

# City of Columbus Traffic Signal Design Manual

## Orientation

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DEPARTMENT OF  
PUBLIC SERVICE


# Website

<http://www.columbus.gov/Templates/Detail.aspx?id=68899>

columbus › departments › public service › design and construction › design resources › **traffic signal design manual**



## TRAFFIC SIGNAL DESIGN MANUAL

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### TRAFFIC SIGNAL DESIGN MANUAL

Effective May 1, 2014, the following documents, drawings, and files provide information regarding the design of a traffic signal in the City of Columbus for Capital Improvement Projects (CIP) and Private Development projects. This is a centralized location that keeps consultants, contractors, developers and other agencies up to date on City standards, policies, practices, standard drawings and typical drawings related to traffic signals.

Click [here](#) for orientation information.

#### CONTACT INFORMATION

Questions about the Traffic  
Signal Design Manual?

Email : [Contact Information](#)

[Traffic Signal Design Manual](#)

[Sample Plan Sheets](#)

#### ADDITIONAL RESOURCES

[Sample Mast Arm Fabrication and Orientation Data Chart \(.dwg\)](#)

[Sample Strain Pole Fabrication and Orientation Data Chart \(.dwg\)](#)

[Sample Phasing and Hook-up Charts \(.dwg\)](#)

[Sample Traffic Signal Symbols \(.dwg\)](#)

[Standard Drawings](#)



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# City of Columbus

- Population 797,434
- >1,000 Traffic signals



# Why a design manual?

- Many consultants
- City requires specific items that vary from ODOT
- Reduce the amount of information needed on each plan set



# One step in the overall process

- CMSC 632, 633, 732, 733
- Standard Drawings
- Sample Plan Sheets
- Qualified Products List



# Best practices recommendation

- Uninterruptable power supplies at critical intersection locations
- Mast arm new standards
- Span backplates & tethering



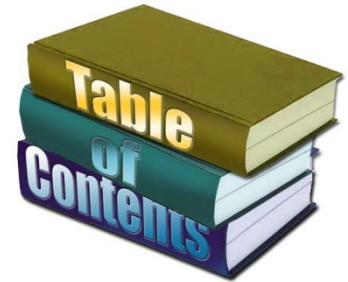




# Recommendations to Streamline Design and Review process

- Develop traffic signal standard drawings
- Formalize pre-design field meetings
- Update detailed check lists for consultant design and City review
- Plans to provide more information in the first submittal
- Reduce the use of “As Per Plan” notes

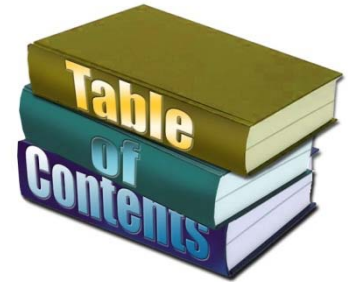
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# 1. General

- Pre-Design Field Meeting Checklist

## Pre-Design Field Meeting Checklist Sheet (1 of 2)

Intersection: \_\_\_\_\_ Date: \_\_\_\_\_  
Consultant: \_\_\_\_\_  
City Representative(s): \_\_\_\_\_

### Controller:

Dual ring: [ yes No ] Master: [ yes no ] Telephone: [ yes no ]  
Type: base \_\_\_\_\_ pole \_\_\_\_\_ Location: [ NE NW SE SW ]  
Side of cabinet Door: [ N S E W NE SE SW NW ]  
Operational phases: [ 2 3 4 5 6 7 8 ] Left turn phases: [ NB SB EB WB ]  
Interconnect type: [ coax twisted fiber wireless future ] other: \_\_\_\_\_  
Cabinet Size: [ K M30 M36 P44 UPS44 ] Other: \_\_\_\_\_

### Pole Configuration:

Mast arm: Standard decorative special color: \_\_\_\_\_  
Span: pole-to-to-pole suspended box combo

### Vehicular heads:

Size: Mainline \_\_\_\_\_ inches Side street \_\_\_\_\_ inches  
Number of heads: NB \_\_\_\_\_ SB \_\_\_\_\_ EB \_\_\_\_\_ WB \_\_\_\_\_

### Pedestrian Signals:

North x-walk \_\_\_\_\_ South x-walk \_\_\_\_\_ East x-walk \_\_\_\_\_ West x-walk \_\_\_\_\_

### Accessible Pedestrian Signals:

North x-walk \_\_\_\_\_ South x-walk \_\_\_\_\_ East x-walk \_\_\_\_\_ West x-walk \_\_\_\_\_

Pushbuttons: NW \_\_\_\_\_ NE \_\_\_\_\_ SW \_\_\_\_\_ SE \_\_\_\_\_

ADA pathways: NEC \_\_\_\_\_ SEC \_\_\_\_\_ NWC \_\_\_\_\_ SWC \_\_\_\_\_

### Pedestal: (height)

NE: N X-walk \_\_\_\_\_ E X-walk \_\_\_\_\_ SE: S X-walk \_\_\_\_\_ E X-walk \_\_\_\_\_  
SW: S X-walk \_\_\_\_\_ W X-walk \_\_\_\_\_ NW: N X-walk \_\_\_\_\_ W X-walk \_\_\_\_\_

### Interconnect Conduit :

Number and Size of conduits: \_\_\_\_\_  
Conduit direction/location: \_\_\_\_\_  
Pull Box size for interconnect system: 27" \_\_\_\_\_ 32" \_\_\_\_\_ 48" \_\_\_\_\_  
Pole attachment agreement: [ yes no ] Company \_\_\_\_\_

# 1. General

- Pre-Design Field Meeting Checklist

## Pre-Design Field Meeting Checklist Sheet (2 of 2)

### Conduit type:

Size (2", 3", 4")	Use	Encased
<input type="checkbox"/> Rigid metal conduit	<input type="checkbox"/>	NO
<input type="checkbox"/> PVC SCH 40	<input type="checkbox"/>	YES OR NO
<input type="checkbox"/> PVC SCH 80	<input type="checkbox"/>	YES OR NO
<input type="checkbox"/> Polyethylene 80	<input type="checkbox"/>	YES OR NO
<input type="checkbox"/> Polyethylene 13.5	<input type="checkbox"/>	YES OR NO
<input type="checkbox"/> Flexible Metal	<input type="checkbox"/>	NO
<input type="checkbox"/> Fiberglass	<input type="checkbox"/>	YES OR NO
Other <input type="checkbox"/>	<input type="checkbox"/>	YES OR NO

### Detector layout:

Speed limit: mainline ☐ side street ☐ Detection Type: [ Video ☐ Loops ☐ Other ☐ ]

Mainline loop locations: far ☐ near ☐ 2<sup>nd</sup> car ☐ / ☐

Side street: Stop line: ☐ ☐ ☐ ☐

Stop line: ☐ ☐ ☐ ☐

2<sup>nd</sup> car: ☐ ☐

### Aerial Utilities:

Overhead electrical clearance conflicts: [ yes ☐ no ☐ maybe ☐ ] corners ☐

Overhead sign on span/mast arm: ☐

Temp pole locations: NE Corner ☐ SE Corner ☐ NW Corner ☐ SW Corner ☐

Work Zone Signal: [ yes ☐ no ☐ ]

### Power source:

Location: ☐ Power company: ☐

Pole/Transformer Tag # X= ☐ Y= ☐

Type: [ Aerial ☐ Pad Mounted ☐ Underground Vault ☐ ]

### Spare equipment to be provided by project:

Controller ☐ Pedestal ☐ Video bracket arm ☐

Video Detector unit ☐ Mastarm Support ☐

Communication Interface Control Unit ☐

Other: ☐

# 1. General

- LG&T (First) Submittal Check List
  - Existing infrastructure
  - Proposed infrastructure

## LG&T Submittal Checklist

Items listed below shall be included or shown on the traffic signal plan for a Line Grade and Typical submittal.

### *Existing infrastructure (minimum items to show):*

- ☐ Underground and overhead utilities
- ☐ Right-of-way and corporation lines
- ☐ Edge of pavement, curb, walk, etc.
- ☐ Curb ramp locations
- ☐ Pavement markings
- ☐ Traffic signal poles and pedestals
- ☐ Traffic signal cabinet
  - If an existing pole mounted cabinet is to be used, check for overhang violations.
- ☐ Traffic pull boxes
  - An existing pull box that will be incorporated in the proposed concrete walk shall be checked to ascertain if it is rated for concrete installation.
- ☐ Pushbuttons and pedestrian signal heads
  - Show each existing pushbutton and each existing pedestrian signal head. Orientate these items correctly on the plans. Check the pushbuttons for proper ADA height and type requirements. Record the height above the ADA pathway and type. Determine if each pushbutton meets current ADA requirements. Mounting heights greater than the City's ADA requirements shall result in the relocation of the pushbutton to the current standard mounting height. Non-ADA type pushbutton shall be replaced with an approved Department ADA pushbutton.
- ☐ Traffic conduit
- ☐ Loop detector
  - Show each loop, its lead-in, and its associated pull box, if any, on all side streets and the main street that are or may be affected by the project. Ascertain whether the loop detector lead-in cable is in a raceway or direct buried. Any direct buried lead-in cable that will be under proposed sidewalk shall be replaced with new cable in conduit. Loops shall be shown to scale. Relocate any existing pull box that lies in a curb ramp, its landing area or its flare area. This may require pull box replacement and a redesign of the loop underground. If loops are not visible in the field, contact the City of Columbus for record plan information.

### *Proposed infrastructure including:*

- ☐ Underground and overhead utilities
- ☐ Right-of-way and corporation lines
- ☐ Edge of pavement, curb, walk, etc.
- ☐ Curb ramp locations
- ☐ Pavement markings
- ☐ Traffic signal poles and pedestals
- ☐ Pull boxes
- ☐ Conduit routings
- ☐ Controller location and orientation
  - Show the proposed pole mounted control cabinet if relocated or the proposed base mounted cabinet and all required installation diagrams and typicals.
- ☐ Vehicular signal head locations and configurations
- ☐ Signal head configuration legend
- ☐ Existing and/or proposed pavement markings
- ☐ Legend
- ☐ Span configuration

# 1. General

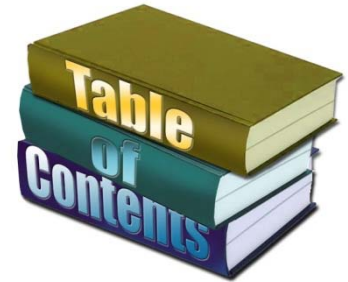
## □ F&OC (Second) Submittal Check List

### F&OC Submittal Checklist

In addition to the items outlined in the LG&T checklist, items listed below shall be included or shown on the signal plan for a Field and Office Check submittal.

- ☐ Traffic signal notes and "As Per Plan" notes.
- ☐ Traffic signal – maintenance of traffic notes
- ☐ Plan sheet notes
  
- ☐ Traffic signal power source
- ☐ Identify the proposed power supplier and source location  
If feasible written documentation from the power company
  
- ☐ Proposed push button and pedestrian signal head locations and orientation  
Show proposed pushbuttons and associated landing areas. Adhere to all Division and ADA guidelines in the plan design as they relate to pushbutton placement and the associated pushbutton landing/ramp area. Clearly show landing areas and all required elevations. All pushbuttons shall be centered over a landing area (explicit or implied by walk design elevations).
- ☐ Detection zones and/or loop locations  
All loops and detection zones shall be drawn to scale.
- ☐ Detailed conduit and wiring callout information
  
- ☐ Timing chart
- ☐ Field wiring hookup chart
- ☐ Wiring diagram
- ☐ Phasing diagram
- ☐ Detection chart
  
- ☐ Signal pole fabrication, orientation and data chart
- ☐ Signal support mounted signs
  
- ☐ Traffic signal interconnect including splicing details and devices
- ☐ Conduit bank details/typicals for encased interconnect
- ☐ Special details
  
- ☐ Traffic signal removal chart
- ☐ Estimate of quantities
- ☐ SWISS calculations for span wire traffic signals
- ☐ Joint use pole attachment agreement and associated permits
- ☐ Traffic signal standard drawing references on the title sheet
  
- ☐ Disposition to LG&T review comments

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## 2. Plan preparation

- Digital standards
  - CAD layering
  - Symbols
- Sample plan sheets
- Plan sheet requirements

**Figure 2.1**  
**Traffic Signal Symbols and Legend**

<b>Signal Heads</b>		<b>Cabinets</b>	
	Existing		Traffic Controller Cabinet w/Pad (Existing)
	Proposed		Traffic Controller Cabinet w/Pad (Proposed)
	Ped Signal		Traffic Controller Cabinet: Pole Mount
<b>Poles</b>			Traffic Controller Cabinet: Ground Mount
	Anchor/Strain Pole (Existing)		Traffic Amplifier Cabinet
	Anchor/Strain Pole (Proposed)		Traffic Camera Cabinet
	Pedestal (Existing)		Traffic Power Supply Cabinet
	Pedestal (Proposed)		UPS Traffic Controller Cabinet w/Pad: Type 1
			UPS Traffic Controller Cabinet w/Pad: Type 2
		<b>Miscellaneous</b>	
			Red Light Camera
			Red Light Camera Flash

Layer Description	Name of Layer	Line weight
Signal Poles - Existing	COC-SGNL-POLE-E	50%
Signal Poles - Proposed	COC-SGNL-POLE-N	70%
Signal Poles - Down Guys - Existing	COC-SGNL-POLE-GUYS-E	50%
Signal Poles - Down Guys - Proposed	COC-SGNL-POLE-GUYS-N	70%
Signal Heads - Existing	COC-SGNL-HEAD-E	50%
Signal Heads - Proposed	COC-SGNL-HEAD-N	70%
Conduit - Existing	COC-SGNL-COND-E	50%
Conduit - Proposed	COC-SGNL-COND-N	100%
Pull boxes - Existing	COC-SGNL-PULL-E	50%
Pull boxes - Proposed	COC-SGNL-PULL-N	70%
Detectors (loop)- Existing	COC-SGNL-DECT-LOOP-E	50%
Detectors (loop)- Proposed	COC-SGNL-DECT-LOOP-N	70%
Detectors (video) - Existing	COC-SGNL-DECT-VDEO-E	50%
Detectors (video) - Proposed	COC-SGNL-DECT-VDEO-N	70%
Detectors (microwave) - Existing	COC-SGNL-DECT-MICR-E	50%
Detectors (microwave) - Proposed	COC-SGNL-DECT-MICR-N	70%
Detectors (RADAR) - Existing	COC-SGNL-DECT-RADR-E	50%
Detectors (RADAR) - Proposed	COC-SGNL-DECT-RADR-N	70%
Pavement markings -Existing	COC-SGNL-MRKG-(TYPE)-E	50%
Pavement markings -Proposed	COC-SGNL-MRKG-(TYPE)-N	70%

- Sample Plan Sheets on City web site.

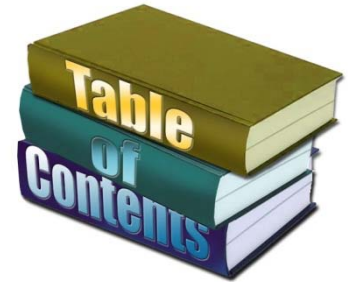
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## 2. Plan preparation

- Quantities
  - Item descriptions

ITEM	UNIT	DESCRIPTION
614	LUMP	MAINTAINING TRAFFIC, AS PER PLAN
614	EACH	SPECIAL - WORK ZONE TRAFFIC SIGNAL
614	EACH	MAINTAINING TRAFFIC, MISC.: TEMPORARY VIDEO DETECTION SYSTEM
625	EACH	GROUND ROD
625	EACH	PULLBOX, 725.06, 12"X18"
625	EACH	PULLBOX, 725.06, 13"X24"
625	EACH	PULLBOX, 725.08, 32"
625	EACH	PULLBOX, 725.08, 48"
625	FT	TRENCH
625	FT	TRENCH, 30" DEEP [for use with 27" Pull box]
625	FT	TRENCH, 36" DEEP [for use with 32" Pull box]
625	FT	TRENCH, 39" DEEP [for use with 48" Pull box]
625	FT	TRENCH IN PAVED AREAS, TYPE A
625	FT	TRENCH IN PAVED AREAS, TYPE B
625	FT	CONDUIT, 2", 725.04,
625	FT	CONDUIT, 3", 725.04,
625	FT	CONDUIT, 1", 725.051
625	FT	CONDUIT, 2", 725.051
625	FT	CONDUIT, 3", 725.051
625	FT	CONDUIT, _____", DRILLED OR DIRECTIONALLY BORED
625	FT	CONDUIT, CONCRETE ENCASED, _____", 725.051
625	FT	NO. 4 AWG 600 VOLT DISTRIBUTION CABLE, AS PER PLAN
625	EACH	BRACKET ARM MISC.: LUMINAIRE BRACKET ARM
625	EACH	BRACKET ARM, 25'
625	EACH	BRACKET ARM, 30'
630	EACH	SIGN HANGER ASSEMBLY, MAST ARM, AS PER PLAN
630	EACH	SIGN SUPPORT ASSEMBLY, POLE MOUNTED, AS PER PLAN
630	EACH	SIGN, FLAT SHEET, AS PER PLAN
630	LUMP	SIGNING, MISC.: TRAFFIC SIGNAL SIGNS

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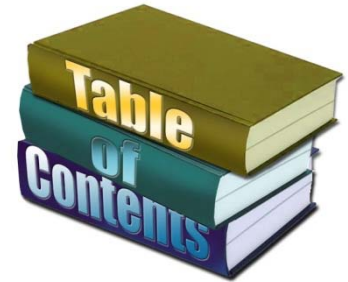
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# 3. Temporary traffic signals

- Items this chapter covers
  - Temporary set-ups to accommodate construction operations at existing signalized intersections.
    - Supports
    - Detection
    - Signal Heads
    - Pedestrian Features
    - Pavement Markings
    - Wiring and Traffic Controller Cabinets



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# 4. Supports and foundations

- Traffic Signal Supports
  - New standard mast arm
    - ODOT Design 4, 12, 13, 14
    - Columbus Design C15 (Max arm length 79')
    - Columbus Double arm C16 (Each max arm length 50')

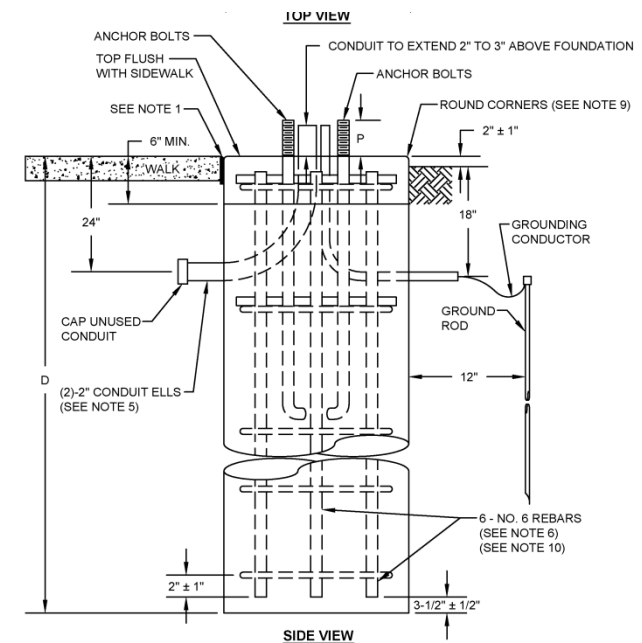
# 4. Supports and foundations

- Traffic Signal Supports
  - New standard mast arm
    - ODOT Design 4, 12, 13, 14
    - Columbus Design C15 (Max arm length 79')
    - Columbus Double arm C16 (Each max arm length 50')
  - New decorative mast arm
    - Equivalent ODOT Design 4, 12, 13, 14
    - Equivalent Columbus Design C15 (Max arm length 79')
    - Equivalent Columbus Double arm C16 (Each max arm length 50')
- Standard Drawings 4120, 4121, 4160, & 4161

# 4. Supports and foundations

## □ Traffic Signal Supports

- Strain poles
    - ODOT standard strain pole designs 5 - 14
    - SWISS
  - Pedestals
    - 5', 10.7', 12.7', 17.5', 21'
  - Foundations
    - Standard
    - In sidewalk area
- 
- Standard Drawings 4100, 4101, 4102, 4103, 4104, 4105, 4160, 4161, 4163, 4170



## 4. Supports and foundations

### ▫ Traffic Signal Support Placement

- Clear zone
- Underground utility clearance
- Overhead clearance
- Pushbutton placement
- Elevation
- Arm length
- Distance from stop line



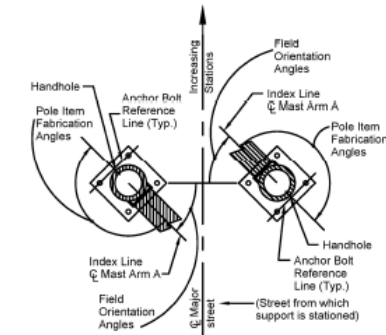
# 4. Supports and foundations

- Plan Requirements
  - Pole identification
  - Pole orientation and fabrication data

INTERSECTION	SHEET NO.	SUPPORT DESIGNATION	POLE COLOR	POLE DESIGN NO.	POLE HT. (FT.)	ARM LENGTH		OBJECT ATTACHMENT HEIGHT			DISTANCE FROM BUTT PLATE (FT.)			POLE FABRICATION DATA-CLOCKWISE FROM MAST ARM A AT 0 DEGREES										FIELD	
						MASTARM (FT.)	VIDEO BRACKET ARM	MASTARM (FT.)	VIDEO BRACKET	VIDEO DETECTOR MOUNTING HEIGHT	L1	L2	S1	VIDEO DETECTOR ANCHOR BOLT REFERENCE LINE	PED. SIGNALS	PED. PUSH BUTTON	VIDEO BRACKET ARM	HANDHOLE	INDEX LINE ANGLE MAST ARM A						
ROAD NAME @ ROAD NAME	#	S/E-1	Black	4	27	32	25	21.5	26	33	12.5	23.5	-	24	90°	264°	255°	0°	180°	0°					
		S/E-2	Black	Pedestal	10.7	-	-	-	-	-	-	-	-	-	90°	344°	-	-	180°	18°					
		S/W-1	Black	4	27	32.5	25	21.5	26	33	14	24	-	24	90°	264°	-	0°	180°	90°					
		S/W-2	Black	Pedestal	10.7	-	-	-	-	-	-	-	-	-	90°	347°	0°	-	180°	106°					
		N/W-1	Black	4	27	32.5	25	21.5	26	33	13	24	-	24	90°	284°	257°	0°	180°	0°					
		N/W-2	Black	Pedestal	10.7	-	-	-	-	-	-	-	-	-	90°	355°	-	-	180°	15°					
		N/E-1	Black	Pedestal	10.7	-	-	-	-	-	-	-	-	-	90°	285°	-	-	180°	75°					
		N/E-2	Black	14	27	50.5	30	21.5	26	33	32	42	37	29	90°	8°	5°	0°	180°	0°					

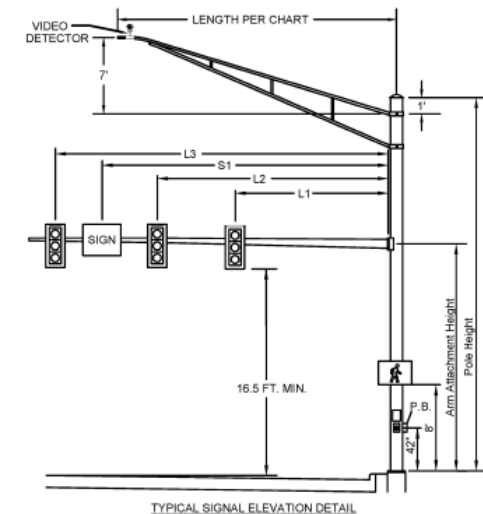
\*The designer may list a "See Sheet #\" in this column containing the sheet # of the detailed elevations on the Intersection Detail and/or Curb Ramp Detail Sheets.

**Figure 4.1**  
**Typical Mast Arm Fabrication and Orientation Data**



All angles measured clockwise.  
Base plate is oriented square to Mast Arm A.  
Mast Arm A is the largest arm if the support has two mast arms.

**TYPICAL SIGNAL SUPPORT ORIENTATION DETAIL**



**TYPICAL SIGNAL ELEVATION DETAIL**

## Slide 25

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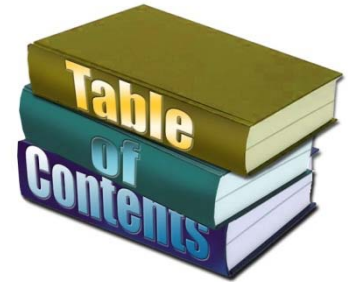
rjb5

Add part of a fabrication and dat chart below.

rjbollo, 2/24/2014



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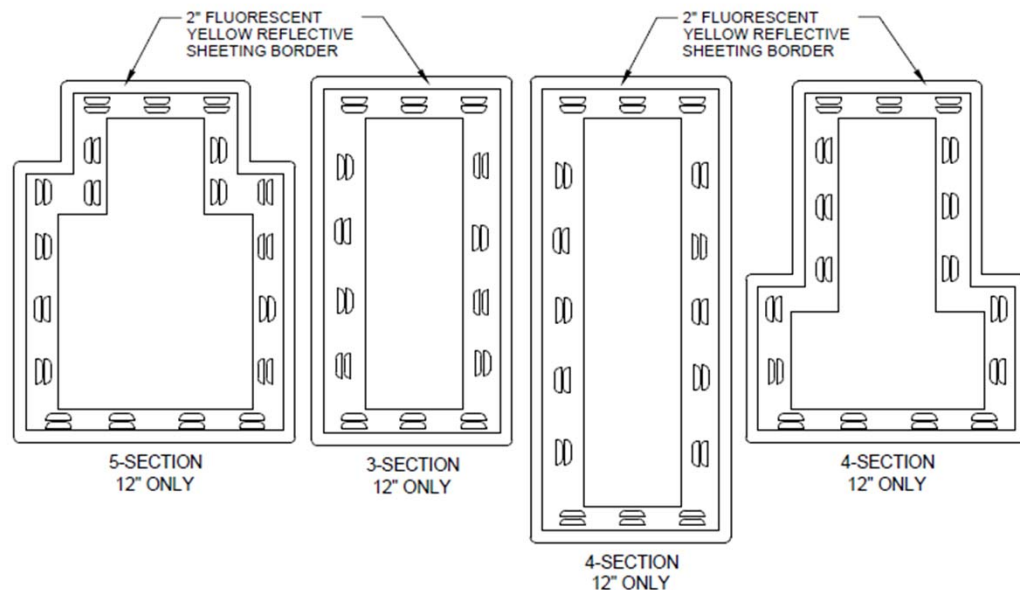


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# 5. Vehicular signals

## ▫ Vehicular Signal head

- Lens size
- Backplates
  - Rigid mount
  - Tethering
- Color



- Standard Drawings 4200, 4201, 4202, 4205

# 5. Vehicular signals

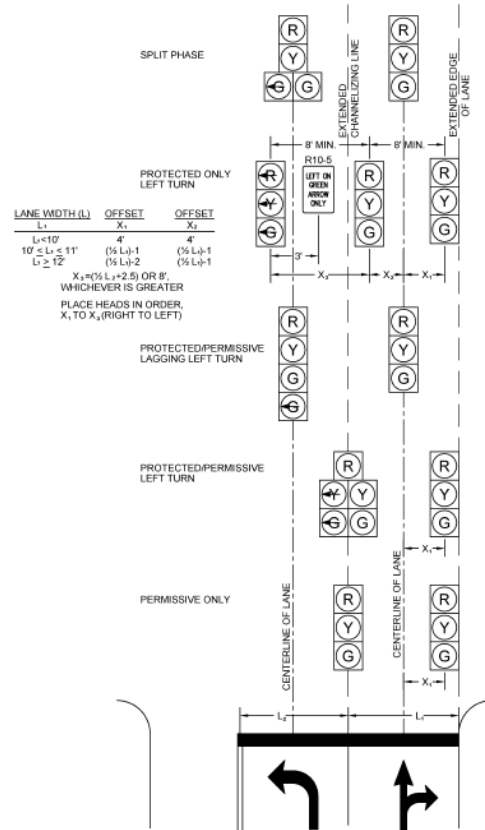
## ▫ Application

- Mounting height
- Through lanes
- Turn lanes

- Sample Figure Configurations 5.2 - 5.31



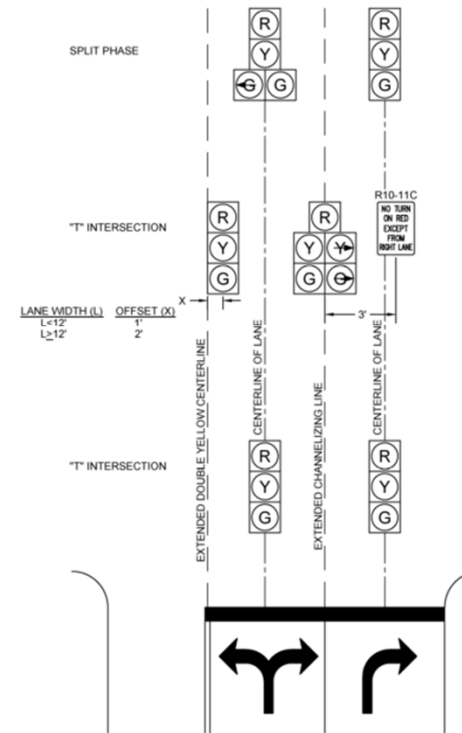
**Figure 5.3**  
**Vehicular Signal Head Alignment**  
**Two Approach Lanes**  
**Configuration A**



Columbus Traffic Signal Design Manual, Version: May 1, 2014

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**Figure 5.10**  
**Vehicular Signal Head Alignment**  
**Two Approach Lanes**  
**Configuration H**



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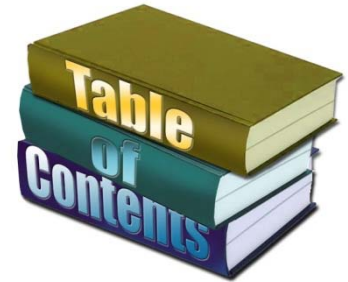
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rjb6

Update with final release ones

rjbollo, 2/24/2014

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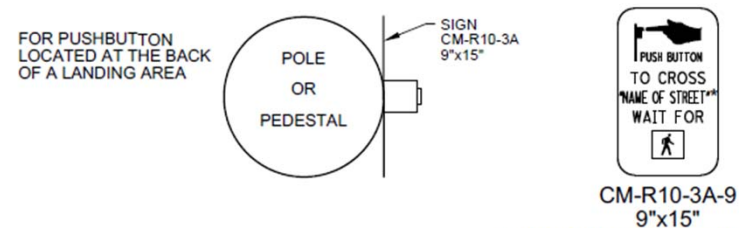
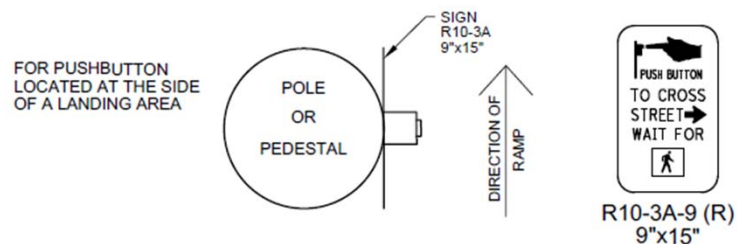
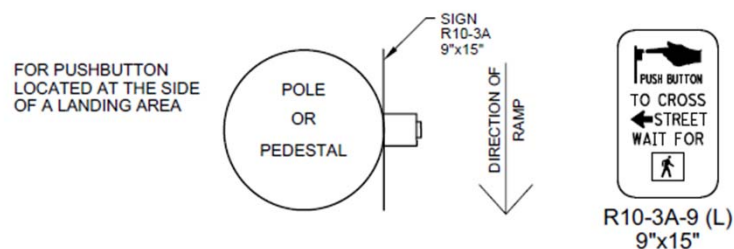
## 6. Pedestrian features

### ▫ Signal Heads

- Countdown heads
  - Symbolic countdown LED
  - Filled hand/filled person

### ▫ Pushbutton

- Affects on signal design
- Signs
- Accessible Pedestrian Signals (APS)
- Standard Drawing 4230



\* Actual Street Name To Be Used

## 6.2 Pedestrian Pushbuttons

Pushbuttons and pushbutton signs shall be used anytime a pedestrian is allowed to cross at a signalized intersection and the signal phase associated with that crossing is actuated. Pedestrian pushbutton activation shall call the associated signal phase and provide adequate crossing time as outlined in **Section 15.1.4**.

One pedestrian pushbutton sign shall be supplied with each pushbutton. The bottom of the sign shall be mounted just above the top of the pushbutton. Signs shall be as illustrated in **Figure 6.3** and detailed on [City of Columbus Standard Construction Drawing 4109](#). For

pushbuttons located at the side of the landing area, sign R10-3a shall be used. If the pushbutton is located at the back of the landing area, sign CM-R10-3a shall be used.

Pedestrian pushbuttons use and placement shall be in conformance with the requirements of the referenced City of Columbus documents listed in **Section 6.2.1**, and **6.2.2**.

### 6.2.1 Pushbutton Specifications

Pedestrian pushbuttons shall be in accordance with 632 and 732 of the current version of the [City of Columbus Construction and Material Specifications](#).

Materials shall also be in accordance with the City of Columbus [Quality Products List](#).

### 6.2.2 Pushbutton Location/Mounting

The mounting height and location of pedestrian pushbuttons shall be in accordance with the [City of Columbus Construction and Material Specifications](#), Section 632.09 and with the [Rules and Regulations, Wheelchair Ramp Requirements](#) as published by the City of Columbus.

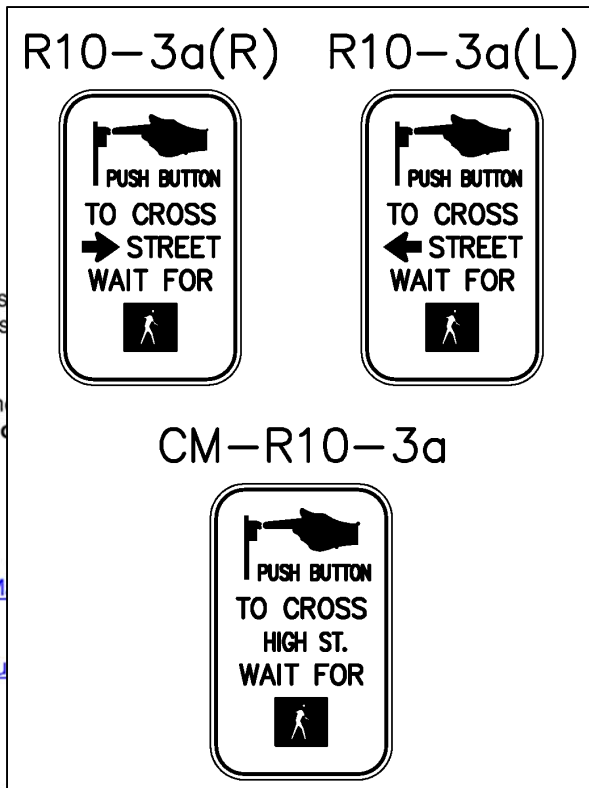
If a traffic signal support pole cannot be located in an acceptable location, as defined in the [Rules and Regulations, Wheelchair Ramp Requirements](#) document, a pedestrian pedestal (see **Section 4.1.5**) shall be used to position the pedestrian pushbutton in a conforming location.

**Figure 6.3**  
**Pushbutton Signs**

R10-3a(R) R10-3a(L)



CM-R10-3a



## Slide 32

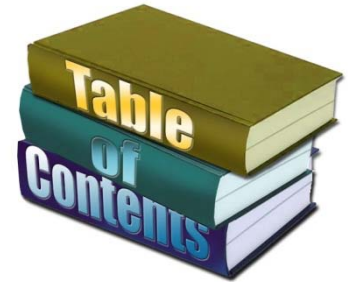
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rjb7

Update sheet with the three signs.

rjbollo, 2/24/2014

# Table of contents

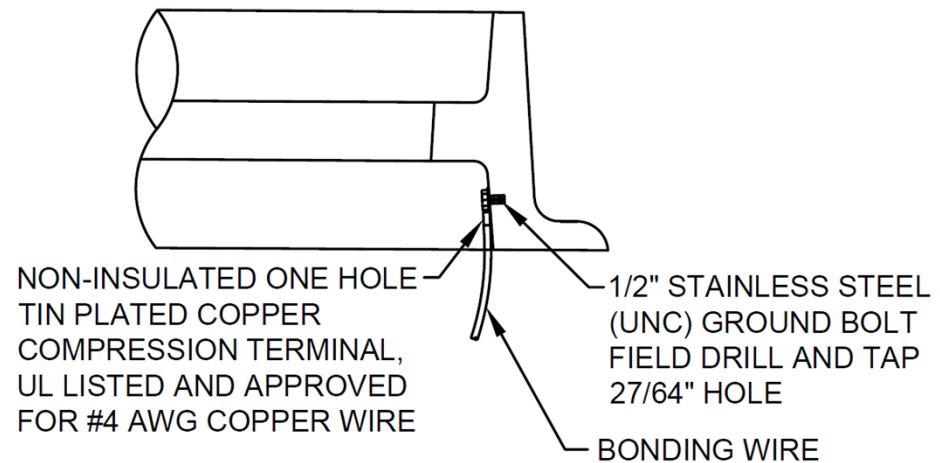


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16. Special conditions

rjbJS1

## 7. Intersection wiring

- **Grounding and Bonding**
  - Follow ODOT requirements
    - Exceptions: pull boxes, wire color, etc.
    - Plan note is required



**GROUND BOLT INSTALLATION DETAIL**

## Slide 34

---

**rjb9**

Jason, what exactly are the differences?

rjbollo, 2/25/2014

**JS1**

The main item to note here that the grounding and bonding process uses the same principals as ODOT, but there are differences as listed below:

COC uses two yellow tracers

Does not bond loop pull boxes

Requires wiring diagram

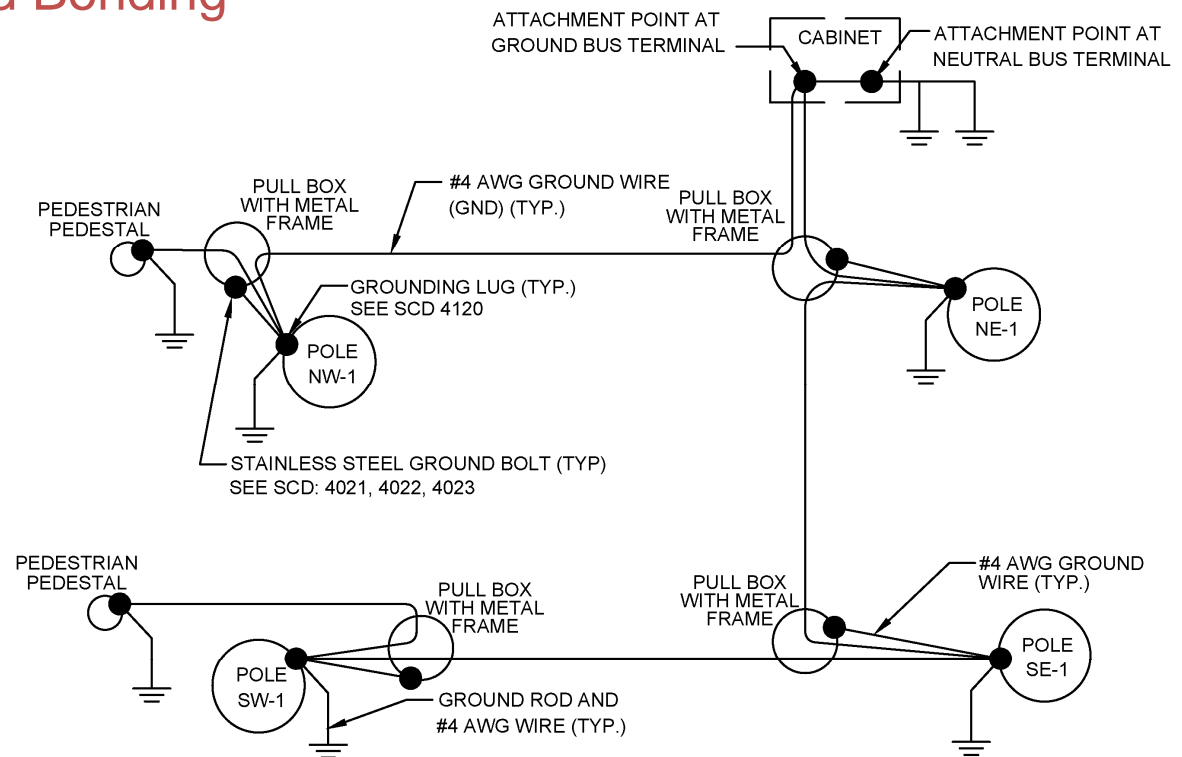
No splices in pull boxes

COC Requires a pay item

Smallwood, Jason, 3/19/2014

# 7. Intersection wiring

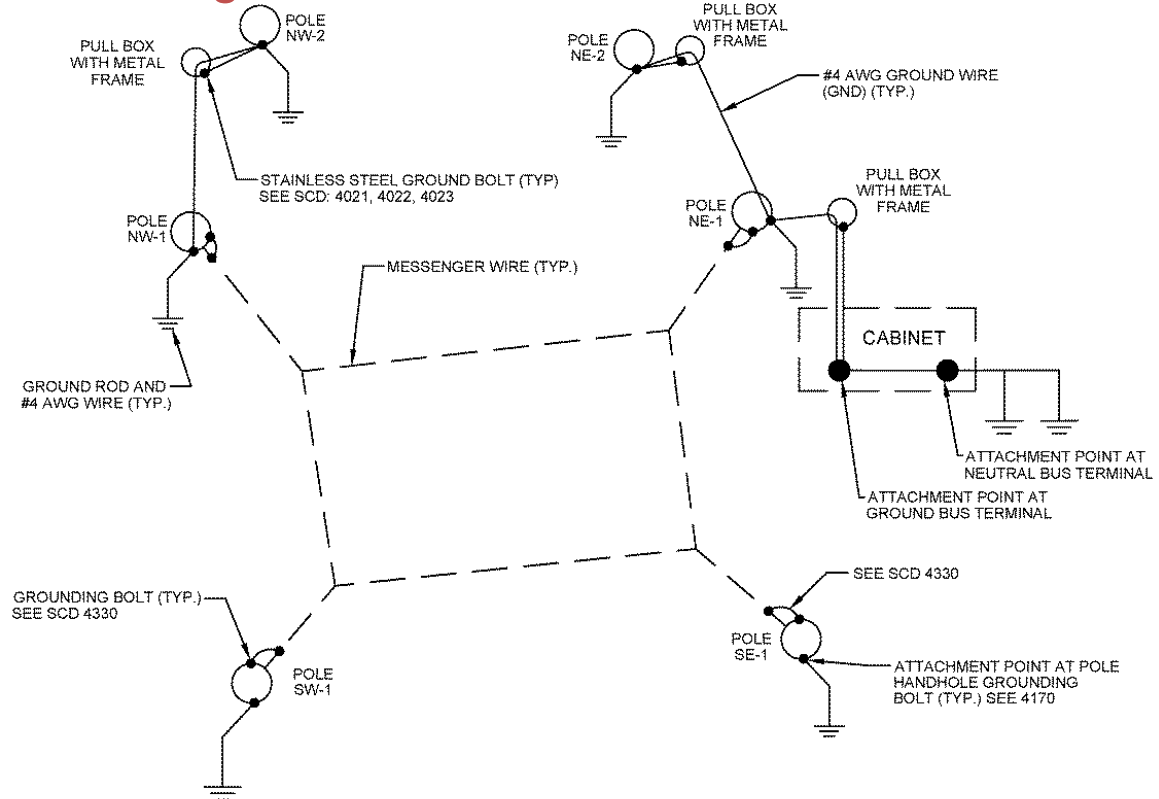
## Grounding and Bonding





# 7. Intersection wiring

## ▫ Grounding and Bonding



# 7. Intersection wiring

- Color and gauge of conductors
- Vehicular and pedestrian wiring

**Table 7.2**  
**Pedestrian Signal Head - Field Wiring Color Codes**

Pedestrian Unit Location	Crosswalk Display	Wire Color
South Crosswalk	Walk	Black
	Don't Walk	Orange
West Crosswalk	Walk	Green
	Don't Walk	Red
North Crosswalk	Walk	Blue
	Don't Walk	White w/Black Tracer
East Crosswalk	Walk	Green w/Black Tracer
	Don't Walk	Red w/Black Tracer
Neutral	---	White

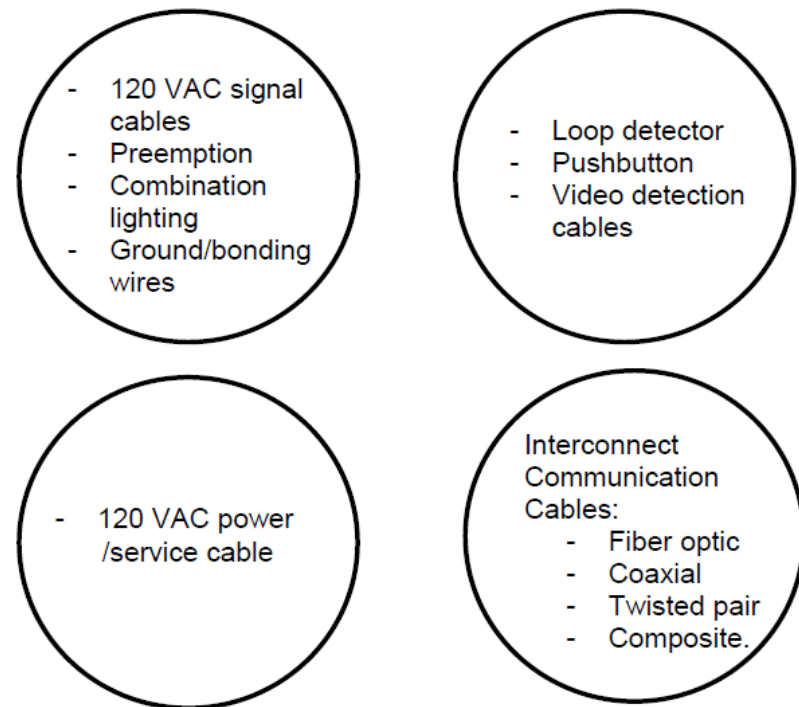
**Table 7.3**  
**Vehicular Signal Head - Field Wiring Color Codes**

Signal Display	Wire Color Per Approach
Thru R	Red
Thru Y	Orange
Thru G	Green
L/T ←R→	Black
L/T ←Y→	White w/Black Tracer
L/T ←G→	Blue
R/T →R←	Orange w/Black Tracer
R/T →Y←	Red w/Black Tracer
R/T →G←	Green w/Black Tracer
Neutral	White

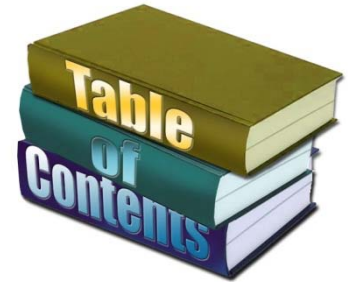
# 7. Intersection wiring

- Underground wiring
- Combination poles
- Overhead utility clearance requirements
- Intersection wiring diagrams

**Figure 7.5**  
**Cable Grouping In Conduit**



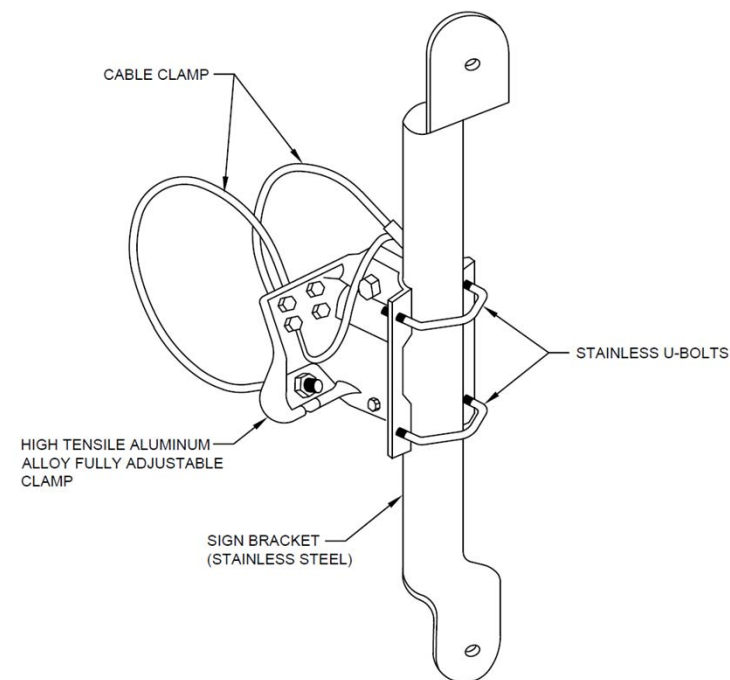
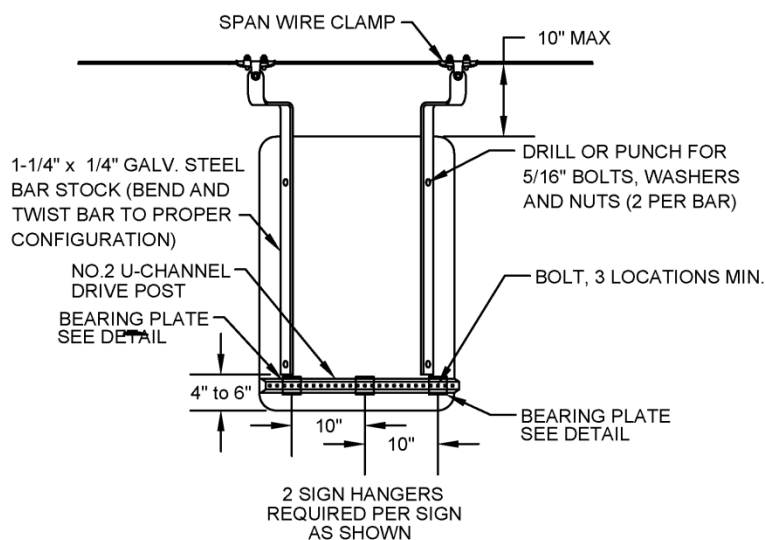
# Table of contents fix me to chapt



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## 8. Traffic signal signs

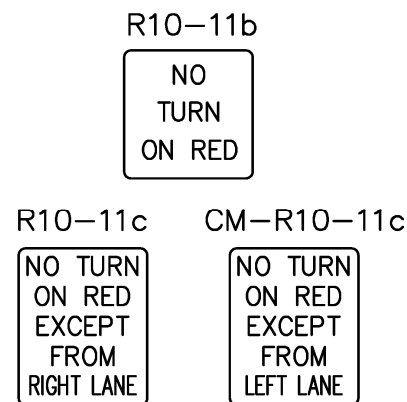
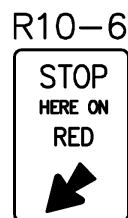
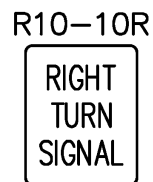
- Mounting to the mast arm and span



- Standard Drawings 4250, 4251, & 4252

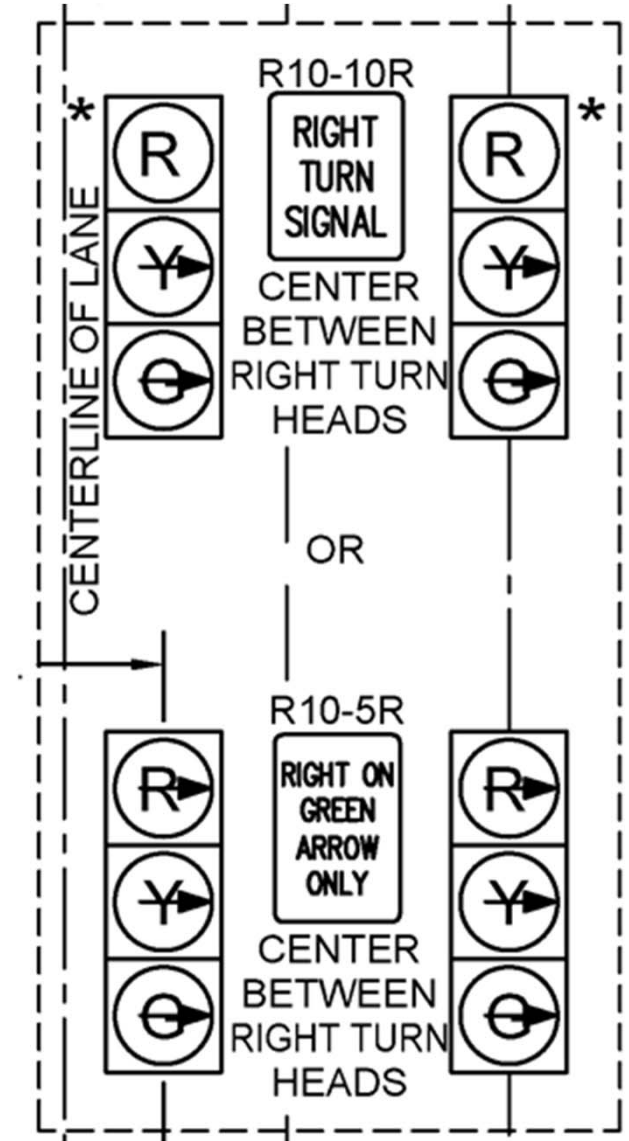
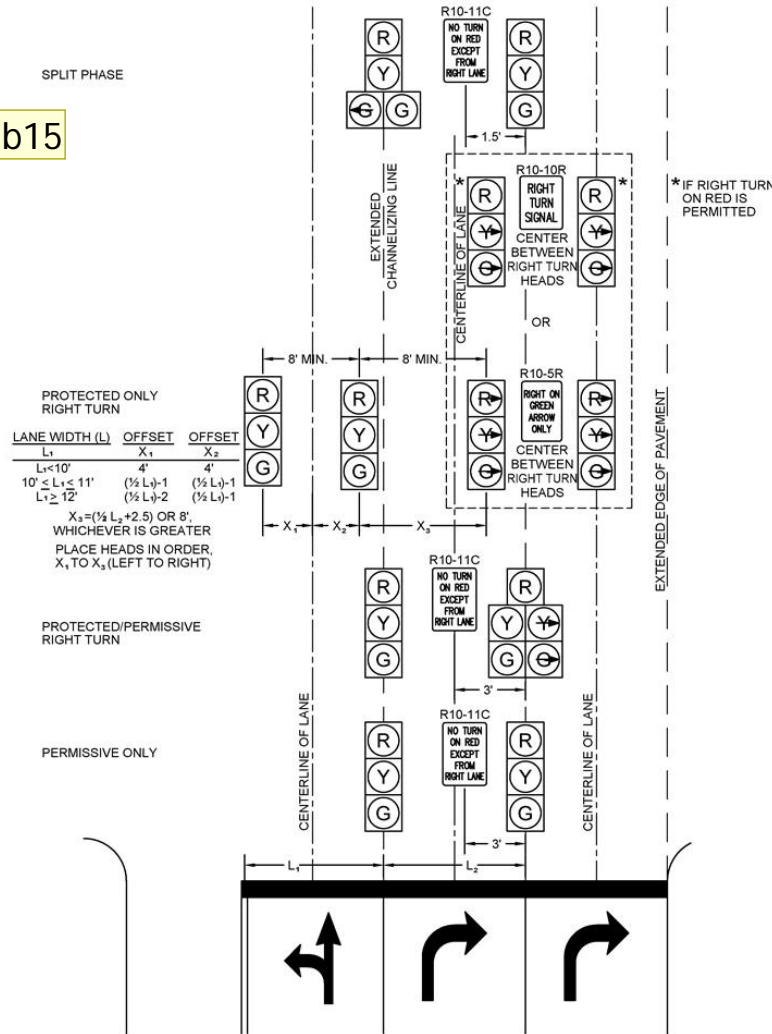
## 8. Traffic signal signs

- **Columbus Modified**
  - CM-R10-11C (No Turn on Red Except from Left Lane)
- **OMUTCD in Columbus**
  - R10-6 (Stop Here on Red)
  - R10-5L & R10-5R (Left/Right on Green Arrow Only)
  - R10-10R (Right Turn Signal)
  - R10-22 (Bicycle Actuation)



rjb15

SPLIT PHASE





## Slide 42

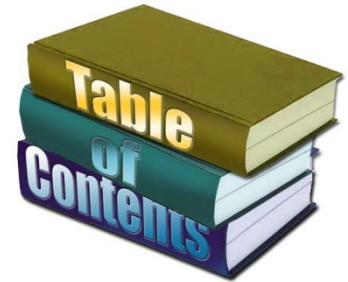
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**rjb15**

Create slide that shows figure 5.17 with the dashed area for the two types of signs with the right turn red arrows and circular red lenses.

rjbollo, 2/24/2014

# Create table of contents

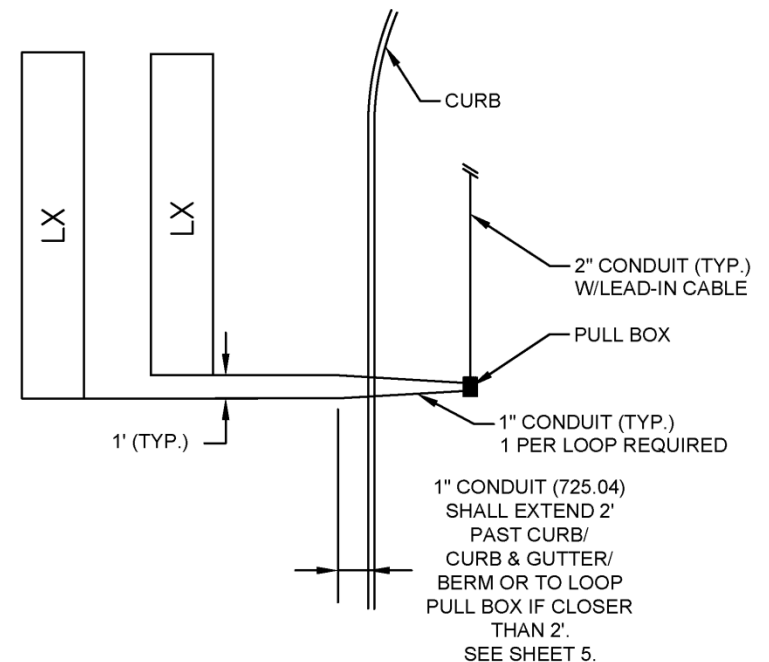


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# 9. Vehicle detection

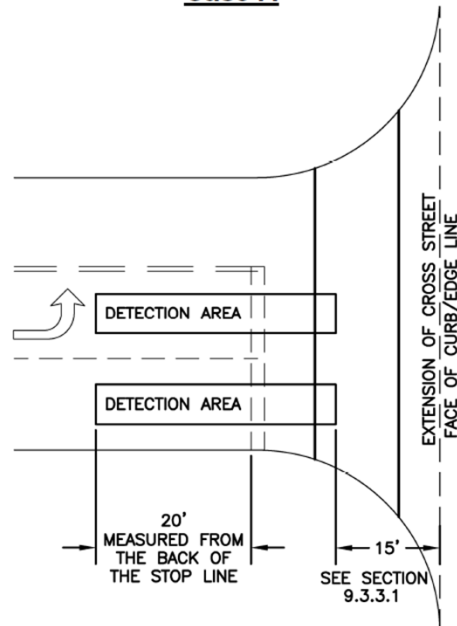
- Detection types
  - Video detection
  - Inductive loop detection
  - Other detection technologies
- Guidance on loops and zones sizes
- Side street detection
- Left turn detection
  - Major street
  - Side street



# 9. Vehicle detection<sup>rjb14</sup>

- Detection placements
  - Figures 9.1 through 9.6

**FIGURE 9.1**  
**Side Street Detection**  
**Case A**

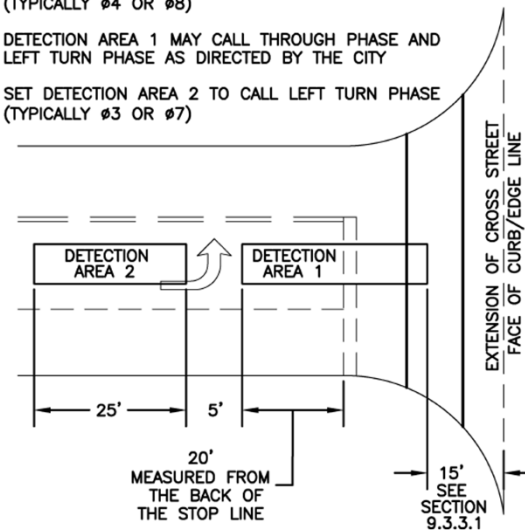


**Figure 9.4**  
**Side Street Left Turn Detection For Protected / Permissive Left-Turn**

SET DETECTION AREA 1 TO CALL THROUGH PHASE  
(TYPICALLY  $\phi 4$  OR  $\phi 8$ )

DETECTION AREA 1 MAY CALL THROUGH PHASE AND  
LEFT TURN PHASE AS DIRECTED BY THE CITY

SET DETECTION AREA 2 TO CALL LEFT TURN PHASE  
(TYPICALLY  $\phi 3$  OR  $\phi 7$ )



## Slide 45

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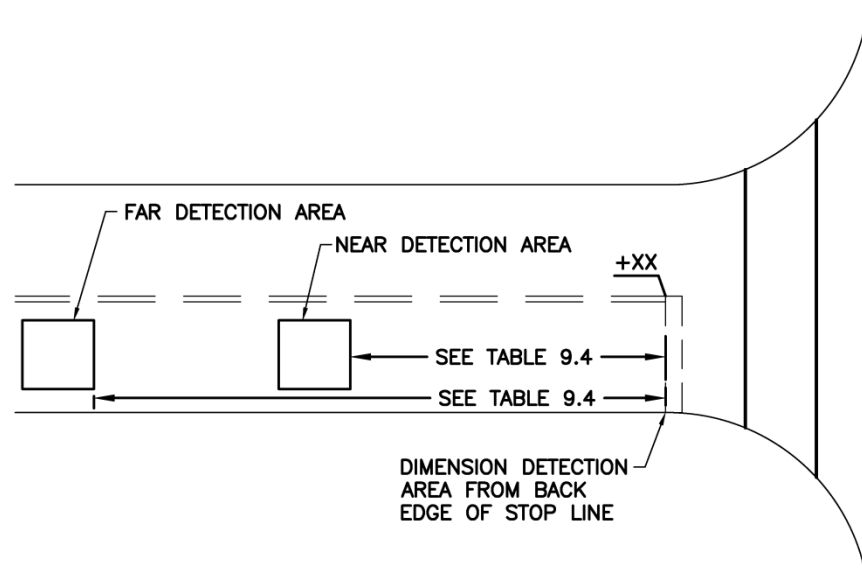
**rjb14**

Add individual slides of figures 9.1 - 9.5 on new slides.

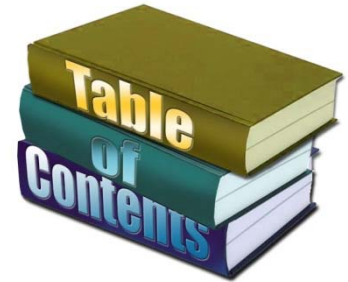
rjbollo, 2/24/2014

# 9. Vehicle detection

- Advanced detection
- Dilemma zone
- Bicycle detection
- Detection chart
  - Detection and identification numbers are assigned based on signal phase
    - Loop number is with the phase (L2a, L2b)
    - Zone number is with the phase (Z4a, Z4b)



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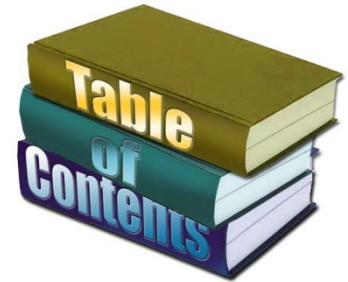
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# 10. Power service

- Power source verification requirements
  - Confirmation from power company
- Overhead power
  - Ground mounted traffic signal cabinet
  - Pole mounted traffic signal cabinet
- Underground power
- Voltage drop calculations

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# 11. Controller / cabinet

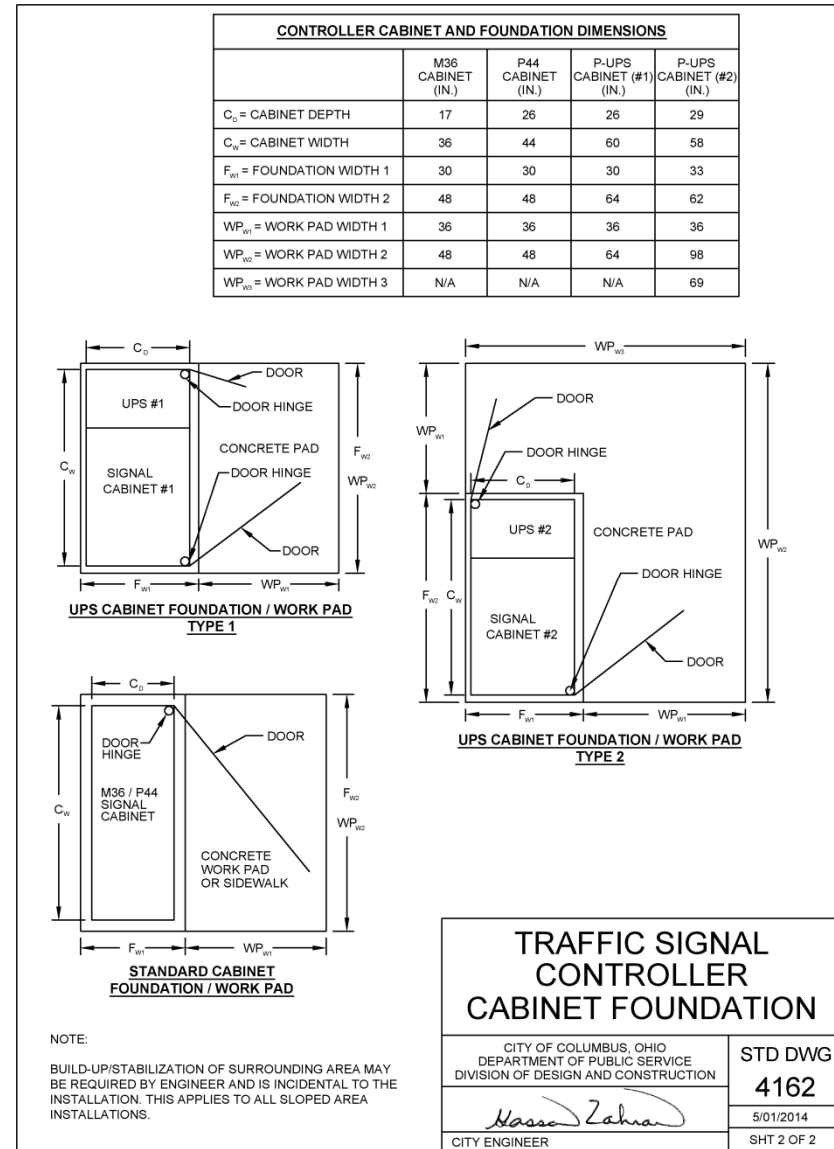
- Cabinets are NEMA TS1
  - 4 or 8 phase
  - “P44” are the standard and “M36” are allowed
- Traffic signal cabinet placement guidelines
  - Safe for maintenance in the City ROW
  - Most protection from errant vehicles
  - Door may fully open for maintenance and equipment
  - Maintenance may view intersection from cabinet with the door open
  - Power service path to the traffic control cabinet
  - Interconnect path to the cabinet

# 11. Controller / cabinet

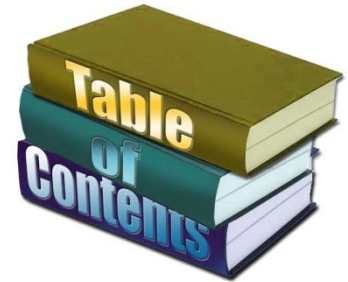
## UPS

- Foundation work pad
  - Sized to accommodate both the main controller cabinet door and auxiliary door

- Standard Drawing 4162



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# 12. Interconnect

## ▫ Systems

- Broadband RF system
- Closed loop system
- Ethernet system



# 12. Interconnect

## ▫ Broadband RF system

- Overview
- Symbols
- Cables
- Passive devices
  - Splitters
  - Couplers
- Active devices
  - Amplifiers
  - Power supplies
  - Pilot generators
- Sample design

**Table 12.1**  
**Coaxial Cable Types by Application**

Cable Type		Size	Flooded	Tracer	dB Loss per 100 ft. @ 300MHz	DC Loop Resistance per 100 ft.
Aerial	Trunk	.750"	N	N	0.90	0.76Ω
	Feeder	.500"	N	N	1.31	1.72Ω
	Drop	RG-6	N	N	3.55	n/a
Underground	Trunk	.500"	Y	Y	1.31	1.72Ω
	Feeder	.500"	Y	Y	1.31	1.72Ω
	Drop	RG-6	N	N	3.55	n/a
	Drop (use as directed)	RG-11	Y	N	2.25	n/a

**Table 12.2**  
**Trunk Coaxial Cable Tracer Colors**

Trunk	Tracer Color
W. Broad St	Purple
Livingston Ave.	Red
Main St.	Orange
High St.	Yellow
Cleveland Ave.	Green
CBD	Blue
Underground Feeder	White



## Symbol Legend

----- .750" Coaxial Trunk

----- .500" Coaxial Feeder

----- RG-6 Drop Cable

----- Feeder to Drop Cable Splice

PS  
P-x  
60VDC Power Supply –  
x = ID

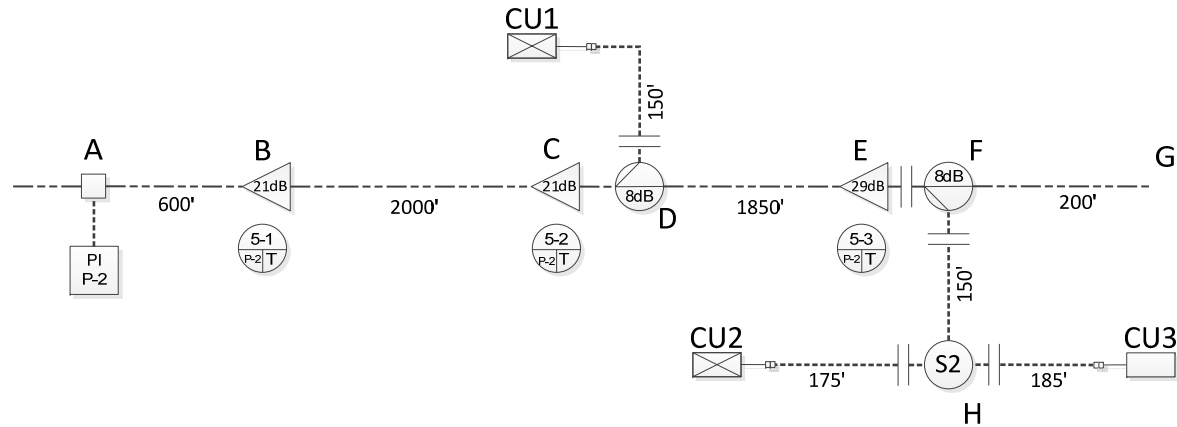
Signal Controller

RF Amplifier –  
x = signal gain (dB)

RF Amplifier Information Tag -  
x=ID, y=Power Supply ID, z=Power  
Blocking: Input/Output/Through

Directional Coupler  
x = signal loss on Tap

Power Blocking

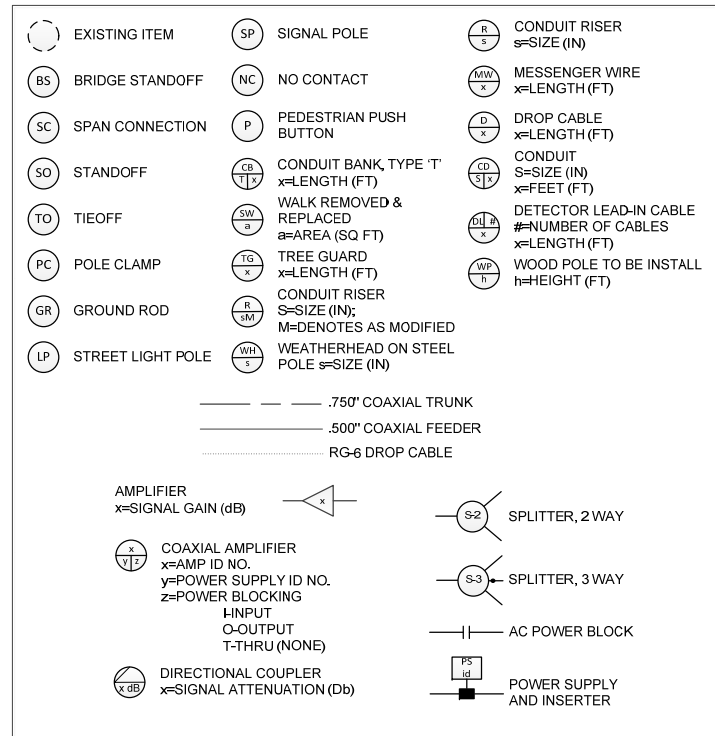


## Typical RF Cable/Equipment Performance

Cable	dB Loss/100ft	Voltage Drop/100ft
0.750 Coaxial Trunk	-0.85	-0.076
0.500 Coaxial Drop	-1.31	-0.172
RG-6 Coaxial Drop	-3.55	n/a
RG-11 Coaxial Drop	-3.65	n/a

Couplers & Splitters	dB Loss	
	Thru	Tap
8dB Directional Coupler	-1.6	-8.5
12dB Directional Coupler	-1.3	-12
16dB Directional Coupler	-0.9	-16
2-Way Splitter	-3.9	-3.9
3-Way Splitter	-6.3	n/a
3-way Splitter (unbalanced)	-4.1 / -7.7	n/a
Power Inserter	-0.5	n/a

Amplifiers	dB Gain	Min. Operating Voltage
21dB Amplifier	18	+42VDC
29dB Amplifier	24	+42VDC
Pilot Generator	n/a	+48VDC



## Slide 55

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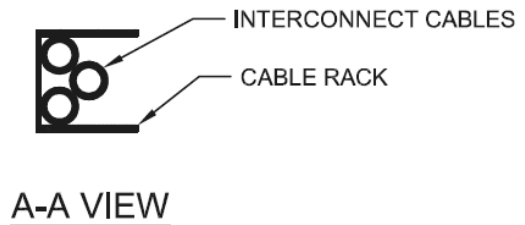
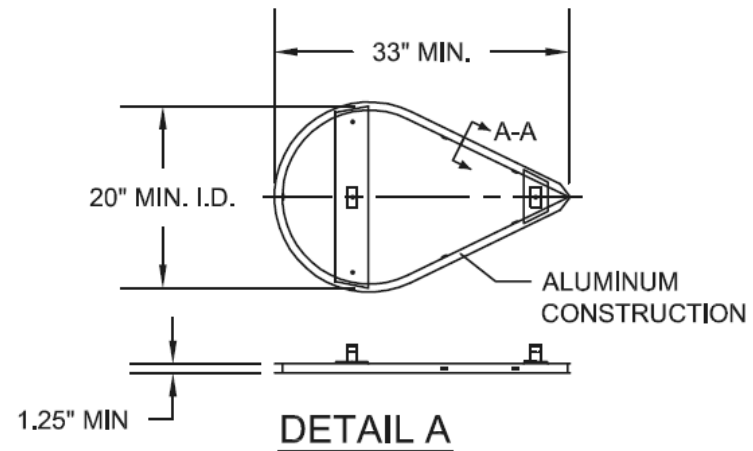
**rjb17**

Insert coax sample from chapter 12 from M Graf.

rjbollo, 2/24/2014

# 12. Interconnect

- Ethernet system
  - Cable
  - Slack storage
  - Splicing
  - Connectivity with device
  - Network Design
    - Channels and patching
  - Communication nodes
  - Typical splicing details





## Slide 57

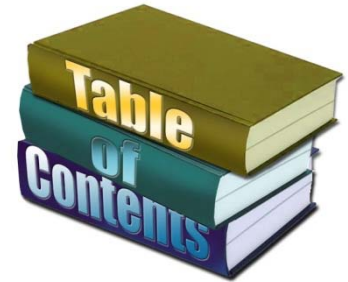
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**rjb16**

Insert splicing detail from M. Graf.

rjbollo, 2/24/2014

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# 13. Underground facilities

## ▫ Conduit Types

- PVC
  - Schedule 40 (725.051) /EPC-40-PVC
  - Schedule 80 (725.051) /EPC-80-PVC
- HDPE
  - Schedule 80 (725.052) / EPEC-80-HDPE
- Multi-cell
  - Schedule 40, 80 (725.20)
- Rigid steel
  - 725.04
- Fiberglas
- Flexible metal

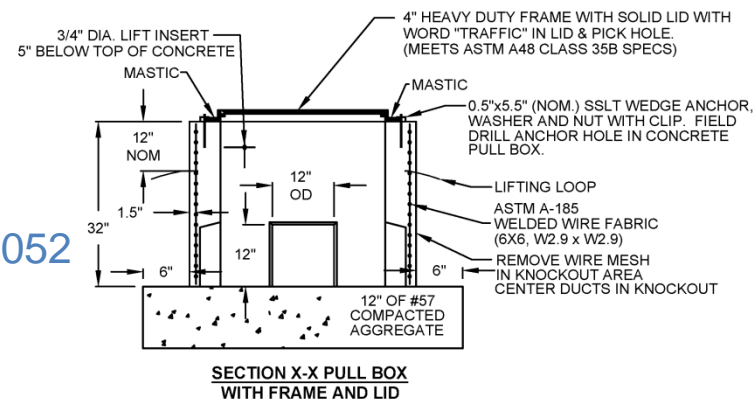
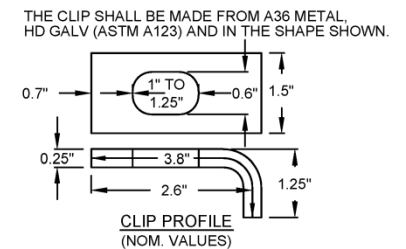
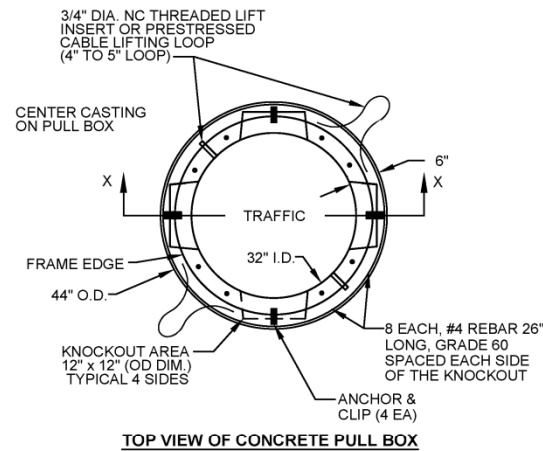


# 13. Underground facilities

- Encasement
- Risers
- Pull boxes

- 27" round
- 32" round
- 48" round
- 12" x 18" non-metallic
- 13" x 24" non-metallic

- Standard Drawings 4020, 4021, 4022, 4023, 4024, 4050, 4051, 4052



# 13. Underground facilities

- Minimum number of conduits

**Table 13.4**  
**Minimum Number of Conduits**

	Minimum No. of Conduits	Size of Conduit in.	Encasement Required
Signal cables - street crossing	2	2	Yes
Signal controller to primary pull box	2	3	No
	2	2	No
Power service	1	2	Yes***
Entry to traffic signal pedestal	2	2	No
Entry to traffic signal pole	2	2	No
Interconnect duct bank (in City ROW)	4	3	Yes
	1	1.5*	
Fiber optic interconnect duct (in LA-ROW**)	1	4 (multicell)	No
	1	4	
	1	1.5*	

\* - Tracer wire conduit

\*\* - EPC-80-PVC or EPEC-80-HDPE

\*\*\* - EPC-80-PVC or EPEC-80-HDPE, non-encased conduit may only be substituted with prior approval from the City Engineer or appointed designee.

## Slide 61

---

rjb18

Insert table 13.4

rjbollo, 2/24/2014

# 13. Underground facilities

- **Plan callout requirements**

- List each conduit and list wires to be placed in that conduit
- List installation method, trench, encased, Directional bored, etc.

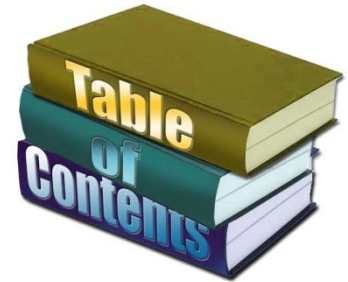
- **Example 1**

- (1)-2" Conduit w/ (1)-9/C, (5)-7/C, (2)-3/C & (1)-GND
- (1)-2" Conduit w/ (8)-2/C
- (1)-3" Conduit w/ (1)-Interconnect Cable
- Encased In Trench = XX'

- **Example 2**

- (1)-2" Conduit w/ (1)-9/C, (2)-7/C, (2)-Lighting, & (1)-GND
- (1)-2" Conduit w/ (4)-2/C & (2)-Video Detection Cables
- In Trench = XX'

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# 14. Removal and reuse of traffic signal installations

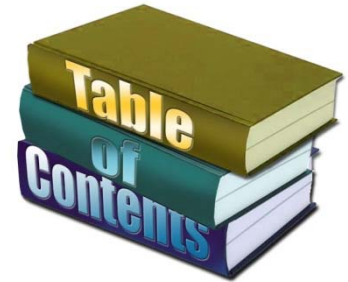
## ▫ Removal of traffic signal.

- Temporary removal
- Removal for replacement
- Permanent removal
  - Removal chart and notes

**Table 14.1**  
**Example Traffic Signal Removal Chart**

Quantity	Removed Item Description	Delivered To 1820 E. 17th Ave.	Disposed of By Project
1	Pole Mounted Cabinet	X	
Lump	Signal Cable and Messenger Wire		X
8	Vehicular Signal Head	X	
4	Pedestrian Pushbutton and Signs	X	
8	Pedestrian Signal Head	X	
2	Audible Pedestrian Unit	X	
2	Anchor Base Pole	X	
2	Embedded Pole		X
2	Pedestrian Pedestal	X	
4	Pull Box (poly-concrete)		X
4	Pull box (concrete; i.e. 27" or 32")	X	
3	Span Mounted Sign	X	
4	Street Name Sign	X	
5	Controller/Pole Foundation		X

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# 15. Timing / phasing

- Yellow Clearance Interval
- Red Clearance Interval

## Equation 15.1 (Yellow Clearance Interval)

$$Y = t + \frac{V}{2a + 64.4g}$$

## Equation 15.2 (Red Clearance Interval)

$$R = \frac{W + L}{V}$$



# 15. Timing / phasing

## □ Timing Chart

- Columbus preference:
  - Min green
  - Max green
  - Passage and extension time

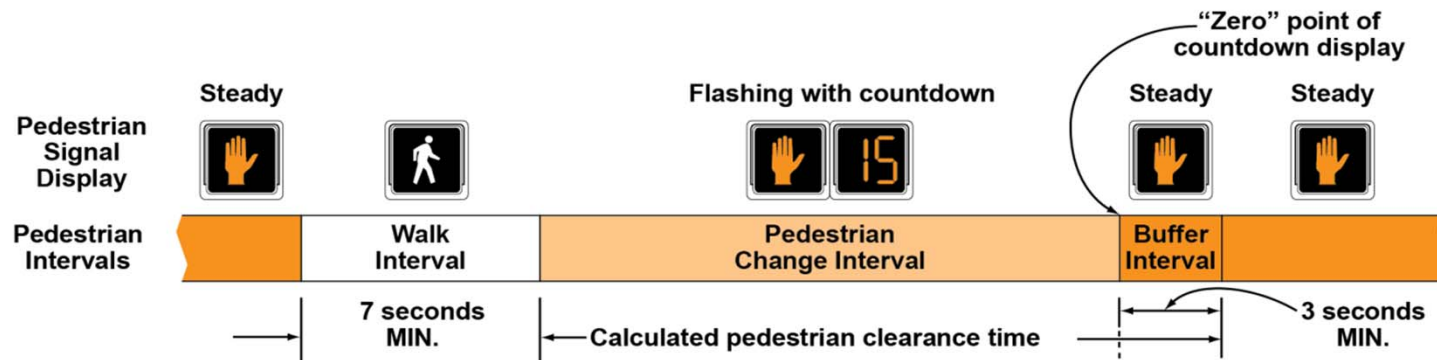
**Table 15.1**  
**Vehicular Clearance Times**

		Intersection Width (ft.)																		
		25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	120
20	Yellow	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	Red	1.5	1.7	1.9	2.0	2.2	2.4	2.6	2.7	2.9	*3.0	*3.0	*3.0	*3.0	*3.0	*3.0	*3.0	*3.0	*3.0	*3.0
25	Yellow	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	Red	1.2	1.4	1.5	1.6	1.8	1.9	2.0	2.2	2.3	2.5	2.6	2.7	2.9	3.0	*3.0	*3.0	*3.0	*3.0	*3.0
30	Yellow	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
	Red	1.0	1.1	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.5	2.6	2.7	2.8	3.0	*3.0
35	Yellow	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
	Red	1.0	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.7
40	Yellow	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
	Red	1.0	1.0	1.0	1.0	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.0	2.1	2.2	2.4
45	Yellow	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
	Red	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.1
50	Yellow	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
	Red	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

\* See the **Section 15.1.2**

# 15. Timing / phasing

## ▫ Pedestrian Change Interval



Relationship to associated vehicular phase intervals:

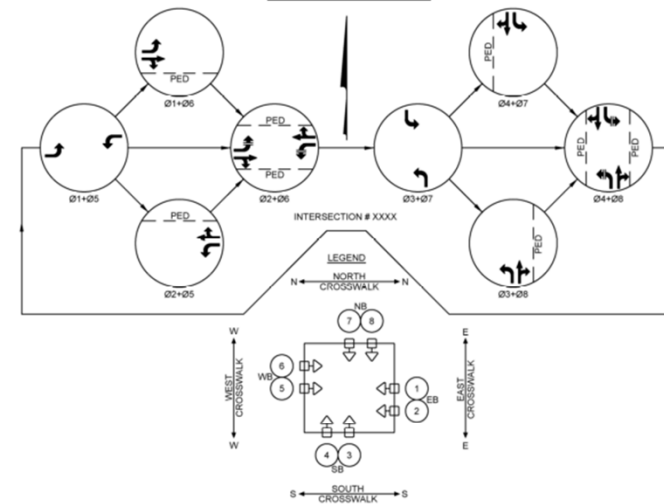


# 15. Timing / phasing

CHAPTER 15: Timing / Phasing

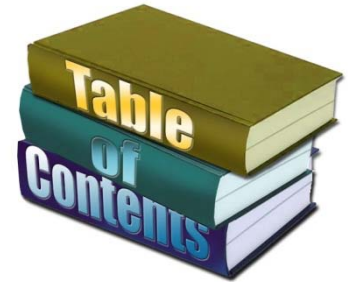
- Plan components
  - Phasing diagram & field wiring hook-up chart
    - Figures 15.2 through 15.24
  - Timing chart
    - Tables 15.2 – 15.5

**Figure 15.18**  
**8 Phase Example**  
**East-West Mainline**



FIELD WIRING HOOK-UP CHART							
SIGNAL HEAD #	INDICATION	FIELD TERMINAL	FLASH	SIGNAL HEAD #	INDICATION	FIELD TERMINAL	FLASH
1 (EBLT)	R	Q05 R	R	6 (WB)	R	Q02 R	R
	Y	Q06 Y			Y	Q02 Y	
	G	Q06 G			G	Q02 G	
	→	Q01 Y			R	Q08 R	
2 (EB)	→	Q01 G	R	7 (NBLT)	Y	Q08 Y	R
	R	Q08 R			G	Q08 G	
	Y	Q08 Y			→	Q03 Y	
	G	Q08 G			→	Q03 G	
3 (SBLT)	R	Q04 R	R	8 (NB)	R	Q08 R	R
	Y	Q04 Y			Y	Q08 Y	
	G	Q04 G			G	Q08 G	
	→	Q07 Y			→	Q03 G	
4 (SB)	→	Q07 G	R	N (NORTH)	WALK	G (Q02)-W	OFF
	R	Q04 R			DON'T WALK	R (Q02)-DW	
	Y	Q04 Y			WALK	G (Q08)-W	
	G	Q04 G			DON'T WALK	R (Q08)-DW	
5 (WBLT)	R	Q02 R	R	S (SOUTH)	WALK	G (Q06)-W	OFF
	Y	Q02 Y			DON'T WALK	R (Q06)-DW	
	G	Q02 G			WALK	G (Q04)-W	
	→	Q05 Y			DON'T WALK	R (Q04)-DW	
	→	Q05 G					

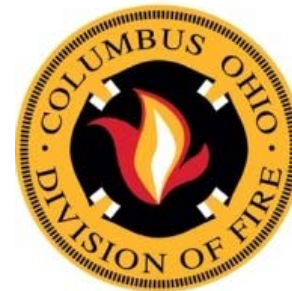
# Table of contents



1. General
2. Plan preparation
3. Temporary traffic signals
4. Supports and foundations
5. Vehicular signals
6. Pedestrian features
7. Intersection wiring
8. Traffic signal signs
9. Vehicle detection
10. Power service
11. Controller / cabinet
12. Interconnect
13. Underground facilities
14. Removal and reuse of traffic signal installations
15. Timing / phasing
16. **Special conditions**

# 16. Special conditions

- Emergency vehicle preemption
- Railroad preemption
- Transit priority
- Flashing operations



- AEP
- Division of Power

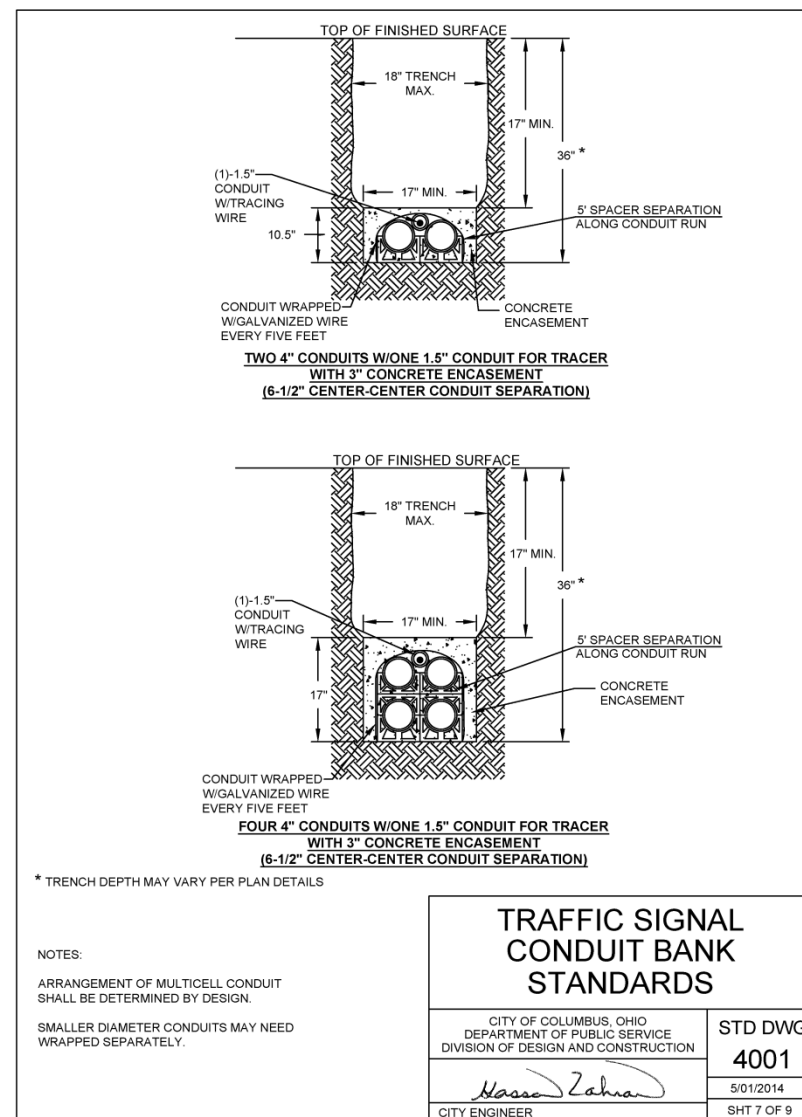
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# Standard drawings

- 4000 – Roadway Conduit Standards
- 4001 – Traffic Signal Conduit Bank Standards
- 4002 – Conduit Guard Rail Protection
- 4020 – Pull Box Underdrain Details
- 4021 – 27" Pull Box
- 4022 – 32" Pull Box
- 4023 – 48" Pull Box
- 4024 – Loop pull box installed over IC duct bank
- 4050 – Signal Cable Conduit Riser Installation
- 4051 – Power Service Conduit Riser for Ground Mounted Cabinet
- 4052 – Power Service Conduit Riser for Pole Mounted Cabinet
- 4100 – 5' pedestal, Pushbutton Mounting
- 4101 – 10.7' pedestal – Pedestrian Signal Head Mountings
- 4102 – 12.7' pedestal – Vehicular Signal Head Mountings
- 4103 – 17.5' pedestal – Street Name Sign Mounting
- 4104 – 21' pedestal – Vehicular Signal Head Mounting
- 4105 – Transformer Base
- 4106 – 10.7' Decorative Pedestal
- 4110 – Video Detector/Traffic Flow Monitor Bracket Arm
- 4111 – Traffic Flow Monitor
- 4120 – Standard City of Columbus Mast Arm
- 4121 – Decorative City of Columbus Mast Arm
- 4122 – Vibration Mitigation Device (VDM)
- 4160 – Signal Support / Strain Pole Foundation
- 4161 – Pole Foundation In Sidewalk Area
- 4162 – Traffic Signal Controller Cabinet Foundation
- 4163 – Pedestal Foundation
- 4170 – Strain Pole
- 4200 – Pole Mountings standards
- 4201 – Overhead Signal Attachment Mastarm
- 4202 – Overhead Signal Attachment Span Wire
- 4205 – Traffic Signal Backplate
- 4230 – Pushbutton and sign installation details
- 4250 – Sign Hanger Assembly, Span Wire
- 4251 – Sign Hanger Assembly, Mast Arm – Rigid Mounted
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- 4300 – Vehicle Detector Standards
- 4301 – Bicycle Detector Markings
- 4330 – Messenger Wire Details 1
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- 4332 – Left Turn Trap Prevention Cut-Out Relay
- 4333 – Inhibit Delay Relay
- 4400 – Interconnect Pedestal Amplifier Cabinet
- 4401 – Interconnect Coaxial Cable Installation
- 4402 – Interconnect Fiber Optic Cable Installation
- 4403 – Interconnect Conduit Attachment
- 4404 – Interconnect Drop Cable Attachment
- 4405 – Communications Node-Foundation Plan
- 4406 – CCTV Assembly Installation
- 4407 – CCTV 70' Concrete Pole Installation
- 4408 – Steel Pole Installation
- 4409 – Lowering Device

# Standard drawings

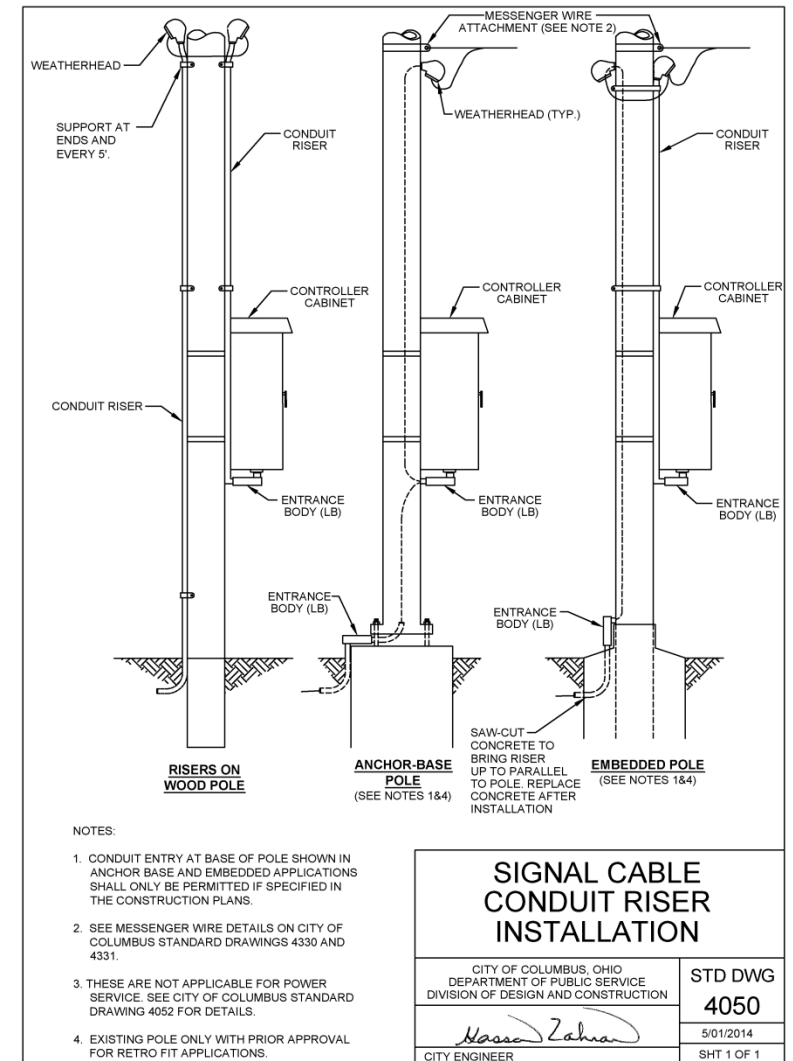
- 4001 Conduit bank details





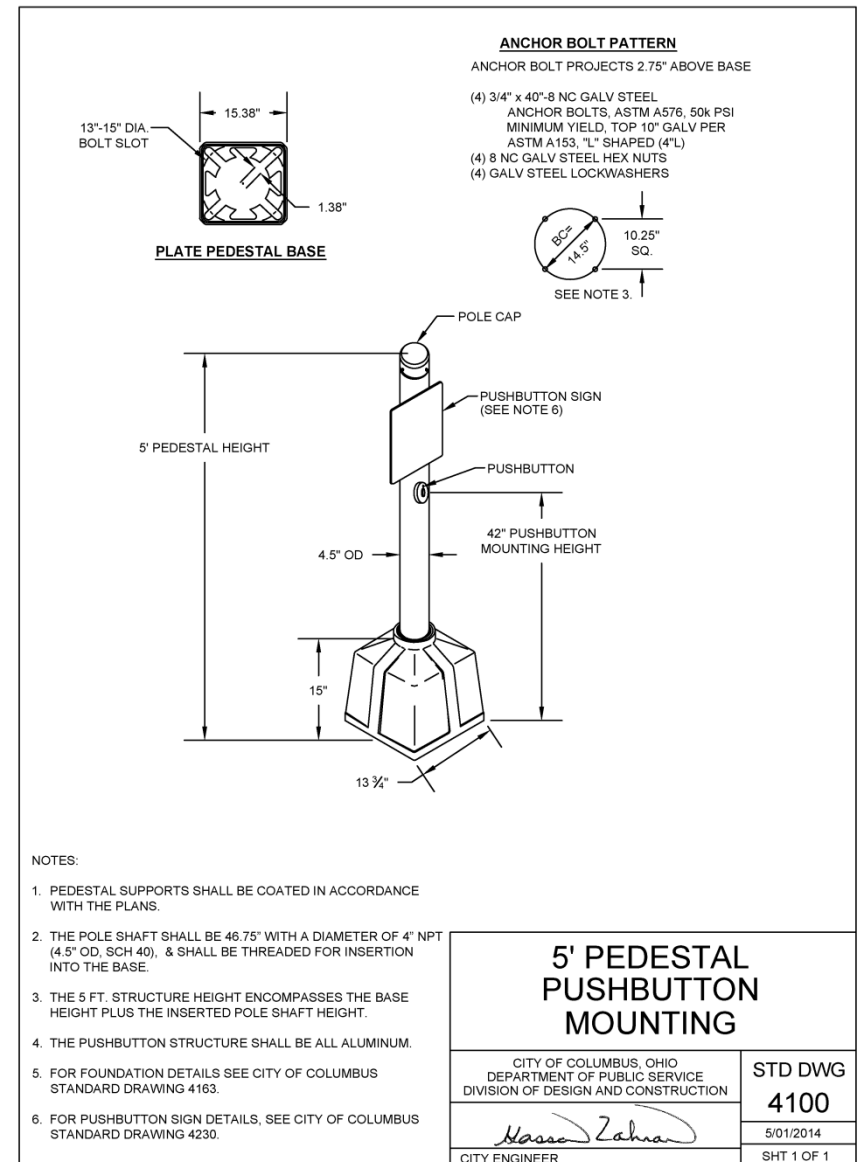
# Standard drawings

- Conduit Risers
- 4500, 4051, 4052



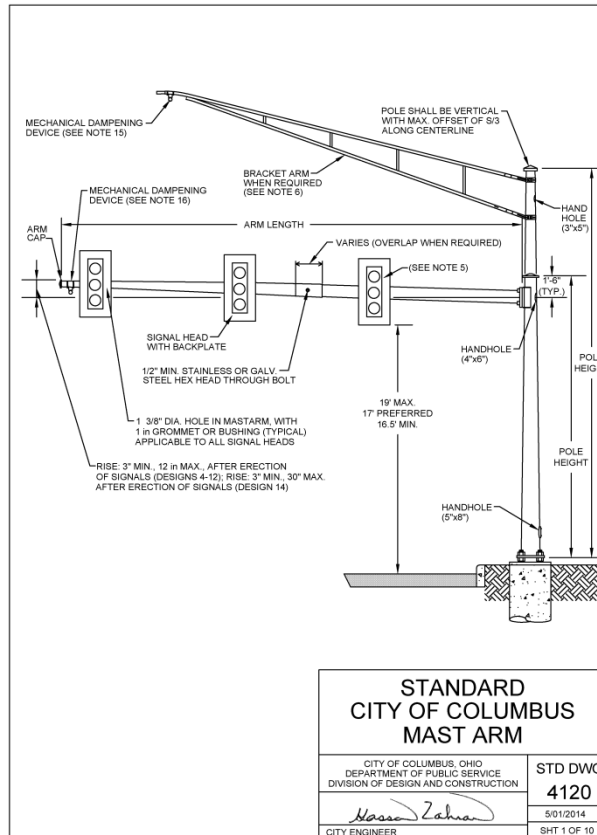
# Standard drawings

- 5' Pushbutton Pedestal
- 4100



# Standard drawings

- 4120 Mast arms



DESIGN NO.	MAXIMUM DESIGN AREA SQ. FT. (NOTE A)	DESIGN DISTANCE FROM C. FT.	POLE			ARM		TWO PIECE ARM		
			TYPE	WALL THICK	SIZE	WALL THICK	SIZE	TYPE	WALL THICK	SIZE
4	42	37.5	ROUND	239	13x9.78x23'	239	10.32x5.00x38'	ROUND		
12	42	47.5	ROUND	299	14x10.78x23'	TOT. LENGTH = 48'		ROUND	299	11x8.62x17' +
									.179	9.19x4.68x32'-3"
13	40	59.5	ROUND	299	16x12.78x23'	TOT. LENGTH = 60'		ROUND	299	13x8.80x30' +
									239	9.62x5.14x32'
14	38	69.5	ROUND	299	17x13.78x23'	TOT. LENGTH = 70'		ROUND	3125	14x9.1x35' +
									239	9.60x4.42x37'
14	38	69.5	ROUND	299	17x13.78x23'	TOT. LENGTH = 70'		ROUND	0.313	14x8.68x38' +
									0.250	9.50x4.74x34'
C15	50	78.5	ROUND	313	18x14.22x27'	TOT. LENGTH = 79'		ROUND	313	14.40x8.70x40.75' +
									.179	9.34x3.71x40.25'
C16 DOUBLE ARM	48 / 48	49.5 / 49.5	ROUND	313	16x12.22x27'	TOT. LENGTH = 50'/50'		ROUND	250	12.00x9.55x17.5' +
									.179	10.19x5.40x34.25'
									250	12.00x9.55x17.5' +
									.179	10.19x5.40x34.25'

ALL DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE NOTED.

DESIGN NO.	ARM ATTACHMENT								ANCHOR BASE				ANCHOR BOLT			PLATE SKIRT	
	A	B	C	D	E	F	G	P	BOLT CIRCLE	S	J	T	H	DIA.	L	M	K
4	16.50	14.50	12.50	9.50	1.50	2	1.25	0.25	18	18.50	12.75	2	2.13	1.75	84	6.75	7.75
12	16.50	14.50	12.50	9.50	1.75	2	1.50	0.31	20	20.50	14.13	2	2.38	2	90	7.5	8.5
13	19.50	16.50	15	12	1.50	2	1.50	0.31	22	23	15.56	2	2.38	2	90	7.5	8.5
14	19.50	16.50	15	12	2.00	2	2.00	0.38	22	23	15.56	2	2.38	2	90	7.5	8.5
C15	24	19	18	13	2.00	2	2.00	0.38	24	24	17	2	2.38	2	90	7.5	8.5
C16 DOUBLE ARM	19	15	14	10	1.75	2	1.50	0.31	22	23	15.56	2	2.38	2	90	7.5	8.5
	19	15	14	10	1.75	2	1.50	0.31									

ALL DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE NOTED.

THESE DESIGNS USE FULL PENETRATION WELDS AT THE ARM AND BASE PLATE CONNECTIONS.

NOTES:

A. MAXIMUM DESIGN AREA IS BASED ON 90 MPH DESIGN WIND SPEED WITH A PRESSURE OF 25 PSF.

B. DIMENSION LOCATIONS ARE ILLUSTRATED ON SHEETS 3 & 4.

## STANDARD CITY OF COLUMBUS MAST ARM

CITY OF COLUMBUS, OHIO  
DEPARTMENT OF PUBLIC SERVICE  
DIVISION OF DESIGN AND CONSTRUCTION

*Hassan Zahran*  
CITY ENGINEER

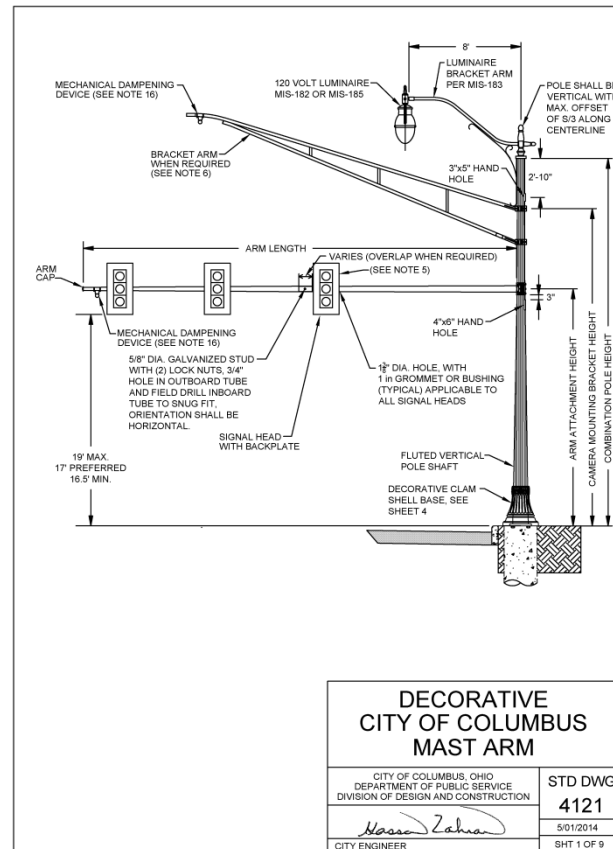
STD DWG 4120

5/01/2014

SHIT 2 OF 10

# Standard drawings

- 4121 Decorative mast arms



DESIGN NO.	MAXIMUM DESIGN AREA SQ FT (NOTE A)	DESIGN DISTANCE FROM CL. FT.	POLE			ARM		TWO PIECE ARM		
			TYPE	WALL THICK	SIZE	WALL THICK	SIZE	TYPE	WALL THICK	SIZE
4	42	37.5	16-FLUTES	.250	13.00x8.94x29'	.250	10.50x5.18x38'	ROUND		
12	42	47.5	16-FLUTES	.250	14.50x10.44x29'	TOT. LENGTH = 48'		ROUND	.250	11.50x7.72x27' + 8.33x5.18x22.5'
13	40	59.5	16-FLUTES	.250	16.00x11.94x29'	TOT. LENGTH = 60'		ROUND	.313	11.50x7.72x27' + 8.33x3.47x34'
14	38	69.5	16-FLUTES	.313	15.50x11.44x29'	TOT. LENGTH = 70'		ROUND	.313	12.75x8.41x31' + 9.05x3.31x41'
C15	50	78.5	16-FLUTES	.313	18.00x13.94x29'	TOT. LENGTH = 79'		ROUND	.313	14.25x8.65x40' + 9.44x3.70x41'
C16 (DOUBLE ARM)	48 / 48	49.5	16-FLUTES	.313	15.50x11.30x30'	TOT. LENGTH = 50' / 50'		ROUND	.250	12.00x9.62x17' + 10.26x5.40x34.75'
									.179	12.00x9.62x17' + 10.26x5.40x34.75'
									.179	12.00x9.62x17' + 10.26x5.40x34.75'

ALL DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE NOTED.

DESIGN NO.	ARM ATTACHMENT										ANCHOR BASE								ANCHOR BOLT
	A1	A2	B	C	D	E	F	G	U	BOLT CIRCLE	S	J	K	T	R	H	DIA.	L	
4	17.5	19.5	17.5	14	14	1.5	1.25	1.25	10	18	18.5	12.75	6	2	2	2.13	1.75	84	
12	19	21	19	15	15	1.5	1.25	1.25	11	20	20.5	14.13	6	2	2	2.38	2	90	
13	21	23	21	17	17	2	1.5	1.5	13	22	23	15.56	6	2	3.5	2.38	2	90	
14	21	23	21	17	17	2	1.5	1.5	13	22	23	15.56	6	2	3.5	2.38	2	90	
C15	25	27	25	20	20	2	2	2	16	24	24	17	8	2	2	2.38	2	90	
C16 (DOUBLE ARM)	21	23	21	17	17	2	1.5	1.5	13	22	23	15.56	6	2	3.5	2.38	2	90	
	21	23	21	17	17	2	1.5	1.5	13										

ALL DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE NOTED.

THESE DESIGNS USE FULL PENETRATION WELDS AT THE ARM AND BASE PLATE CONNECTIONS.

## NOTES:

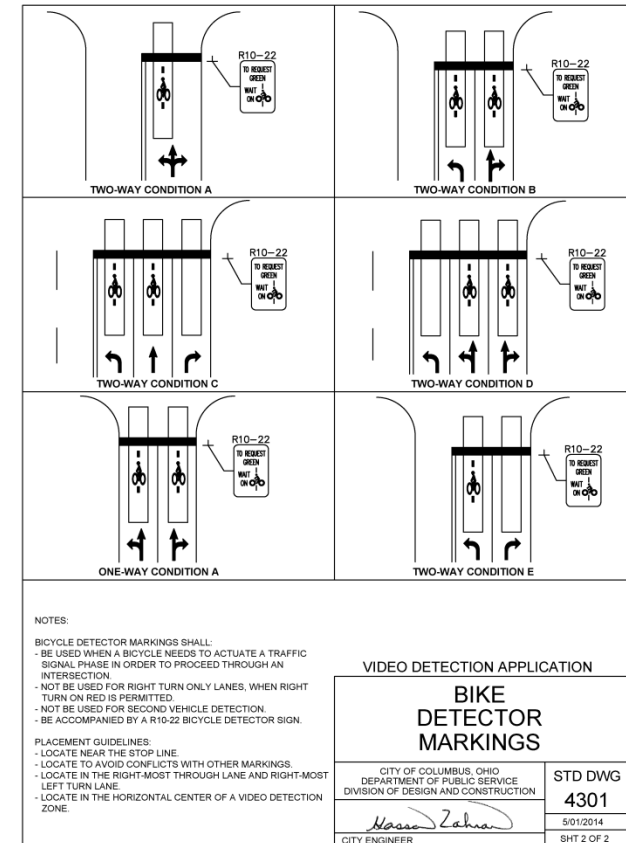
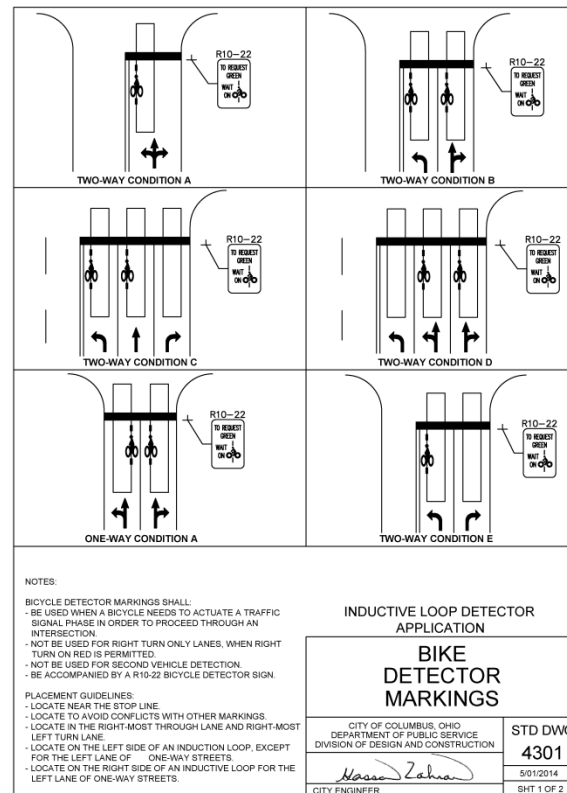
A. MAXIMUM DESIGN AREA IS BASED ON 90 MPH DESIGN WIND SPEED WITH A PRESSURE OF 25 PSF.

B. DIMENSION LOCATIONS ARE ILLUSTRATED ON SHEETS 3 & 5.

<b>DECORATIVE CITY OF COLUMBUS MAST ARM</b>	
CITY OF COLUMBUS, OHIO DEPARTMENT OF PUBLIC SERVICE DIVISION OF DESIGN AND CONSTRUCTION	STD DWG <b>4121</b> 5/01/2014 SHT 2 OF 9
<i>Hassan Zahra</i> CITY ENGINEER	

# Standard drawings

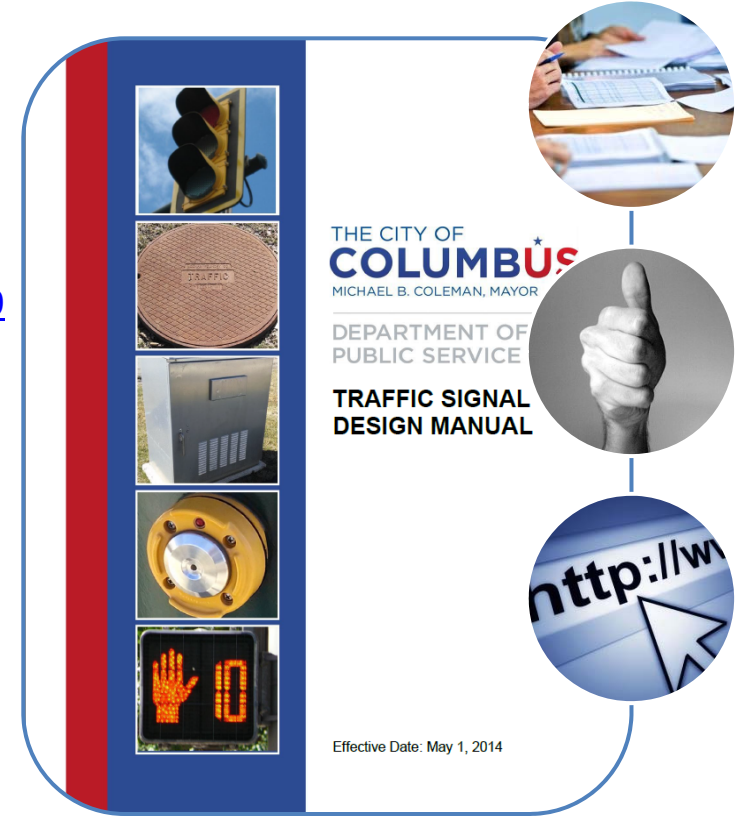
- 4301 Bike detector markings



# Conclusion

- How to access the manual

<http://www.columbus.gov/Templates/Detail.aspx?id=68899>



# Questions?

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