- e) Cubic yards batched
- f) Time batched
- g) Mix design number
- h) Type, brand, and amount of each admixture
- i) Type, brand, and amount of cement and fly ash
- j) Weights of fine and coarse aggregates
- k) Moisture of fine and coarse aggregate
- l) Gallons (Pounds) of batch water (including ice)
- m) Gallons of water added by truck operator plus quantity of concrete in the truck each time water is added
- n) Number of revolutions of drum at mixing speed (for truck mixed concrete)
- o) Discharge time
- p) Location of batch in placement
- q) Water to cementitious material ratio (required for deck concrete only)

The drum on each truck mixer shall be reversed prior to charging to eliminate any wash water remaining in the mixer.

- a) *Portland Cement and Fly Ash.* Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed.

All bulk cement shall be weighed on an approved weighing device. The bulk cement weighing hopper shall be sealed and vented to preclude dusting during operation. The discharge chute shall be so arranged that cement will not lodge in it or leak from it.

Separate storage and handling equipment shall be provided for the fly ash. The fly ash may be weighed in the cement hopper and discharged with the cement.

- b) *Water.* Unless water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the calibration unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank. In lieu of the volume method specified

above, the Contractor will be permitted to use a water metering device that is accurate within the prescribed limits.

- c) *Aggregates.* Aggregates from different sources and of different gradings shall not be stockpiled together.

Aggregate shall be handled from stockpiles or other sources to the batching plant in such manner as to secure a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or non-uniform moisture content, storage or stockpile period in excess of 12 hours may be required.

- d) *Bins and Scales.* The batching plant may include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, hopper, and scale for cement shall be included. A single weighing hopper with an accumulative scale will be permitted, provided a separate scale is used for weighing cement.

Mixing

Concrete may be mixed in stationary mixers, in a central-mix plant, in truck mixers, or in self-contained mobile mixers. Mixing time shall be measured from the time all materials, except water, are in the drum.

Silica fume, when specified, shall be added to the mix during initial batching.

- a) *Mixing General.* The concrete shall be deposited in place within 90 minutes after batching when concrete is delivered in truck mixers or agitating trucks, and within 60 minutes when delivered in non-agitating trucks.
- a. The 90 minute time limit for mixer or agitating trucks may be extended to 120 minutes if:
 - i. No water is added after 90 minutes.
 - ii. The concrete temperature prior to placement is less than 90 °F
 - b. The 90 minute time limit for mixer or agitating trucks may be extended to 180 minutes if:
 - i. No water is added after 90 minutes.
 - ii. The concrete temperature prior to placement is less than 90 °F.
 - iii. The approved concrete mix contains a water reducing and retarding admixture which conforms to AASHTO M 194, Type D.
- b) *Stationary Mixing.* When mixed in a central mixing plant, the mixing time shall be between 50 and 90 seconds. Four seconds shall be added to the specified mixing time if timing starts the instant the skip reaches its maximum raised position. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

The volume of concrete mixed per batch may exceed the mixer's nominal capacity, as shown on the manufacturer's standard rating plate on the mixer, up to 10 per cent provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided spillage of concrete does not occur.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

The timing device on stationary mixers shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal each time the lock is released. In case of failure of the timing device, the Contractor will be permitted to operate while it is being repaired, provided the Contractor furnishes an approved timepiece equipped with minute and second hands. If the

timing device is not placed in good working order within 24 hours, further use of the mixer will be prohibited until repairs are made.

- c) *Truck Mixing.* Truck mixed concrete shall conform with one of the following:
- a. Concrete mixed entirely in a truck mixer equipped with a mechanical counter shall be partially mixed at the plant or in transit for not less than 20 revolutions of the drum at mixing speed. The revolutions of the drum at charging speed shall not be counted as mixing revolutions. The concrete shall be mixed between 50 and 100 revolutions of the mixer drum at mixing speed at the delivery site before discharge of the concrete.
 - b. Concrete partially mixed in a stationary central mixing plant with mixing brought to completion in a truck mixer (known as shrink mixing) shall be mixed for a minimum of 30 seconds in the stationary mixer. Mixing shall be completed in the truck mixer for at least 20 but not more than 100 revolutions of the mixer drum at mixing speed at the delivery site before discharge of the concrete.
 - c. Concrete mixed entirely in a stationary mixer and delivered to the job in a truck mixer shall be remixed for a minimum of 20 revolutions of the mixing drum at mixing speed at the job site prior to discharge.

When water is added at the delivery site to control the consistency of the concrete, the concrete shall be mixed for at least 20 revolutions of the mixer drum at mixing speed for each addition of water before discharge. These revolutions are in addition to the minimum revolutions required for mixing at the delivery site. Water from all sources shall be documented by the ready mix producer on the delivery slip for each load of concrete.

The Contractor shall provide a Concrete Truck Mixer Certification. This certification shall show the various pick-up and throw-over configurations and wear marks so that the wear on the blades can be checked. Blades shall be replaced when any part or section is worn one (1) inch or more below the original height of the manufacturer's design. A copy of the manufacturer's design, showing the dimensions and arrangement of blades, shall be available to CCD at all times.

The Contractor shall furnish a water-measuring device in good working condition, mounted on each transit mix truck, for measuring the water added to the mix after the truck has left the charging plant. Each measuring device shall be equipped with an easy-to-read gauge. Water shall be measured to the accuracy prescribed in AASHTO M 157.

- d) *Self Contained Mobile Mixer.* Proportioning and mixing equipment shall be of the self-contained, mobile, continuous mixing type subject to the following:
- a. The mixer shall be self-propelled and be capable of carrying sufficient unmixed dry, bulk cement, fine aggregate, coarse aggregate, admixtures and water to produce on the site not less than 6 cubic yards of concrete. The mixer shall have one bin for each size aggregate.
 - b. The mixer shall be capable of positive measurement of cement being introduced into the mix. A recording meter visible at all times and equipped with a ticket printout shall indicate the quantity of total concrete mix.
 - c. The mixer shall provide positive control of the flow of water into the mixing chamber. Water flow shall be indicated by flow meter and be readily adjustable to provide for minor variations in the aggregate moisture.
 - d. The mixer shall be capable of being calibrated to automatically proportion and blend all components of indicated composition on a continuous or intermittent basis as required by the finishing operation, and shall discharge mixed material through a conventional chute directly in front of the finishing machine.
 - e. The Contractor shall perform calibration tests according to the equipment manufacturer's recommendations at the beginning of each project, and when there is a change in the mix design proportions or source of materials. CCD may require a calibration test or yield check whenever a change in the characteristics of the mixture is observed. The tolerances in proportioning the various ingredients shall be according to subsection 6.8 of AASHTO M 241.

Air Content Adjustment

When a batch of concrete delivered to the project does not conform to the minimum specified air content, an air entraining admixture conforming to AASHTO M 154 may be added. After the admixture is added, the concrete shall be re-mixed for a minimum of 20 revolutions of the mixer drum at mixing speed. The concrete shall then be re-tested.

Acceptance and Pay Factors (City Owned and/or City Contract Only)

These provisions apply to all concrete. The Contractor shall sample concrete items in accordance with AASHTO T 23 Making and Curing Concrete Test Specimens in the Field. At CCD's discretion, CCD will witness the sampling and take possession of the samples at a mutually agreed upon location.

- a) *Air Content.* The first three batches at the beginning of production shall be tested for air content. When air content is below the specified limit, an air entraining admixture may be added. After the admixture is added, the concrete shall be re-mixed for a minimum of 20 revolutions of the mixer drum at mixing speed and then re-tested.
- b) *Slump.* Slump acceptance, but not rejection, may be visually determined by CCD. During the placement of the concrete, when a batch exceeds the maximum slump specified, the following procedure shall be used to analyze the acceptability of the concrete.
 - a. A batch that exceeds the maximum slump specified by more than 2 inch will be rejected. If the slump is greater than 2 inches lower than the approved concrete mix design, the load may be adjusted by adding a water reducer or by adding water and retested.
- c) *Strength (When Specified).* The concrete will be considered acceptable when the running average of three consecutive strength tests is equal to or greater than the specified strength and no single test falls below the specified strength by more than 500 psi. A test is defined as the average strength of three test cylinders cast in plastic molds from a single sample of concrete and cured under standard laboratory conditions prior to testing. If the compressive strength of any one test cylinder differs from the average by more than 10 percent that compressive strength will be deleted and the average strength will be determined using the compressive strength of the remaining two test cylinders.

For concrete having specified strength of 4500 psi or greater, when the compressive strength test is below the specified strength by more than 500 psi but not more than 1000 psi, the concrete represented will be evaluated by CCD for removal, corrective action, or acceptance. When the compressive strength test is below the specified strength by more than 1000 psi, the concrete represented will be rejected.

If the concrete in the structure is still found to be deficient, resulting time delays will be considered non-excusable for this evaluation.

Unless otherwise stated in the plans or specifications, tolerances for concrete construction and materials shall be in accordance with ACI 117.

END OF SECTION

B.5 Reinforcing Steel

Description

This work consists of furnishing and placing reinforcing steel in accordance with these specifications and in conformity with the plans.

Reinforcing Steel

Reinforcing steel shall conform to the requirements of the following specifications:

Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	ASTM A 615
Axle-steel Deformed and Plain Bars for Concrete Reinforcement	ASTM A 996
Low-Alloy Steel Deformed Bars for Concrete Reinforcement [to be Welded]	ASTM A 706
Fabricated Deformed Steel Bar Mats for Concrete Reinforcement	ASTM A 184

Unless otherwise designated, bars conforming to ASTM A 615 & ASTM A 996 shall be furnished in Grade 60 for # 5 bars and larger and Grade 40 or 60 for bars smaller than # 5.

In ASTM A 184, bar material conforming to ASTM A 616 will not be permitted.

Bar List

Two copies of a list of all reinforcing steel and bending diagrams shall be furnished to CCD at the site of the work at least one week before the placing of reinforcing steel is begun. Such lists will not be reviewed for accuracy. The Contractor shall be responsible for the accuracy of the lists and for furnishing and placing all reinforcing steel in accordance with the details shown on the plans.

Bar lists and bending diagrams which are included on the plans, do not have to be furnished by the Contractor. When bar lists and bending diagrams are included on the plans, they are intended for estimating approximate quantities. The Contractor shall verify the quantity, size and shape of the bar reinforcement against those shown on the plans and make all necessary corrections before ordering.

Protection of Materials

Reinforcing steel shall be protected at all times from damage. When placed in the work, the reinforcing steel shall be free from dirt, loose mill scale, paint, oil, loose rust, or other foreign substance.

Bending

Unless otherwise permitted, all reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent except as shown on plans or permitted. Bars shall not be bent or straightened in a manner that will injure the material. Should CCD approve the application of heat for field bending reinforcing bars, precautions shall be taken to assure that the physical properties of the steel will not be materially altered.

Placing and Fastening

The minimum spacing center to center of parallel bars shall be 2½ times the diameter of the bar. However, the clear distance between the bars shall not be less than 1½ times the maximum size of the coarse aggregate or 1½ inches, whichever is greater.

All reinforcement shall have a clear coverage of 2 inches, except as shown on the plans. Clear coverage shall be measured from the surface of the concrete to the outside of the reinforcement.

The placing, fastening, splicing and supporting of reinforcing steel reinforcement shall be in accordance with the plans and the latest edition of "CRSI Recommended Practice for Placing Reinforcing Bars." In case of discrepancy between the plans and the CRSI publication stated above, the plans shall govern.

END OF SECTION