Pima County
Department of Transportation

Traffic Signal Design Manual

Second Edition
January 2008

TRAFFIC SIGNAL DESIGN MANUAL

Pima County Department of Transportation

SECOND EDITION
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INTRODUCTION

Purpose

The purpose of this manual is to provide a consistent set of guidelines, practices, and standards for the design of Pima County traffic signals for use by designers, contractors, and Pima County Department of Transportation Traffic Engineering Division (PCDOT/TED) staff.

This second edition of the Pima County Traffic Signal Design Manual expands upon and supersedes the first edition, dated January, 2002. This manual supplements the current Manual on Uniform Traffic Control Devices (MUTCD), and should be used in conjunction with the current editions of the Pima County/City of Tucson Standard Details and Specifications for Public Improvements. Roadway lighting design guidelines are addressed only to the extent that intersection lighting is provided at signalized intersections. The Pima County Department of Transportation Street Lighting and ITS Conduit Design Manual contains detailed information regarding those specific topics.

Application of Manual

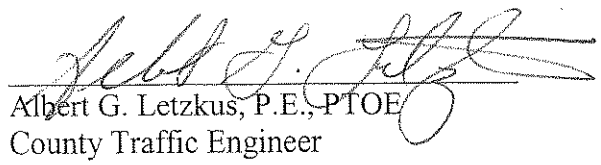
This manual assembles and documents guidance developed by the PCDOT/TED regarding typical traffic signal design, operations, and construction. It is designed to expedite the production and review of plans by providing equipment placement guidelines, plan formatting instructions, drafting guidance, and standard notes relating to traffic signals, including intersection control beacons, warning beacons, and HAWK crossings.

This manual will also serve as a reference for PCDOT/TED staff in the construction and operation of traffic signals. Designers and contractors should be able to use the information presented in this manual to develop plans consistent with PCDOT/TED standards. Users of this manual are encouraged to use engineering judgment when site-specific conditions exist that are not addressed in this manual.

Revision Process

All users are also encouraged to suggest changes to the manual. Suggestions should be submitted in written and/or diagram form to PCDOT/TED. Each suggestion will be reviewed and responses will be provided, if applicable. If PCDOT/TED staff agrees with the suggested change or addendum, it will be incorporated into the next revision of the manual.

Should questions arise in the use of this manual, users are referred to the Pima County Traffic Engineer.



Albert G. Letzkus, P.E., PTOE
County Traffic Engineer

1. GENERAL INFORMATION

This section provides general information regarding traffic signal designs, sheet assignments, and sheet numbering protocols.

A. Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ANSI	American National Standards Institute
AWG	American Wire Gauge
IESNA	Illuminating Engineering Society of North America
IMSA	International Municipal Signal Association
LED	Light emitting diode
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
PCDOT/TED	Pima County Department of Transportation Traffic Engineering Division
POLT	Protected- Only Left Turn
PORT	Protected- Only Right Turn
PPG	Process/Procedure Guideline
UPS	Uninterrupted Power Supply (Battery Backup)

B. Definitions

Accessible Pedestrian Signal	A device that communicates information about pedestrian timing in non-visual format, such as audible tones, verbal messages, and/or vibrating surfaces.
Advance Loop	A loop used in advance of an intersection that detects a vehicle's passage, and which is typically used to extend the green interval.
Approach	All lanes of traffic moving toward an intersection or a mid block location from one direction, including any adjacent parking lane(s).
Backplate	A thin strip of material that extends outward from and parallel to a signal face on all sides of a signal housing to provide a background for improved visibility of the signal indications
Beacon	A highway traffic signal with one or more signal sections that operates in flashing mode
Clear Zone	The unobstructed, relatively flat area provided beyond the edge of the traveled way for the recovery of errant vehicles. The clear zone includes any shoulder or auxiliary lanes.
Call Loop	A loop that detects a vehicle and indicates its presence.

B. Definitions (continued)

Conduit Run	An underground conduit from pull box to pull box or from pull box to pole foundation. Multiple conduits in the same trench are given one conduit run number.
Conventional Pedestrian Signal	A device that communicates information about pedestrian timing in a visual format.
Curb Access Ramp	A short section of the pedestrian access route that joins the street elevation to the public sidewalk elevation, through a cut in the curb face.
Curb Access Ramp Landing	A level area on a public sidewalk, adjoining a curb access ramp, used for maneuvering and waiting.
Emergency Vehicle Pre-emption	Transfer of normal operation of a traffic signal to a special mode of operation that quickly gives the green phase for the direction of traffic from which the approaching emergency vehicle is arriving.
HAWK crossing	A signalized pedestrian crossing that utilizes flashing and steady red and yellow signal indications. HAWK is an acronym for High intensity Activated crossWalK.
Intersection Control Beacon	A beacon used only at an intersection to control two or more directions of travel
Lead-in Cable	Cable used from the controller cabinet to the embedded loop detectors.
Louver	A device that can be mounted inside a signal visor to restrict visibility of a signal indication from the side, or to limit the visibility of the signal indication to a certain lane or lanes.
Major Street	The street normally carrying the higher volume of vehicular traffic at an intersection.
Minor Street	The street normally carrying the lower volume of vehicular traffic at an intersection.
Multiconductor Cable	A combination of conductors insulated from one another. The component conductors of the multiconductor cable may be either solid or stranded and have a common insulation covering.
Multiconductor Cable Schematic	An illustration of multiconductor cabling requirements for a traffic signal design that replaces/supplements the conductor schedule.
NEMA Traffic Signal Phasing Diagram	A diagram illustrating traffic movements at a signalized intersection that utilizes NEMA standard movement designations.
Pedestrian Indication	A signal head, which contains the symbols WALKING PERSON (symbolizing WALK) and UPRAISED HAND (symbolizing DON'T WALK), that is installed to direct pedestrian traffic at a traffic control signal.
Pedestrian Push Button	A button to activate pedestrian timing.

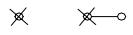
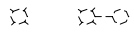
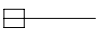
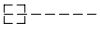
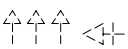
B. Definitions (continued)

Pre-emption Beacon	A flashing strobe mounted on the signal mast arm to indicate emergency vehicle detection.
Pre-emption Detector	A device that detects a request from an emergency vehicle for priority control of an intersection.
Presence Loop	A loop that detects vehicles within the loop area.
Pulse Loop	A loop that detects a vehicle and notifies the controller of an approaching vehicle, typically used in advance of an intersection (see advance loop).
Signal Coordination	The establishment of timed relationships between adjacent traffic control signals.
Signal Face	That part of a traffic control signal provided for controlling one or more traffic movements on a single approach.
Signal Head	An assembly of one or more signal sections.
Signal Indication	The illumination of a signal lens or equivalent device
Signal Lens	That part of the signal section that redirects the light coming directly from the light source and its reflector, if any.
Signal System	Two or more traffic control signals operating in signal coordination.
Signal Terminal Strip	Component of the terminal compartment in the traffic signal mounting assembly where the conductor is attached to the signal head.
Span-Wire Installation	A traffic signal installation in which the traffic signal heads are suspended from cables that span the intersection, rather than installed on a mast arm.
Stop Line	A pavement marking that indicates where motor vehicles should begin to queue for a red traffic signal indication.
Type 'R' Signal Head	A three section signal head in which all indications are arrows pointing in the same direction, either all left or right, as shown in the MUTCD Figure 4D-3(c).
Video Detection	Vehicle detection accomplished through the use of machine vision technology.
Warning Beacon	A beacon used only to supplement an appropriate warning or regulatory sign or marker.

C. CADD Symbols

CADD Symbols are shown on Figures 1-1A and 1-1B on the following pages.

FEATURE	PEN SIZE	NEW	PEN SIZE	EXISTING
PEDESTRIAN PUSH BUTTON	1		00	
TRAFFIC CONTROL CABINET WITH FOUNDATION	1		00	
PULL BOX (1), NO. 3-1/2	1		00	
PULL BOX, NO. 5	1		00	
PULL BOX, NO. 5 W/ EXTENSION	1		00	
PULL BOX, NO. 7	1		00	
PULL BOX, NO. 7 W/ EXTENSION	1		00	
(1) TELEPHONE PULL BOXES SHALL BE DESIGNATED BY "T", ELECTRIC BY "E" AND TRAFFIC BY "TS" (TYP. ALL SIZES)				
SERVICE CABINET W/ FOUNDATION	1		00	
RAILROAD CABINET W/ FOUNDATION	1		00	
DETECTOR LOOP	1		00	
TRAFFIC COUNT STATION	1		00	
TRAFFIC SIGNAL UNINTERRUPTED POWER SUPPLY CABINET (UPS BATTERY BACKUP)	1		00	
IRRIGATION CONTROL CABINET WITH FOUNDATION	1		00	

FEATURE	PEN SIZE	NEW	PEN SIZE	EXISTING
POLE W/ LUMINAIRE: (W/O AND WITH MAST ARM)	1		00	
LUMINAIRE W/O PHOTOCELL	1		00	
LUMINAIRE W/ PHOTOCELL	1		00	
POLE WITH MAST ARM AND SIGNAL	1		00	
FLASHING SIGNAL	1		00	
PEDESTRIAN SIGNAL	1		00	
POLE KEY LETTER	1		00	
CONDUIT RUN NUMBER	1		00	
EMERGENCY VEHICLE PRE-EMPTION BEACON	1		00	
EMERGENCY VEHICLE PRE-EMPTION SENSOR	1		00	
TRAFFIC SIGNAL VIDEO CAMERA	1		00	
METRO STREET NAME SIGN	1		00	
TRAFFIC SIGNAL ('F' HEAD)	1		00	
TRAFFIC SIGNAL WITH TURN ARROW ('Q' HEAD)	1		00	
TRAFFIC SIGNAL ('R' HEAD)	1		00	

D. Standard References for Traffic Signals

The following are standard reference documents for the design of traffic signals.

1. For new or upgraded signal installations, the number of signal indications and their location should conform to requirements in Part 4 of the current *Manual on Uniform Traffic Control Devices* (MUTCD).

2. Equipment, materials and installation procedures should meet or exceed the current Pima County/City of Tucson Standard Specifications for Public Improvements and the current Pima County/City of Tucson Standard Details for Public Improvements, unless noted otherwise in the construction documents, or superseded by direction in this manual.

3. All installations should meet current *National Electric Code* requirements.

4. Steel pole, control cabinet, and electric service pedestal foundations should be positioned beyond the clear zone requirements as specified in the current AASHTO *Roadside Design Guide.*

E. Standard References for Street Lighting at Signalized Intersections

While this manual is not intended to be a street lighting design manual, intersection lighting is included in traffic signal designs. For this reason, standard references for intersection lighting are listed below.

1. Street lighting design should meet or exceed average luminance per the current AASHTO publication, *"Roadway Lighting Design Guide"*.

2. Pole locations should be positioned beyond the AASHTO clear zone requirement specified in the current AASHTO *Roadside Design Guide*.

3. Light distribution shall satisfy the current Pima County Outdoor Lighting Code.

4. All installations should meet current *National Electric Code* requirements.

5. Installations should be in conformance with Roadway Lighting – Illuminating Engineering Society of North America, current ANSI/IESNA RP-8.

F. Sheet Assignment

1. Overview

   A typical traffic signal design is comprised of five sheets, as enumerated below:

   a. Sheet 1 – Cover Sheet
   b. Sheet 2 – General Traffic Signal Notes and Responsibilities Sheet
   c. Sheet 3 – Plan View Sheet
   d. Sheet 4 – Pole Schedule and Multi-conductor Cable Schematics Sheet
   e. Sheet 5 – Traffic Signal Detail Sheet

The final sealed/signed sheets should be drawn on Mylar. Vellum is acceptable for intermediate submittals. Details regarding requirements for each sheet are provided in the following guidance. Example plans are provided in Appendix A.

Traffic signal designs are frequently included as part of a larger civil design package, which may include multiple signal designs. In these instances, no separate cover sheet for each signal design is required. The General Notes and Responsibilities Sheet is a single sheet for the project. Sheets showing the pole schedule and multiconductor cable schematics follow the corresponding plan view.

The Traffic Signal Detail Sheet will be the last sheet in the package. Dual numbering systems may be required.

2. Sheet 1 – Cover Sheet

   Elements required for the traffic signal design cover sheet include:

   a. **Location Map** - Indicates where the project is located in Pima County, including Township, Section and Range.

   b. **Vicinity Map** - Indicates the general location of the project (approximately four square miles).

   c. **Sheet Index** - Includes sheet numbers and descriptions.

   d. **Seal of Pima County** - Includes Board of Supervisors' names and the Supervisor's district in which project is located.

   e. **General Description**.

   f. **Work Order or Project Number.**

   The layout of this sheet shall adhere to PCDOT drawing standards for Cover Sheets. Refer to the current Pima County Roadway Design Manual.

3. Sheet 2 – General Traffic Signal Notes and Responsibilities Sheet

   Appendix B contains an example of General Traffic Signal Notes and Responsibilities; however, they may need to be revised to meet the needs of each project. Both General Traffic Signal Notes and Responsibilities should be organized into a logical sequence. General Traffic Signal Notes and Responsibilities may be obtained from the PCDOT/TED.

4. Sheet 3 - Plan View Sheet

The plan view of the proposed intersection geometry and traffic signal installation should be drawn to a scale of 1"=20' and contain the following elements:

a. NEMA Traffic Signal Phasing Diagram (vehicle and pedestrian)

b. Table of Stations for Stop Lines and Vehicle Detection Loops

c. North Arrow (oriented so that North is at the top or right of the sheet)

d. Graphical scale

e. Blue Stake emblem

f. Pima County Ordinance Number

For the purposes of streamlining traffic signal operations, NEMA standard phase designations should be used. The NEMA movements should be oriented such that phases 2 and 6 align with the major street. For a street with an east-west major street, phase 2 should be eastbound and phase 6 should be westbound. For an intersection for which the main street is oriented north-south, phase 2 is southbound and phase 6 is northbound. The geographic orientation of phasing is presented in Figure 1-2. For intersections of two major streets, PCDOT/TED will provide phasing orientation.

The traffic signal phasing diagram should show both vehicular and pedestrian movements and a north arrow.

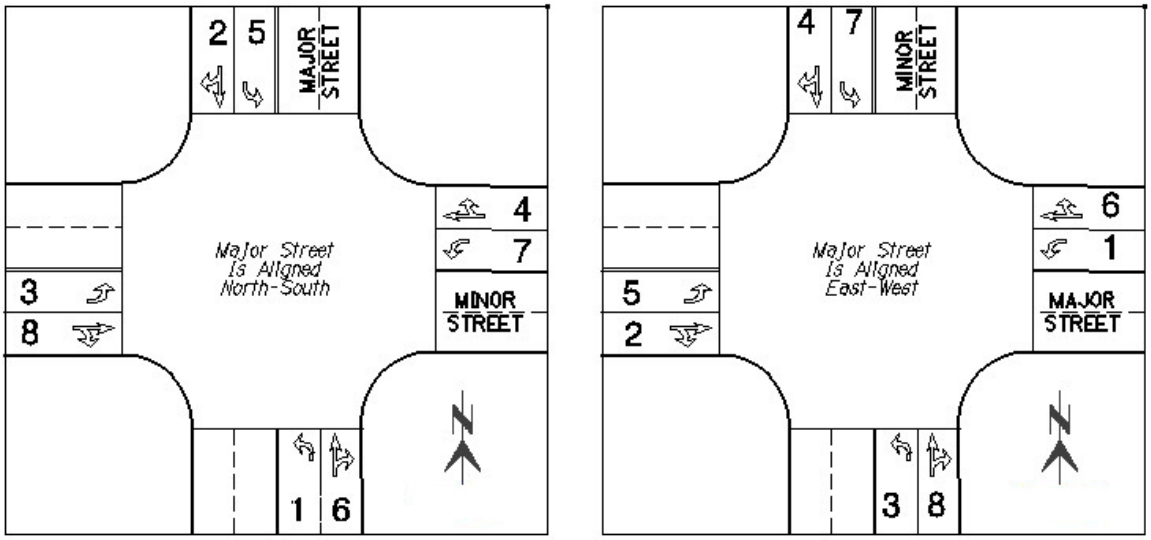
Table of Stations for Stop Lines and Vehicle Detection Loops should include the stations of the centers of loops and offsets from the construction center line to the centers of the loop. Use the approach edge for 6'x70' loops and other long loops.

The plan view should also show existing geometry, existing equipment and existing utilities.

Signal heads and loops should show their phase designation.

Refer to the sample set of plans in Appendix A.

Figure 1-2
NEMA Standard Movements



5. Sheet 4 - Pole Schedule and Multiconductor Cable Schematics Sheet

   This sheet shows the pole schedule and the multiconductor cable schematics. These should be prepared according to the following guidelines/standards. Refer to the sample set of plans in Appendix A.

   Pole Schedules should include the following information:

   a. Pole key letter and schematic of pole showing types of heads and the dimensions between the heads

   b. Pole type

   c. Signal and luminaire mast arm lengths

   d. Signal mounting assembly types and face types

   e. Pedestrian push button stations and signs

   f. Luminaires

   g. Location, including station and offset distance from the construction centerline to the center of each pole. The top of foundation elevation should also be given.

   h. Remarks, which typically include installation of photocell, mounting of cameras and/or pre-empt sensors and beacons

i. Reference standards in the PC/DOT Standard Details for Public Improvements

j. Low-voltage and high-voltage circuits shall be displayed as separate International Municipal Signal Association (IMSA) multiconductor cable schematics. Multiconductor cable schematics should include the following information:

i. Conduit run identification numbers and quantities

ii. High and low-voltage schematics legends

The table below illustrates the column headings to be included in the pole schedule. Each pole will have a separate row/line in the pole schedule.

Table 1-1
Pole Schedule Column Designations

POLE NUMBER	POLE TYPE	MAST ARM		SIGNALS		LUMINAIRE TYPE	PED PB TYPE/SIGN	REMARKS	LOCATION	STANDARDS
		SIGNAL	LUMIN	MTG.	FACE					

6. Sheet 5 - Pima County Traffic Signal Detail Sheet

Sheet 5 is comprised of traffic signal details prepared by PCDOT to be included in the final design package. PCDOT/TED will submit to the consultant an electronic copy of this sheet. The consultant shall include this sheet in the final plan set.

7. Other Sheets

Other sheets may be included in the plan set as required by the scope of work. Other sheets may include interim construction phasing or demolition plans. Use of additional sheets should be approved by PCDOT/TED Project Manager.

G. CADD Level Structures

Refer to the latest PCDOT Engineering Division drafting standards.

H. Other Related Studies

1. Traffic Signal Warrant Analysis

   The designer may on occasion be asked to prepare a warrant study for new signal installations. The warrants in the MUTCD are used for making such a study. There are eight warrants which relate to the volume, delay, and crash experience of the intersection. Satisfying one or more of these warrants may be an indication that installation of traffic signals is appropriate. PCDOT/TED has revised the MUTCD warrants for use in unincorporated Pima County. Refer to the PCDOT/TED Process/ Procedure Guidelines (PPG's).

2. Left-Turn Warrant Study

   A left turn warrant study using Pima County criteria is typically completed by PCDOT/TED for the existing year volumes prior to the traffic signal design, if necessary. Refer to the PCDOT/TED Process/Procedure Guidelines (PPG's).

3. Traffic Signal and Lighting Report

   A Traffic Signal and Lighting Report may be required under certain circumstances. Additional details regarding the Traffic Signal and Lighting Report can be found in the Pima County Street Lighting and ITS Conduit Manual.

4. Project Traffic Engineering Report

   For many roadway civil designs, a project Traffic Engineering Report may have been completed. This report presents existing and future conditions and discusses proposed improvements. The report also includes information about proposed traffic signal operation and phasing.

2. POLE PLACEMENT STANDARDS AND GUIDELINES

A. Curb Access Ramp Locations

Curb access ramps are required by the Americans with Disabilities Act (ADA). These ramps should be provided via two separate ramps per corner, one for each crossing direction. Special circumstances may require the use of single ramps, which requires the approval of the PCDOT/TED Project Manager.

B. Curb Access Ramp Landings

A curb access ramp landing is a relatively flat area to be used by a pedestrian to access and activate a pedestrian push button.

A landing should be provided at the top of each curb access ramp. The landing should contain a 60-inch square or 60-inch circle, and should slope no more than 1:48 in any direction, in accordance with the Final Report of the Public Rights-of-Way Access Advisory Committee (January 2001). The landing shall be provided with a stable, firm, and slip resistant surface. Poles, utility boxes, and other obstructions **shall not** be located in the curb access ramps or in the landings.

C. Relationship of Curb Access Ramps with Crosswalks and Stop Lines

The location of the curb access ramps determines the location of the marked crosswalks and associated stop lines. The stop lines determine the placement of the detection loops and any "near right" poles. Therefore, the design/ location of any of these features must be coordinated with the design of the other features. Listed below are design/operation factors to be balanced in the location of curb access ramps, crosswalks, and stop lines:

1. Align crosswalks and stop lines as close to perpendicular to the approach traffic lanes as possible.

2. Center the curb access ramps in the crosswalks.

3. Locate curb access ramps near the radius PT and PC.

4. Minimize pedestrian exposure to turning vehicles.

5. Ensure that the pedestrians waiting at the radius, at **both** curb access ramps, are readily visible to approaching and turning vehicle drivers.

6. Minimize pedestrian crossing distance and crossing time.

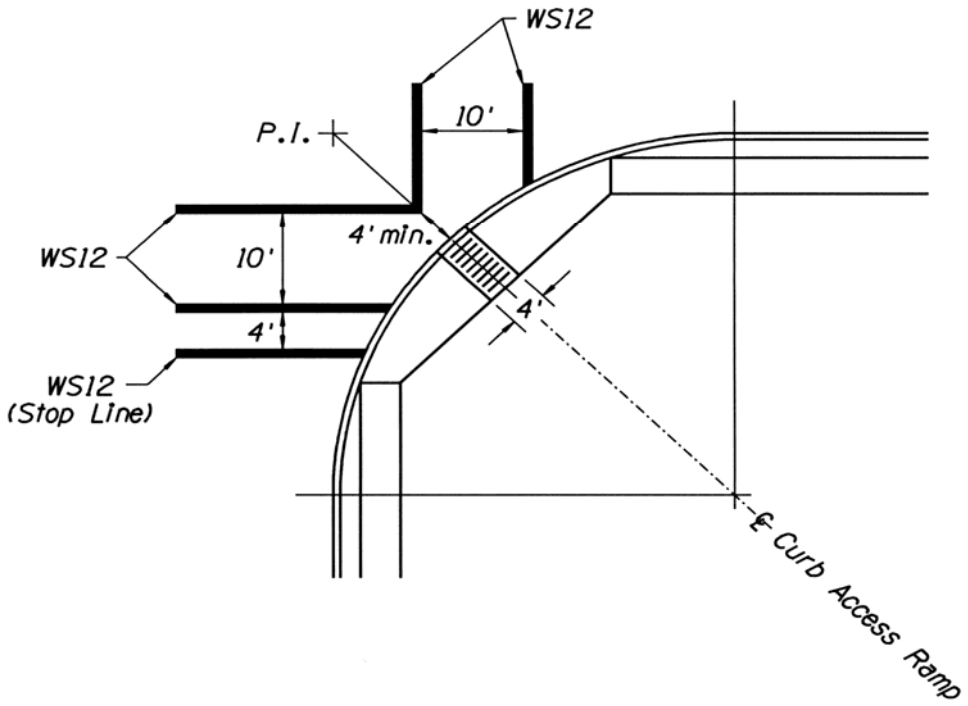
7. Clarify and simplify the pedestrians crossing route.

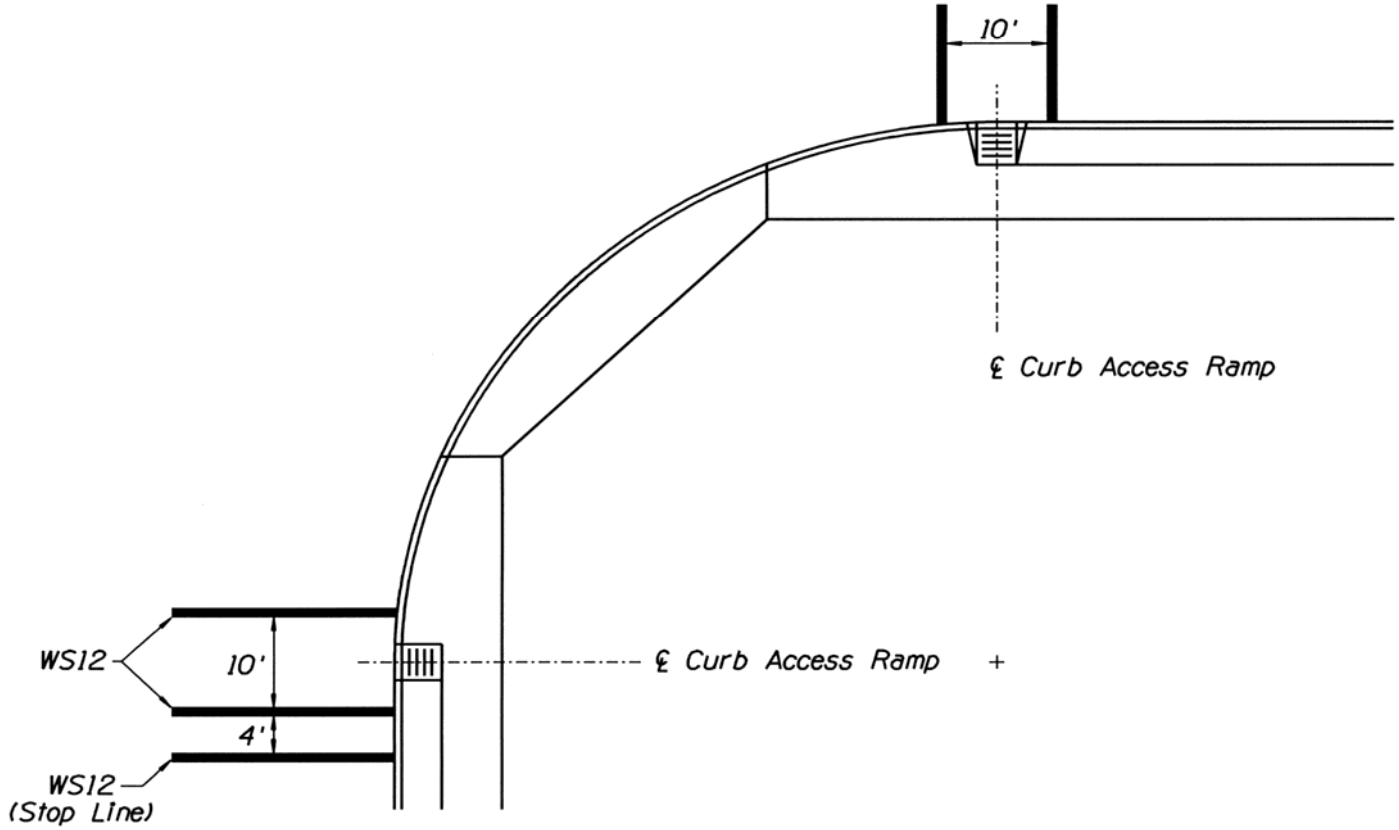
   See Figure 2-1 for an illustration of the relationship between crosswalk and stop line.

D. General Considerations For Traffic Signal Pole Locations

Traffic signal poles should be located to provide for the best **visibility of signal faces** by balancing the following design issues.

1. Satisfy clear zone requirements plus 1 foot.
2. Accommodate right-of-way limitations.
3. Locate signal heads (vehicle and pedestrian heads) to maximize visibility and minimize confusion.
4. Accommodate approach lane configuration.
5. Accommodate alignment of intersecting roadways (skew intersections).
6. Accommodate approach alignment (horizontal and vertical curves).
7. Minimize the number of poles for signal heads, pedestrian buttons, and street lighting.
8. Provide street lights in reasonable locations.
9. Account for nearby underground and overhead utilities (existing/proposed).
10. Account for nearby drainage structures, bridges and embankments.
11. Account for nearby buildings, walls, fences, and other structures.
12. Account for the corner radius.
13. Determine reasonable curb access ramp locations.
14. Enhance access to pedestrian push buttons.
15. Account for nearby trees and other landscaping features.
16. Use standard mast-arm lengths (35 feet or 40 feet for Type Q poles, 45 feet, 50 feet or 55 feet for Type R poles).





ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-1
REVISED: 11/2007		Pole Placement Standards & Guidelines		**PAGE:** 2-3

The following signal pole location criteria should also be incorporated:

1. The distance between the stop line and the mast arm heads should be 70 feet to 180 feet

2. On roads with curbing, type A poles on breakaway bases must be located a minimum of 5 feet from the back of curb (preferred distance of 8-10 ft.). On roads without curbing, type A poles on breakaway bases must be located a minimum of 12 feet from the edge of pavement (preferred distance of 15-20 ft.). A supplemental pedestrian push button pole may be required within 10 feet of the edge of pavement to satisfy ADA requirements. Type A poles may be located farther than the minimum required from the back of curb or edge of pavement to accommodate other site design factors.

3. Luminaires should be positioned to illuminate crosswalks.

4. Type A poles should not be installed in the medians of 4-lane, divided roadways.

5. Type A poles on break away bases may be permitted on the medians of 6-lane roadways.

6. Poles or posts should not obstruct pedestrian routes. (**DO NOT INSTALL** in curb access ramps or landings.)

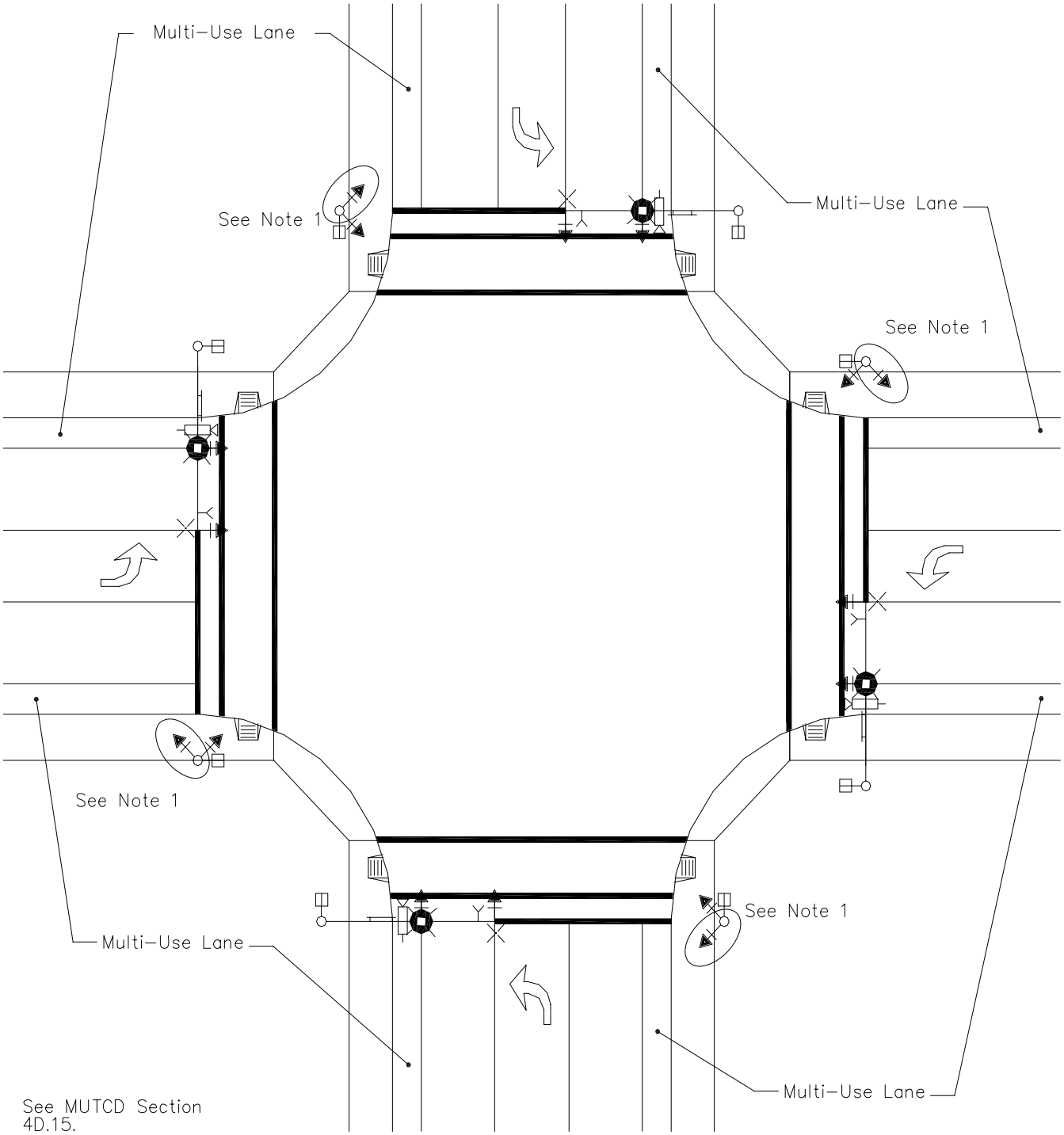
7. Pedestrian push buttons for intersecting approaches should not be within 10 feet of each other. (MUTCD and ADA requirements should also be satisfied.)

8. Use standard mast arm lengths (35 feet or 40 feet for Type Q poles, 45 feet, 50 feet or 55 feet for Type R poles).

9. Typically do NOT locate poles other than Type A poles or posts in triangular islands. (This requires TED Project Manager approval.)

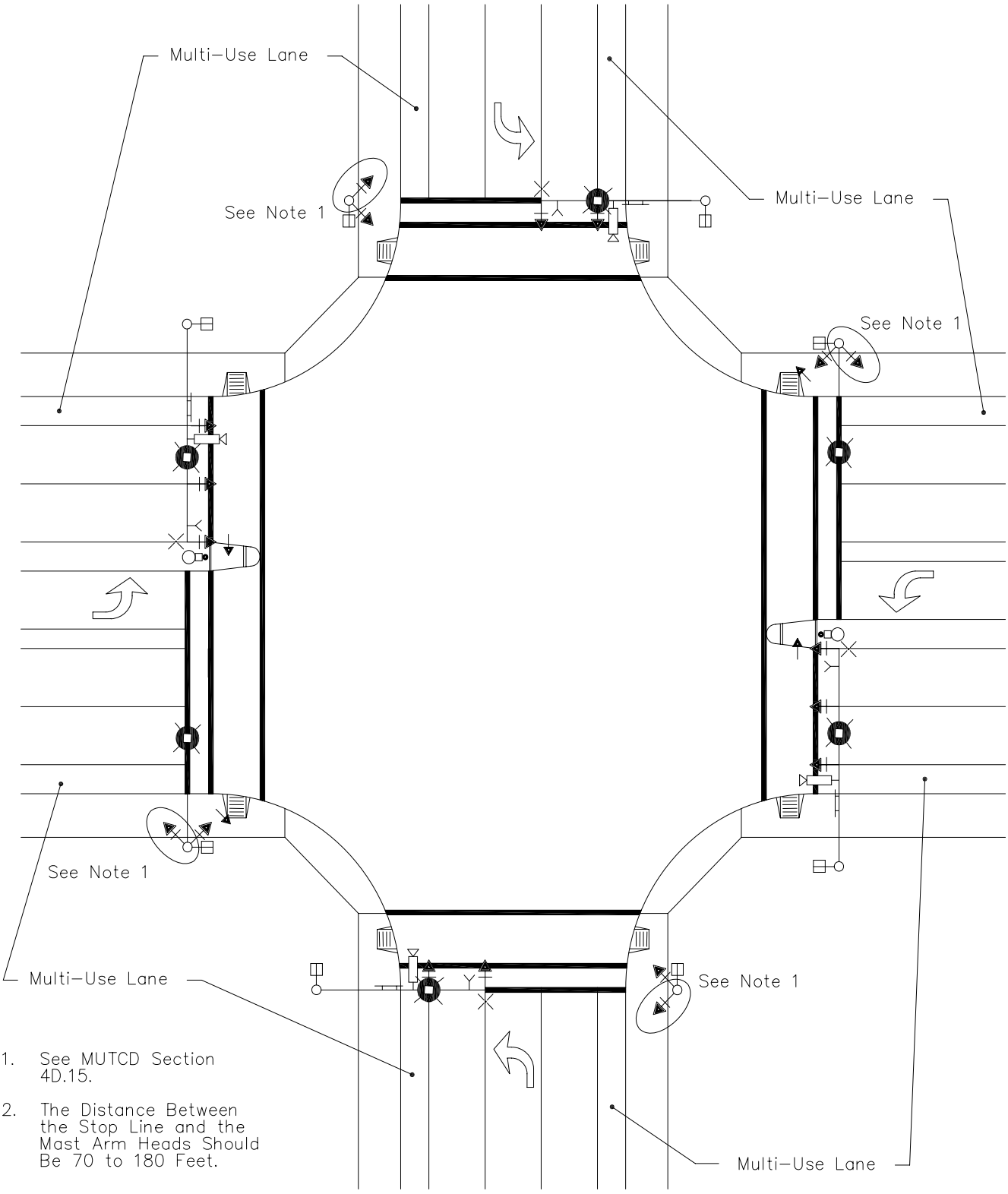
10. All type A poles must be installed on a breakaway (frangible) base.

See Figures 2-2 through 2-12 for sample drawings illustrating common intersection and signal configurations.



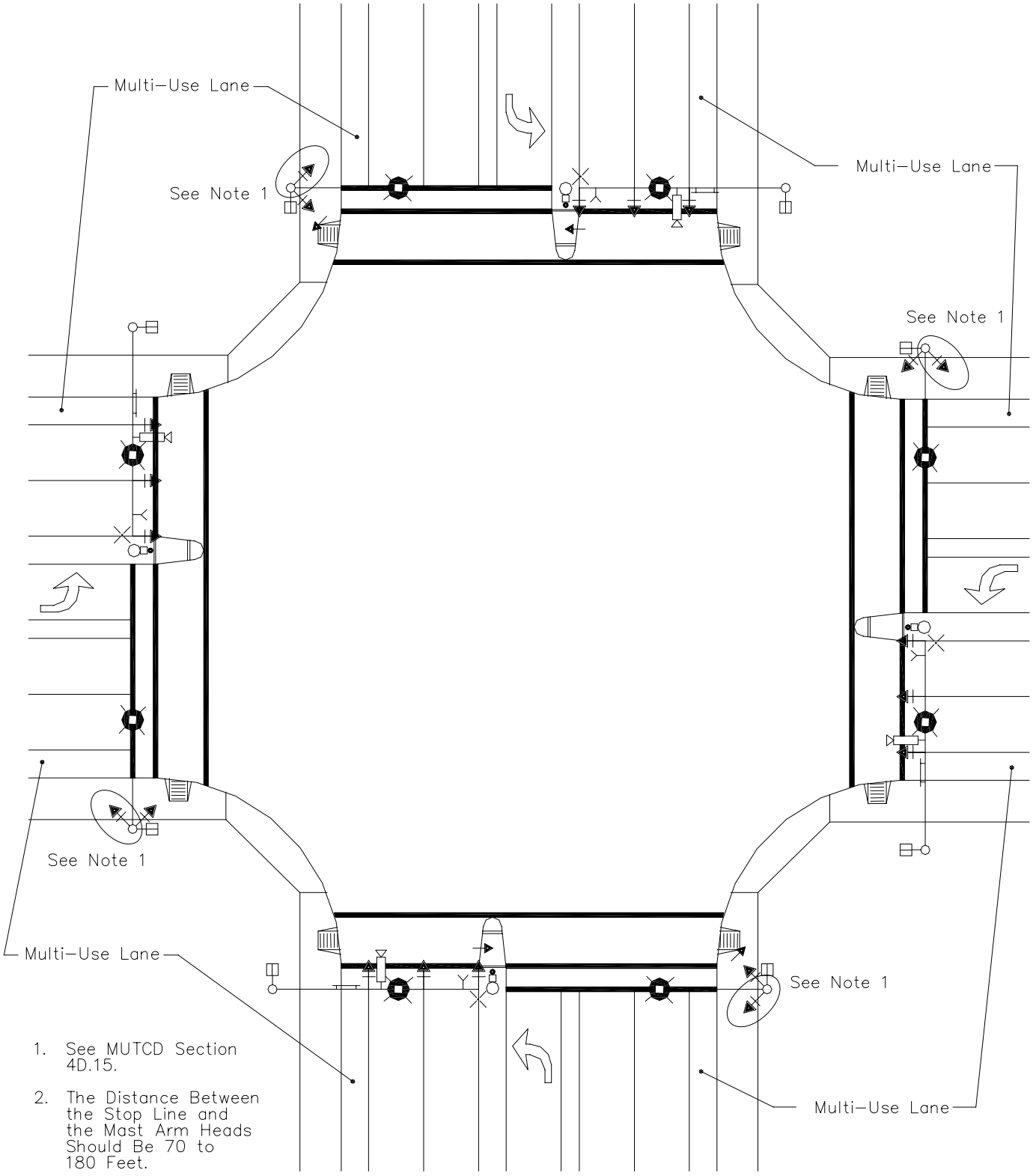
1. See MUTCD Section 4D.15.
2. The Distance Between the Stop Line and the Mast Arm Heads Should Be 70 to 180 Feet.

ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-2
REVISED: 11/2007		Pole Placement Standards & Guidelines 3L Undivided X 3L Undivided		**PAGE:** 2-5



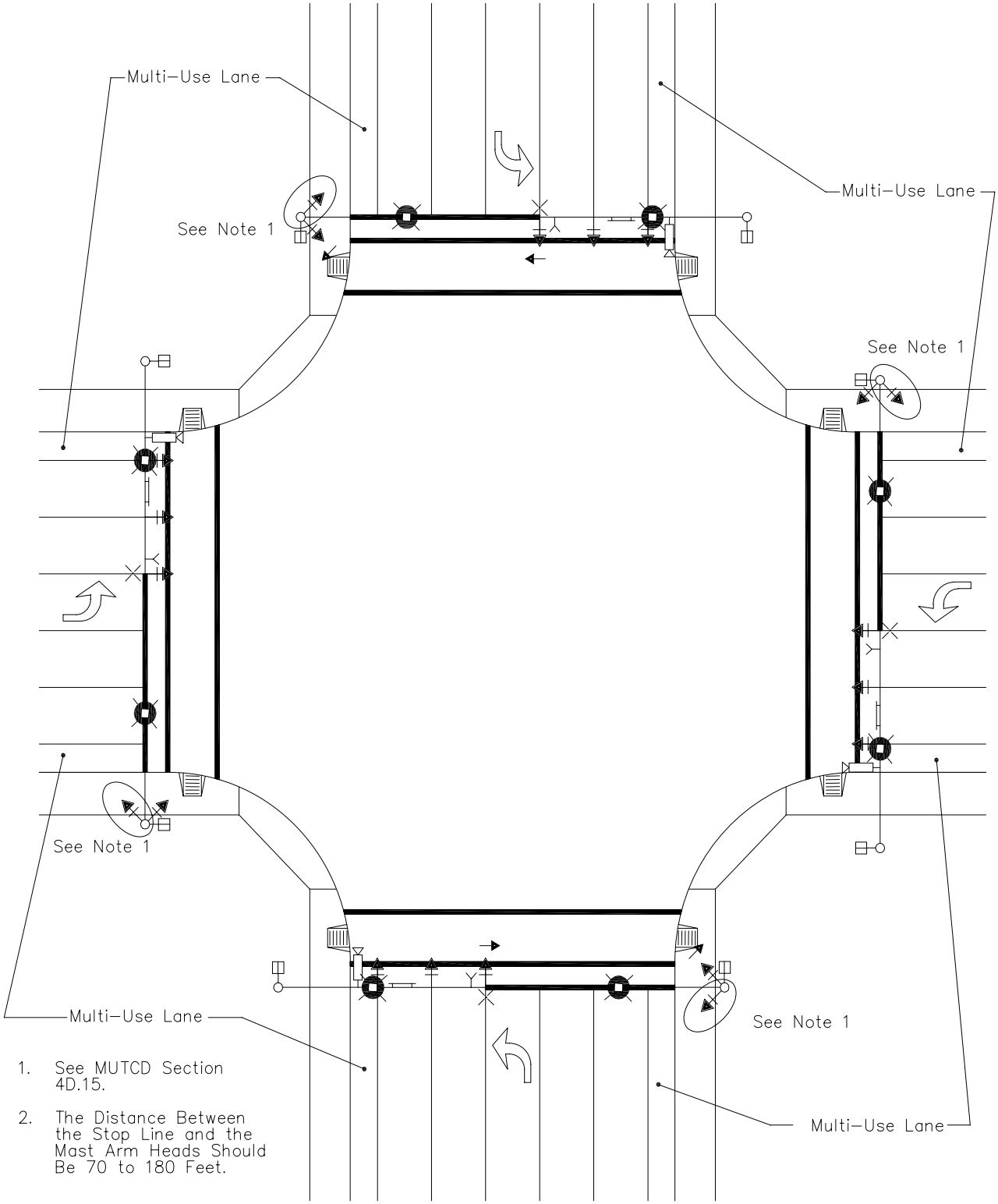
1. See MUTCD Section 4D.15.
2. The Distance Between the Stop Line and the Mast Arm Heads Should Be 70 to 180 Feet.

ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-3
REVISED: 11/2007		Pole Placement Standards & Guidelines 3L Undivided X 4L Divided		**PAGE:** 2-6

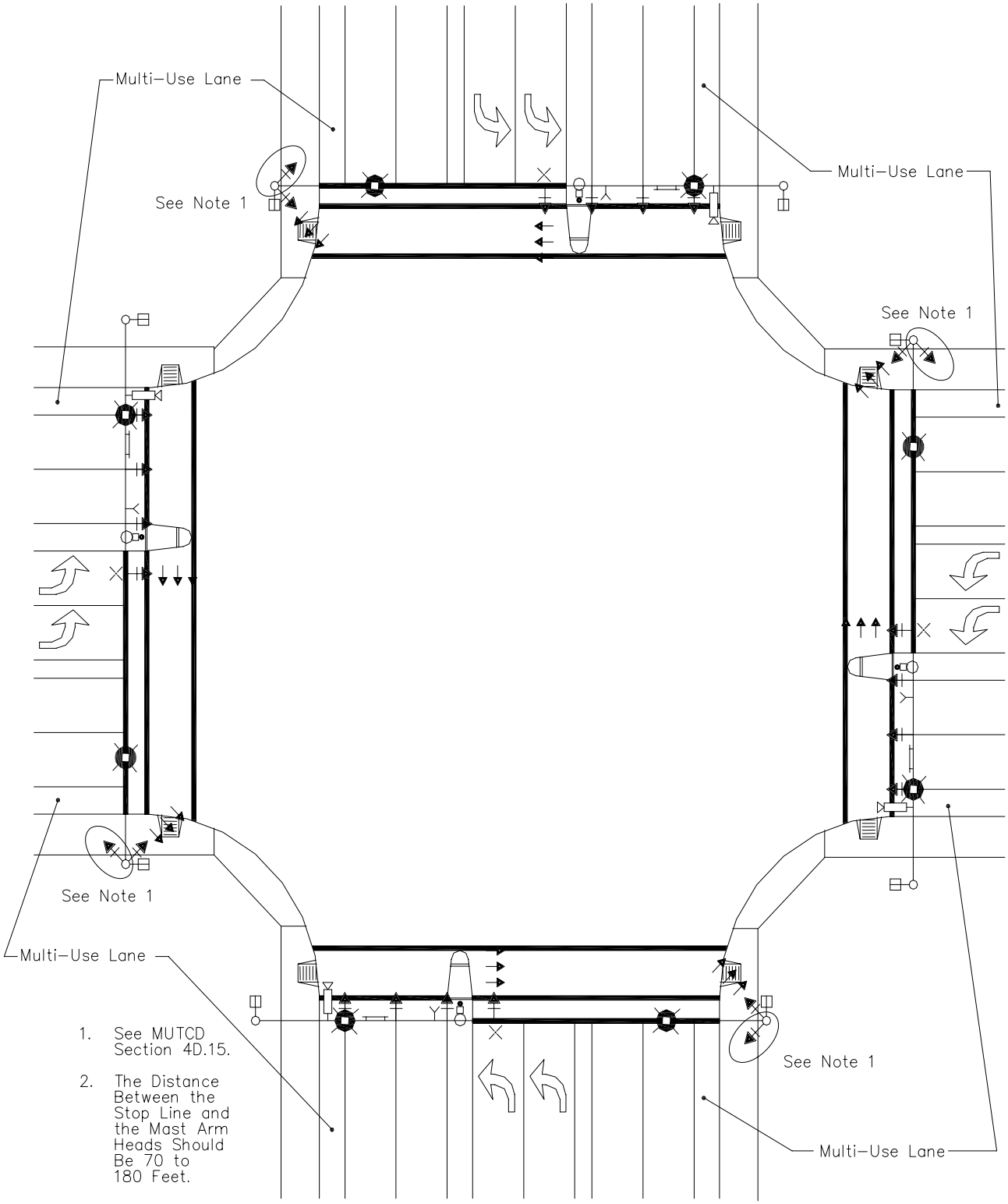


1. See MUTCD Section 4D.15.
2. The Distance Between the Stop Line and the Mast Arm Heads Should Be 70 to 180 Feet.

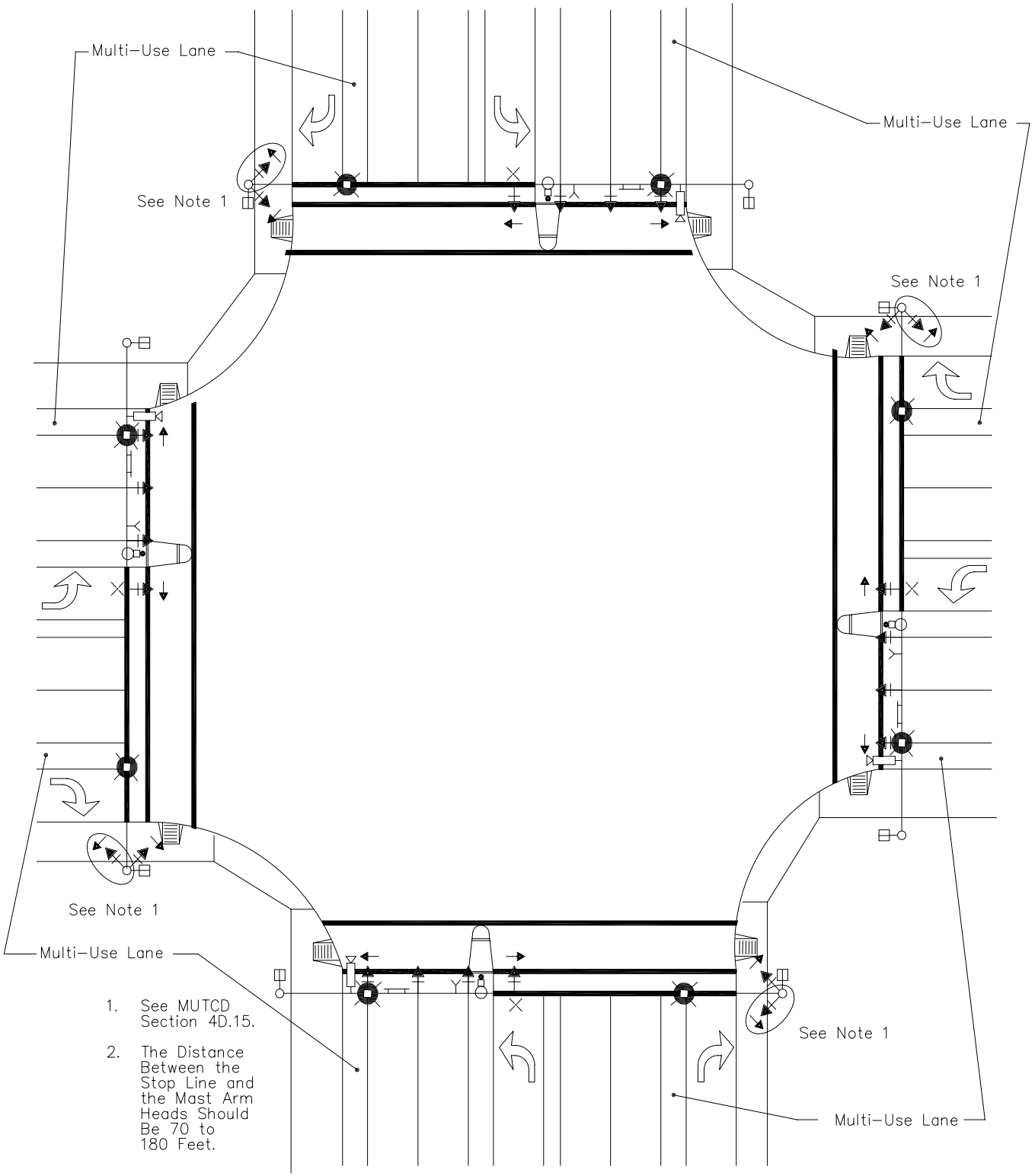
ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-4
REVISED: 11/2007		Pole Placement Standards & Guidelines 4L Divided X 4L Divided		**PAGE:** 2-7



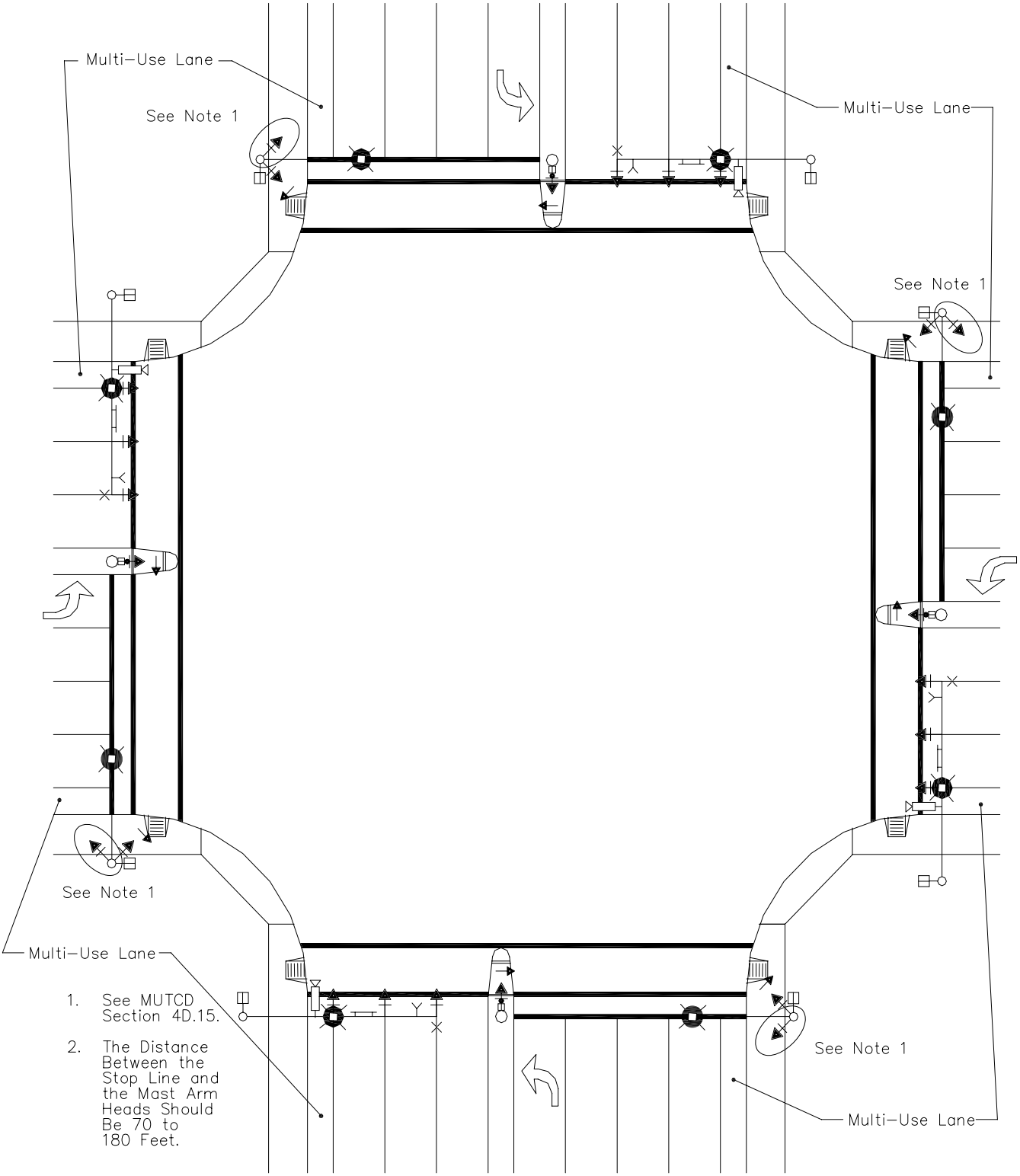
ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-5
REVISED: 11/2007		Pole Placement Standards & Guidelines 5L Undivided X 5L Undivided		**PAGE:** 2-8



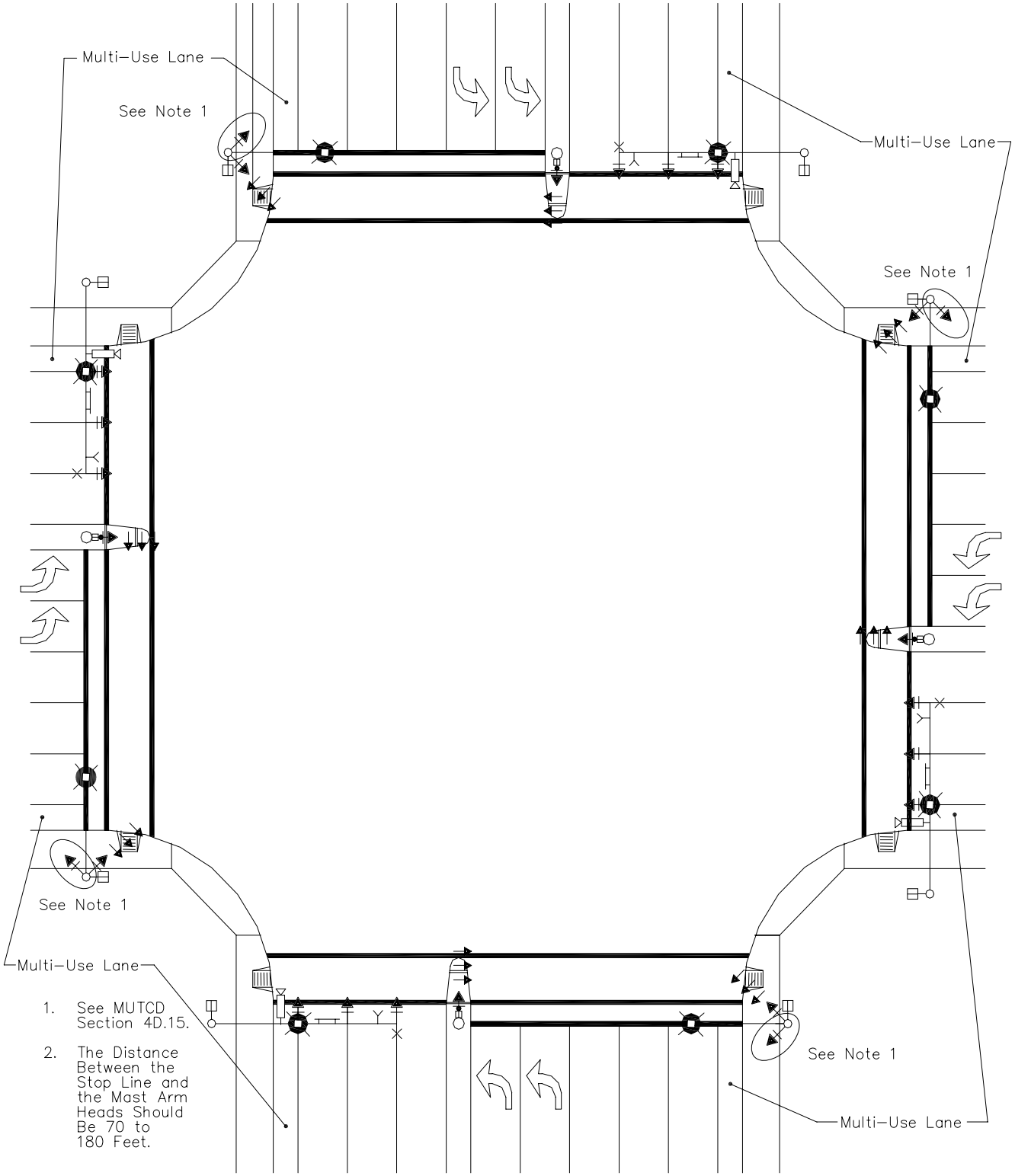
ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-6
REVISED: 11/2007		Pole Placement Standards & Guidelines 4L Divided X 4L Divided, Dual Left		**PAGE:** 2-9



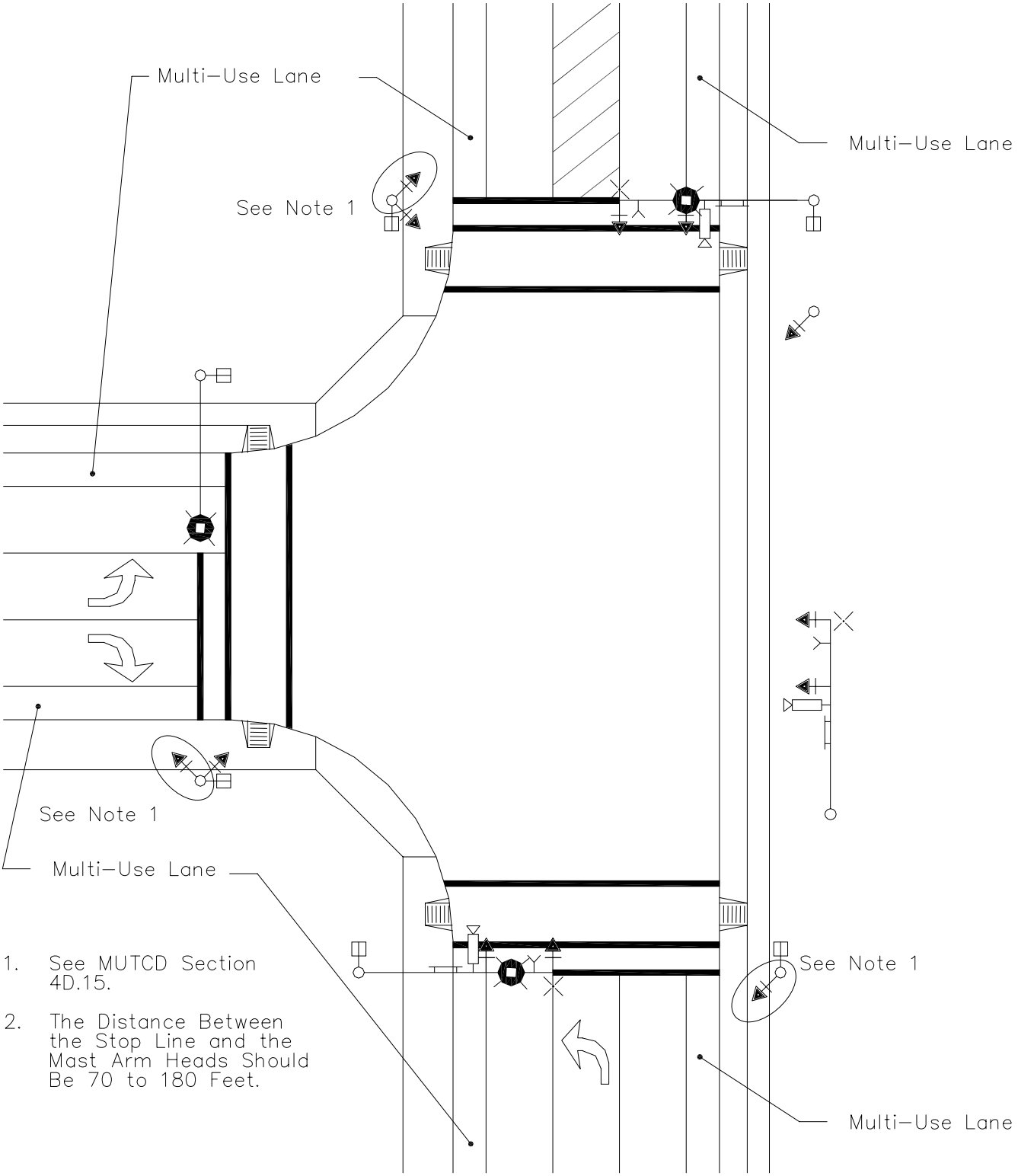
ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-7
REVISED: 11/2007		Pole Placement Standards & Guidelines 4L Divided X 4L Divided, Right Turn Lane		**PAGE:** 2-10



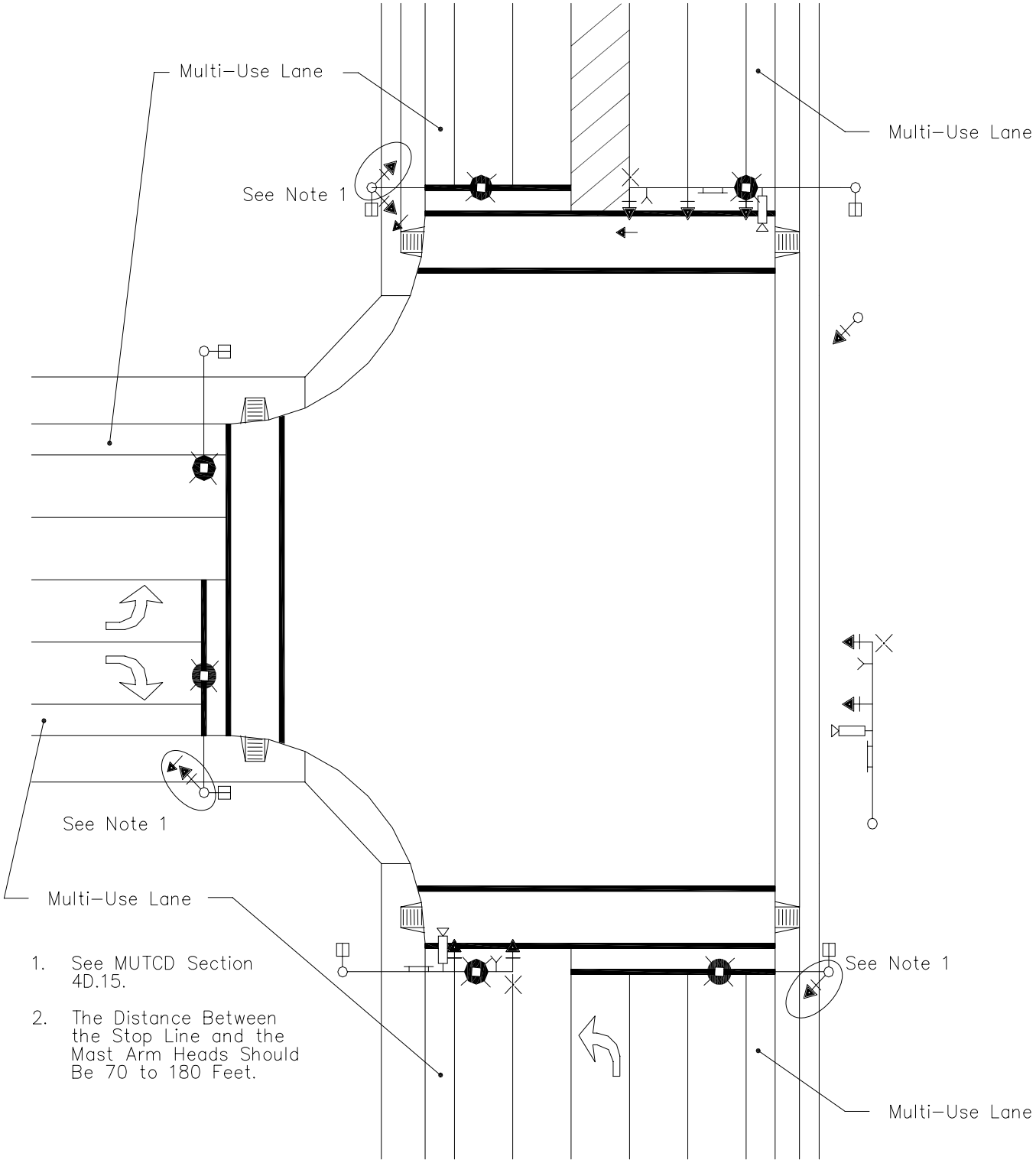
ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-8
REVISED: 11/2007		Pole Placement Standards & Guidelines 6L Divided X 6L Divided		**PAGE:** 2-11



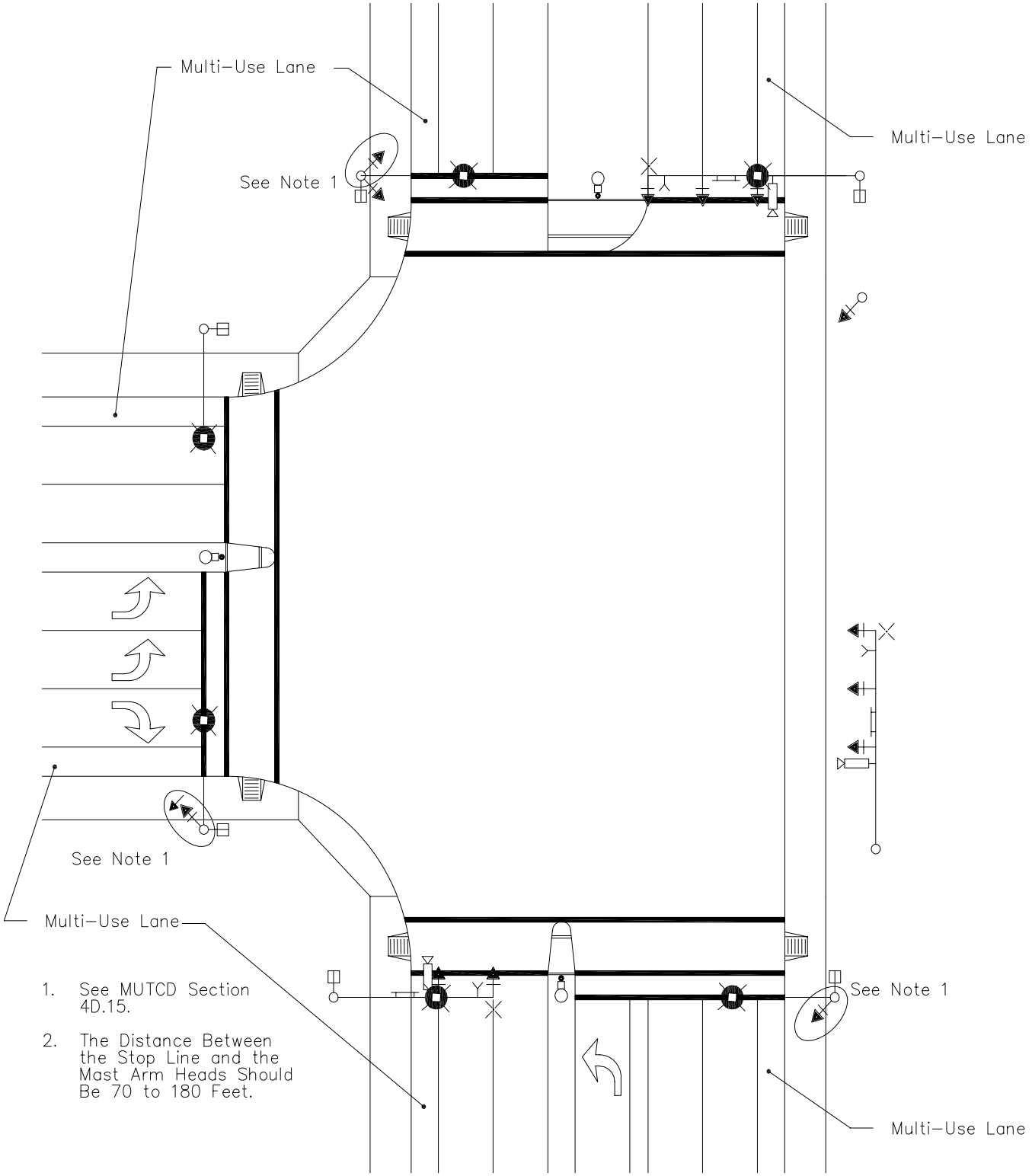
ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-9
REVISED: 11/2007		Pole Placement Standards & Guidelines 6L Divided X 6L Divided, Dual Left		**PAGE:** 2-12



ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-10
REVISED: 11/2007		Pole Placement Standards & Guidelines 3L Undivided X 3L Undivided, T-Intersection		**PAGE:** 2-13



ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-11
REVISED: 11/2007		Pole Placement Standards & Guidelines 5L Undivided X 4L Undivided, T-Intersection		**PAGE:** 2-14



ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 2-12
REVISED: 11/2007		Pole Placement Standards & Guidelines 4L Divided X 4L Divided, Dual Left, T-Int.		**PAGE:** 2-15

3. TRAFFIC SIGNAL FACES AND MOUNTING HARDWARE

A. Traffic Signal Indications

1. All signal lenses shall be 12-inch diameter.

2. All traffic signal and pedestrian indications shall utilize light emitting diodes (LEDs) as the light source. All arrow indications shall be LED.

3. All signal lenses shall be tinted to the color of the indication.

B. Traffic Signal Faces

1. Typical traffic signal faces should be yellow polycarbonate. The traffic signals at signalized intersections shall be Type F, Q, R, or as illustrated in MUTCD Figure 4D-3 (o), which should be used for span-wire installations. All signal faces should have black aluminum louvered back plates.

2. Optically programmed or louvered heads may be used if the physical geometry or operational problems indicate their use. The PCDOT/TED Project Manager must approve the use of optically programmed or louvered heads.

3. Left turn signal faces shall be Type Q or R, or MUTCD Figure 4D-3 (o). Type R faces are used for POLT phasing.

4. Right turn signal faces shall be Type Q or R. Type R faces are used for PORT phasing.

5. Type D and E signal faces shall be used as flashing beacons (see Chapter 11 of this manual).

6. Traffic signal faces are shown in Standard Detail T 801 of the current Pima County/City of Tucson Standard Details for Public Improvements.

C. Placement Considerations For Traffic Signal Faces

Placement of traffic signal faces will consider the following:

1. The requirements of MUTCD Sections 4D.15, 4D.16, and 4D.17 shall be satisfied.

2. Minimum spacing of traffic signal faces should be 12 feet.

3. Traffic signal faces for one direction of travel should not obstruct the visibility of signal faces for any other direction of travel.

4. Install one overhead signal face per through lane and one overhead signal face for a turn lane that is not controlled by a turn signal. Use a minimum of two overhead faces per approach.

5. Typically, provide a far left signal face.

6. Position overhead traffic signal faces to align with edge lines, lane lines and centerlines/medians, plus or minus three feet.

7. Provide two faces for left turn lanes, as discussed below:

    a. Single left-turn lane – Provide one overhead face positioned over the right edge of center median or center double yellow line. Provide a second face on far left corner on a Type A pole or street light pole near the stop line for opposing traffic.

    b. Dual left-turn lane – For four-lane divided roads, provide one overhead signal face aligned with the line separating the left turn lanes. Provide a second signal face on the far left corner, as discussed in item a, above. For six-lane divided roads, replace the overhead signal face with a signal face mounted on a Type A pole in the median. Provide a second far left signal face as discussed in item a, above.

8. Provide two signal faces for right-turn lanes with right-turn signal phasing, as detailed below:

    a. Provide an overhead signal face aligned with the right side of the right turn lane.

    b. Provide a near right signal face on a Type A pole or street light pole near the stop line.

9. Additional signal faces may be needed when the view of the normal signal faces are concealed from approaching drivers due to horizontal or vertical alignment.

Refer to Figures 2-2 through 2-12 for sample drawings illustrating common intersection and signal configurations.

D. Traffic Signal Mounting Hardware

All mounting assemblies for traffic signals mounted on mast arms and poles should conform with Table 3-1.

Table 3-1
Mounting Assemblies for Type F, Q, and R Signal Faces On Mast Arms and Poles

	Type of Mounting Assembly by Mounting Location		
	Mast arms	A pole	Side of pole
Type of Mounting	Astro Brackets	Type XI	Type V Type VII Type VIII

4. PEDESTRIAN CONTROL FEATURES

As with curb-access ramps, pedestrian control features need to meet accessibility standards.

A. Conventional Pedestrian Signals

1. Conventional pedestrian signals are typically utilized for all legs of all intersections. There may be occasions where some legs of some intersections will be without crosswalks. These will be intersection and project specific.

2. Pedestrian signals will be of the conventional type, as depicted in the Pima County/City of Tucson Standard Details for Public Improvements, unless otherwise approved by the PCDOT/TED Project Manager.

B. Accessible Pedestrian Signals

1. Accessible Pedestrian Signals are described in detail in the MUTCD Section 4E.06. Accessible pedestrian signals communicate information about pedestrian signal timing in a non-visual format, through the use of audible tones (or verbal messages) and vibrating surfaces.

2. Upon request for an accessible signal for a particular location, PCDOT/TED will conduct an engineering study that considers the safety and effectiveness for pedestrians in general, as well as the information needs of pedestrians with visual disabilities. Accessible pedestrian signals should conform with MUTCD Section 4E.06.

C. Pedestrian Signal Indications and Push Buttons

1. Pedestrian signal indications shall utilize light emitting diodes (LEDs).

2. Pedestrian signal indications shall be side by side, and filled in.

3. The pedestrian push button shall be a 2-inch stainless steel ADA button.

D. Placement Considerations For Pedestrian Signal Heads and Detectors

1. Mount the pedestrian push button adjacent to the landing on the sidewalk area leading to the crosswalk.

2. Mount the pedestrian push button no further than 5 feet from the extension of the crosswalk lines and within 10 feet of the curb line, unless the curb ramp is longer than 10 feet.

3. For two pedestrian push button stations on the same corner, mount the pedestrian push buttons on poles or posts separated by at least 10 feet. (Refer to MUTCD Figure 4E-2)

4. The control face of the push button should be parallel to the direction of the crosswalk controlled by the push button, and no closer than 30 inches to the curb line (from the Final Report of the Public Rights of Way Access Advisory Committee of the US Access Board, January 10, 2001).

5. Mounting pedestrian push buttons to support poles for pedestrian signal indications is acceptable when the push button activates the pedestrian signal mounted on the same pole and the control face of the push button should be parallel to the direction of the crosswalk controlled by the push button.

6. Typically, pedestrian push button stations are installed in medians on pedestrian push button posts, or on type A poles.

7. Pedestrian signal heads should be placed to maximize the visibility of the signal for pedestrians using the crosswalk for which the signal head provides indications.

E. Other Pedestrian Control Features

1. Pedestrian push button signing should be R10-3b in the 2003 MUTCD, Page 2B-40.

2. Mounting assemblies for pedestrian signal indications should be type XI mounts.

3. Installation of Pedestrian Controls for Equestrians is site specific. Any installation of Pedestrian Controls for Equestrians must be approved by the County Traffic Engineer.

5. LIGHTING REQUIREMENTS FOR TRAFFIC SIGNAL INSTALLATIONS

PCDOT/TED does not support advance intersection street lighting. Intersection lighting is included at signalized intersections. The following are considerations for intersection street lighting.

A. Considerations for Intersection Lighting

1. Illuminate each approach. At a minimum, utilize one luminaire for each leg of the intersection. Wider streets, higher volumes and/or urban conditions may require two fixtures per leg.

2. Location of luminaire poles should meet guidance contained in Chapter 2 of this document.

3. Light distribution should conform with the current Pima County Outdoor Lighting Code.

4. All installations should meet the current *National Electric Code* requirements.

5. Roadway Lighting – The current Illuminating Engineering Society of North America, ANSI/IESNA RP-8, provides guidelines that can be used by the designer upon approval of the PCDOT/TED Project Manager.

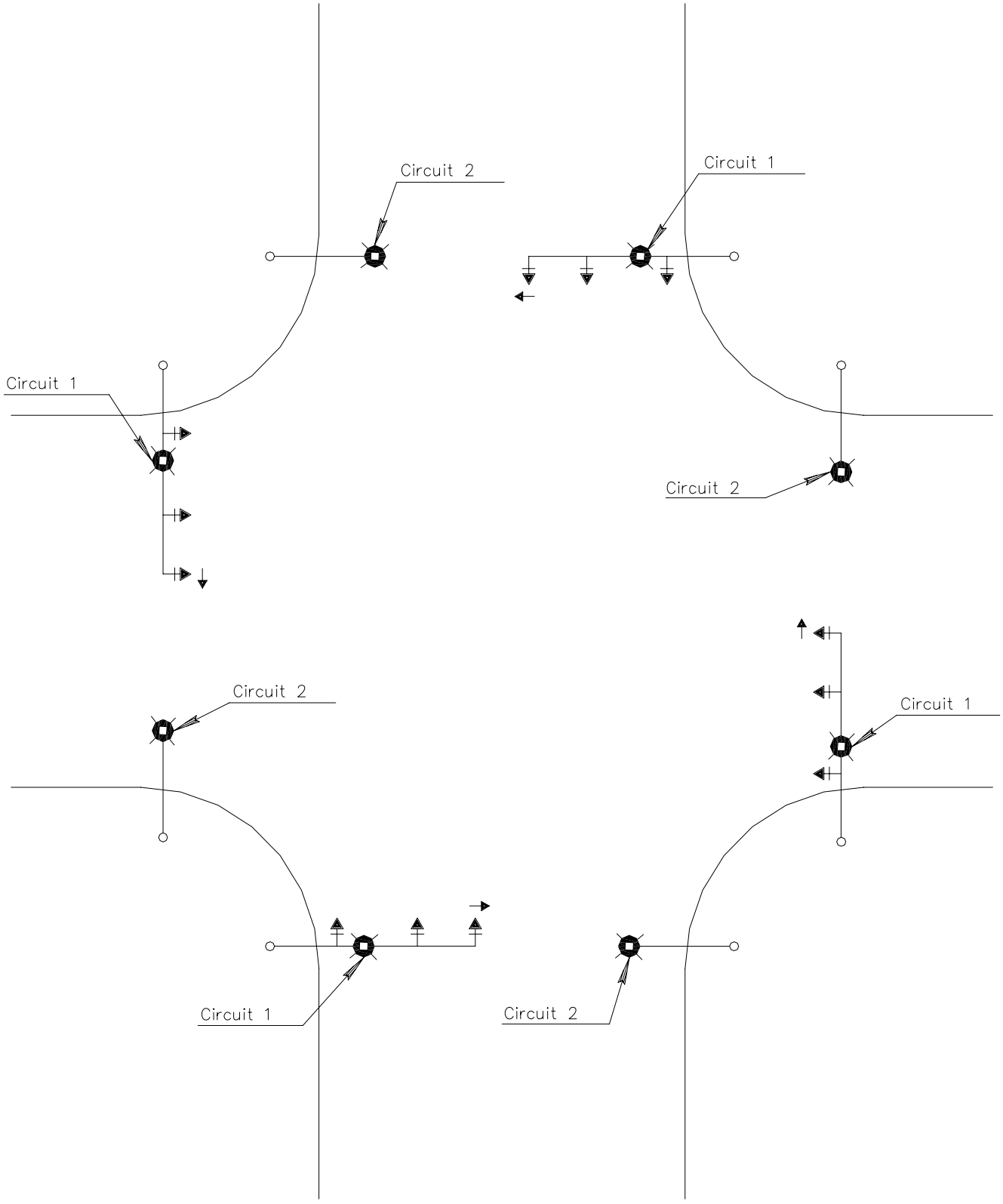
B. Lighting Requirements for Traffic Signal Installations

1. Intersection lighting shall use 120 volt, 400 watt, high pressure sodium luminaires with horizontal cut-off lenses meeting Pima County/City of Tucson specifications. Prior approval for wattage and voltage from PCDOT/TED Project Manager is required, if the intersection design does not conform to the current Street Lighting and ITS Conduit Design Manual.

2. The street lighting photo electric cell shall be mounted on the luminaire on the pole closest to the traffic signal controller cabinet.

3. For corners with dual luminaires, provide alternating separate circuits for each luminaire.

4. Power for the street lighting should come from the traffic signal controller cabinet. Refer to Figure 5-1 for circuit design.



ISSUED: 01/2002		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 5-1
REVISED: 11/2007		Lighting Requirements for Traffic Signal Street Lighting Circuit Diagram		**PAGE:** 5-2

6. CONTROLLER CABINET AND ELECTRIC SERVICE PEDESTAL

A. Equipment Requirements

1. The electric service pedestal installed shall be 120/240 volt 125 amp metered Myers MEUG16-125 WTB or equivalent. The equipment shall meet local utility company design requirements.

2. The controller cabinet shall be a NEMA TS 2-1998 Type 1, TS 2 Size 6, Detector Rack Configuration 1, equipped for video detection and all peripherals for a functional eight-phase signal.

3. The traffic signal controller shall be NEMA TS 2 Type 2 controller, specifically; an Econolite ASC/2-2100 shall be supplied and installed.

4. An uninterrupted power supply (UPS) may be required (Note: the UPS may also be referred to as a battery backup system or BBS). The UPS shall be an Airpax Dimensions, Inc. 24M11 with 2 (two) 105 Ah, group 31 AGM batteries installed in an Airpax Dimensions 392614 enclosure with 2 (two) removable shelves (or approved equal).

B. Placement Requirements

1. Controller cabinet and electric service pedestal foundations shall be positioned beyond the AASHTO clear zone requirement of both roadways.

2. Controller cabinets shall be located to provide technicians working at the controller cabinet visibility of the indications on both streets.

3. Controller cabinets and electric service pedestals shall not be located in areas susceptible to water immersion, flooding, or sprinkler spray.

4. The UPS cabinet shall be located adjacent to the electric service pedestal on a shared or common foundation.

7. VEHICLE DETECTION STANDARDS AND GUIDELINES

A. Detection Types and Considerations

The guidelines below include the use of both vehicle detection loops and video detection systems, balancing construction and maintenance costs while operating within the reliable range of effectiveness for video detection.

B. Detection Guidelines

1. Coordinated Signals on the Major Street Leg

    a. Typically, vehicle detection is not used on a major street leg of an intersection that is part of a coordinated traffic signal system.

    b. Vehicle detection for a left turn phase will be accomplished through the use of video detection.

2. Coordinated Signals on the Minor Leg with Posted Speeds of 25-30 mph

    a. Use video detection for all through and turn movements.

3. Coordinated Signals on the Minor Leg with Posted Speeds of 35-45 mph

    a. Video detection should be utilized for through and left turn movements instead of presence loops.

    b. Use pulse loops in advance of the intersection to detect an approaching vehicle.

4. Isolated Signals

    a. Use video detection for both major and minor street.

    b. Use pulse loops in advance of the intersection for both major and minor street approaches.

C. Video Detection System Requirements

1. Video detection system equipment shall conform to the requirements provided in the current Pima County/City of Tucson Standard Specifications for Public Improvements, unless noted otherwise in the construction documents.

2. The contractor shall install and align the video detection cameras and shall provide all field terminations.

3. Cameras are typically mounted on luminaire mast arms. (Twenty-foot mast arms on Type Q poles and 25 foot mast arms on Type R poles.)

4. Cameras shall not be mounted on Type 2, Type F or Type G poles.

D. Vehicle Loop Detection Guidelines

Vehicle loop detection guidelines apply when vehicle detection loops are utilized, as discussed above. In addition, vehicle loop detection may be used where horizontal and/or vertical geometries interrupt line of sight, or where glare may be an issue.

1. Vehicle loop detection deviating from the Detection Guidelines will be used upon direction by the Pima County Project Manager.

2. Driveways or median breaks on a minor leg near a traffic signal may require "call" vehicle detection loops, if video detection is not used.

3. Pulse loops are connected in series.

4. Vehicle Loop Detection Equipment

   a. Presence Loops

      i. Quadrupole presence loops (6' x 70') are typically used for left-turn lanes. A 50 foot distance should separate the approach edge of the loop from the center of the stop line. If used in a shared/right turn lane, establish the need for a short presence loop to serve the right turn movement or curve the loop parallel to the corner return.

ii. Quadrupole presence loops (4' x 10') are used for bicycle and golf cart detection when bike or auxiliary lanes are present. Its use is not necessary at legs of intersections equipped with video detection. A 10-foot distance separates the approach edge of the loop from the center of stop line.

b. Pulse Loops

i. Pulse loops (6' x 6') are typically used in advance of an intersection to notify the controller of an approaching vehicle. The distance from the center of the stop line to the center of the loop is the distance a vehicle travels in five seconds, based on the posted speed limit. See Table 7-1, below.

Table 7-1
Placement of Pulse Loops
(6'x6')

Posted Speed (mph)	Distance[1] (ft)
25	185
30	220
35	260
40	295
45	330
50	370

Note: [1] Calculated distance is from the center of the Stop Line to the center of the loop, rounded up to next 5 foot increment

8. CONDUCTOR CABLE REQUIREMENTS

A. General

1. Wiring for PCDOT traffic signals is based on the use of multiconductor cables rather than individual conductors. Wiring for street lighting uses individual conductors.

2. Signal conductors shall be IMSA 19-1 multiconductor cable in #14 AWG Solid 7- and 16-conductor configurations.

B. Signal Power Requirements

1. The power supply to the signal electric service pedestal shall meet local utility company design and service requirements.

2. The signal power conductors from the electric service pedestal to the controller cabinet shall consist of four #6 AWG THW or XHHW conductors, one #8 AWG THW or XHHW conductor and one #4 AWG bare copper conductor.
   The four #6 conductors shall be color coded with two white, one red and one green. The #8 conductor shall be color coded black.

C. Signal Conductor Requirements

1. Two unspliced IMSA 19-1 16-conductor cable should be installed from the controller cabinet to each corner of the intersection.

2. Each traffic signal head shall have a #14 AWG IMSA 7-conductor cable from the traffic signal terminal strip to the concrete pull box adjacent to the steel pole foundation.

3. Unspliced multiconductor signal cable runs from the controller cabinet shall terminate at the concrete pull box adjacent to the pole foundation.

4. Poles with pedestrian indications and push button stations should share one 7-conductor cable for both the push button and the pedestrian traffic signal.

5. A pedestrian push button located by itself should be powered by a #14 AWG IMSA 7-conductor cable.

D. Street Light Conductor Requirements

1. Intersection street light luminaires should be fed from the traffic signal controller cabinet.

2. Two #10 AWG XHHW conductors should be installed from each luminaire to the concrete pull box adjacent to the pole foundation.

3. Four #10 AWG XHHW conductors should be installed from the luminaire with photoelectric cell to the pull box adjacent to the pole.

4. Separate street light conductors should be run from the controller cabinet to each corner of the signalized intersection.

5. For corners with two street lighting fixtures, provide two circuits to the corner and wire each fixture on a separate circuit (see Figure 5-1).

E. Loop Detector Conductor Requirements

1. All vehicle roadway detection loop cable shall be #14 AWG IMSA 51-5-1985 stranded cable.

2. Loop detector lead-in cable from the loop pull box to the cabinet shall be #16 AWG IMSA 50-2-1984, shielded cable.

3. No splices shall be allowed in roadway detection loop cable or lead-in cable except at the pull box adjacent to loop.

4. Loop detector conductors should come in one conduit to the curb line, and cross the curb line perpendicularly. Provide separate saw cuts for each loop up to conduit. Each pulse loop detector shall have a separate lead-in cable to the controller cabinet.

F. Wireless Communications Requirements

1. Provide wireless communications hardware to establish communications between the signal controller and the regional mesh network, as shown on the detail plans and specifications available from Pima County.

2. Wireless video camera image connections to the mesh network may also be required, as determined by the Project Manager, and shall be as shown on the detail plans and specifications available from Pima County.

G. Emergency Vehicle Pre-emption Conductor Requirements

1. The emergency vehicle pre-emption sensor cable shall be Opticom Detector Cable Model 138.

2. Conductors for preemption beacons shall be two No. 14 conductors, as specified in Section 732 of the Pima County/City of Tucson Standard Specifications for Public Improvements. One conductor shall be colored blue and one conductor shall be colored white.

H. Video Detection Requirements

1. Econolite cable, Part No. 1175-00X, shall be installed, unspliced, from the pole hand hole to the controller cabinet.

2. The contractor shall determine spool length. Part No. 1175-005 is a 500' spool. Part No. 1175-003 is a 1000' spool.

9. CONDUIT AND PULL BOX REQUIREMENTS

A. General Requirements

1. Provide conduit to each corner of the intersection in a ring configuration, under all intersection approaches.

2. Provide separate conduit for low-voltage and high-voltage conductors.

   a. Low voltage conductors include: emergency pre-empt sensor, telephone interconnect, detector cable, and video to the controller cabinet.

   b. High voltage conductors include: signal and street lighting conductors, emergency-vehicle pre-emption beacon, photo cell, and bare bond.

3. Number all conduit runs on plan sheet.

B. Conduit Size and Placement

1. See Figure 9-1 for conduit size guidelines.

2. For divided highways, conduit for advance pulse loops should be installed in the median.

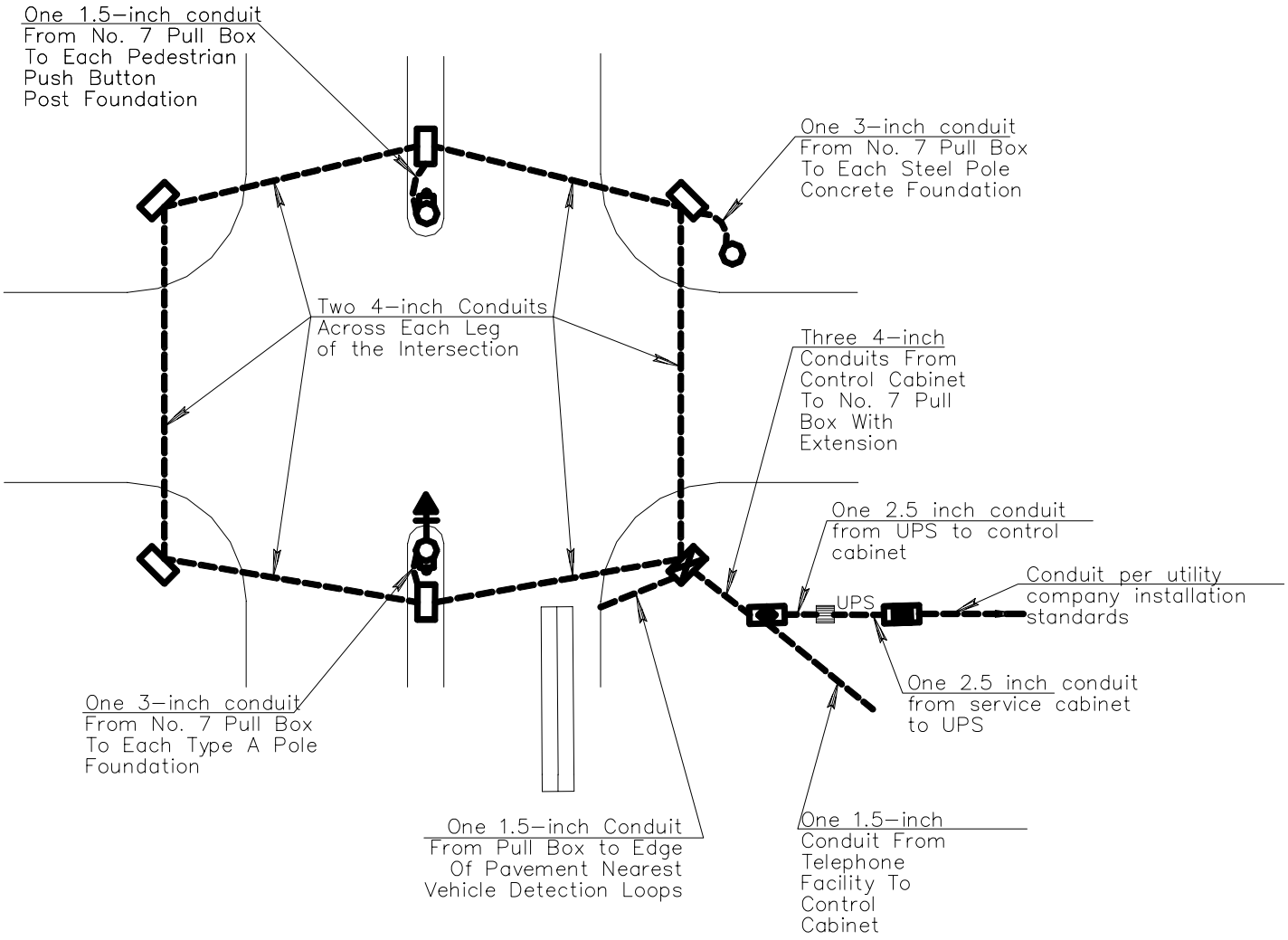
3. Conduit that is installed under existing paved driveways that are not scheduled to be reconstructed as part of this project should be installed by means of boring.

C. Pull Box Considerations

1. A No. 7 pull box with extension should be installed on the same corner as the traffic signal controller cabinet. A ¾ in. x 10 ft. ground rod shall be installed in the No. 7 pull box with extension adjacent to the controller cabinet. Two ground rod clamps shall be furnished for grounding the ground wire.

2. For all other corners, typically a No. 7 concrete pull box is installed near each steel pole foundation (one per corner), except Type 2, Type G and Type A poles, which may have a No. 3 ½ pull box adjacent to the foundation.

3. When signal cable crosses the roadway, install a No. 7 pull box in the median nose, adjacent to the pedestrian push button post.


One 1.5–inch conduit
From No. 7 Pull Box
To Each Pedestrian
Push Button
Post Foundation
One 3–inch conduit
From No. 7 Pull Box
To Each Steel Pole
Concrete Foundation
Two 4–inch Conduits
Across Each Leg
of the Intersection
Three 4–inch
Conduits From
Control Cabinet
To No. 7 Pull
Box With
Extension
One 2.5 inch conduit
from UPS to control
cabinet
Conduit per utility
company installation
standards
UPS
One 2.5 inch conduit
from service cabinet
to UPS
One 3–inch conduit
From No. 7 Pull Box
To Each Type A Pole
Foundation
One 1.5–inch Conduit
From Pull Box to Edge
Of Pavement Nearest
Vehicle Detection Loops
One 1.5–inch
Conduit From
Telephone
Facility To
Control
Cabinet

4. Install No. 3 ½ pull boxes in medians or shoulders for detection cable.

5. Pull boxes should not be located in drainage areas susceptible to water immersion or flooding.

6. Pull boxes shall not be installed within concrete wheelchair ramps. In addition, any pull boxes installed behind curbs shall be installed between the curb and the proposed/future sidewalk or beyond the proposed/future sidewalk (except when pull boxes are installed in a median.)

7. Any pull boxes installed along an uncurbed roadway should not be within 10 feet of the pavement edge.

D. ITS Improvements

1. In addition to the conduit run for low- and high-voltage traffic signal circuits, a second conduit run in a ring configuration, may be required, under each leg of the intersection, for low-voltage fiber-optic cable in future ITS applications. The TED Manager shall determine if ITS conduit shall be required.

    a. Use 4-inch conduit with four 1-inch inner ducts. Provide three feet of slack for each inner duct in the pull box.

    b. Install a No. 7 pull box with extension at each corner.

    c. Outside of the inner duct, run an unspliced #6 AWG green THW/XHHW for locating the conduit run.

2. Refer to special provisions regarding installation of fiber optic conduit and pull boxes.

3. Install 2-inch conduit to connect fiber optics pull box to traffic signal pull box on the cabinet corner.

10. OTHER TRAFFIC SIGNAL RELATED EQUIPMENT

A. Emergency Vehicle Pre-emption Systems

1. All Pima County traffic signal designs shall include Emergency Vehicle Pre-emption Systems. These systems include detectors, beacons and associated wiring and cabling.

2. Beacons and detectors shall be centered between the signal head at the signal mast arm tip and the first inboard signal head. Refer to the signal detail sheet for the mounting bracket assembly detail.

3. The minimum detection range for approaching emergency vehicles shall be 1800 feet. Auxiliary detectors may be required to maintain the minimum detection range.

B. Street Name Signs

1. Street Name Signs shall be attached to the major signal mast arm for each approach to the intersection.

2. Refer to the current Pima County/ City of Tucson Signing Manual for additional information related to street name signs. Also, refer to PCDOT Process/ Procedure Guideline 05.13, “Street Name Sign Standards”.

11. OTHER TRAFFIC SIGNALS

All installation discussed below should conform to the Manual on Uniform Traffic Control Devices (MUTCD).

A. Intersection Control Beacons

1. An intersection control beacon is used only at an intersection to control two or more directions of travel. It consists of one or more signal faces directed toward each approach to the intersection, flashing circular yellow or circular red signal indications.

2. Intersection control beacons may be used at intersections where traffic or physical conditions do not justify conventional traffic control signals but crash rates indicate the possibility of special need.

B. Warning Beacons

1. A warning beacon may be used to supplement an appropriate warning or regulatory sign or marker, and consists of one or more signal sections of a standard traffic signal face with a flashing circular yellow signal indication in each signal section.

2. Typical applications of warning beacons may include:

   a. At obstructions in or immediately adjacent to the roadway.

   b. As supplemental emphasis to warning signs.

   c. On approaches to intersections where additional warning is required, or where special conditions exist.

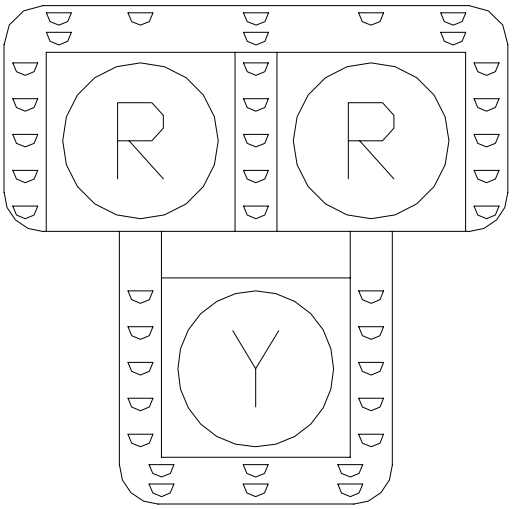
3. The condition or regulation justifying warning beacons should largely govern their location with respect to the roadway.

4. Warning beacons should be operated only during those periods when the condition or regulation exists.

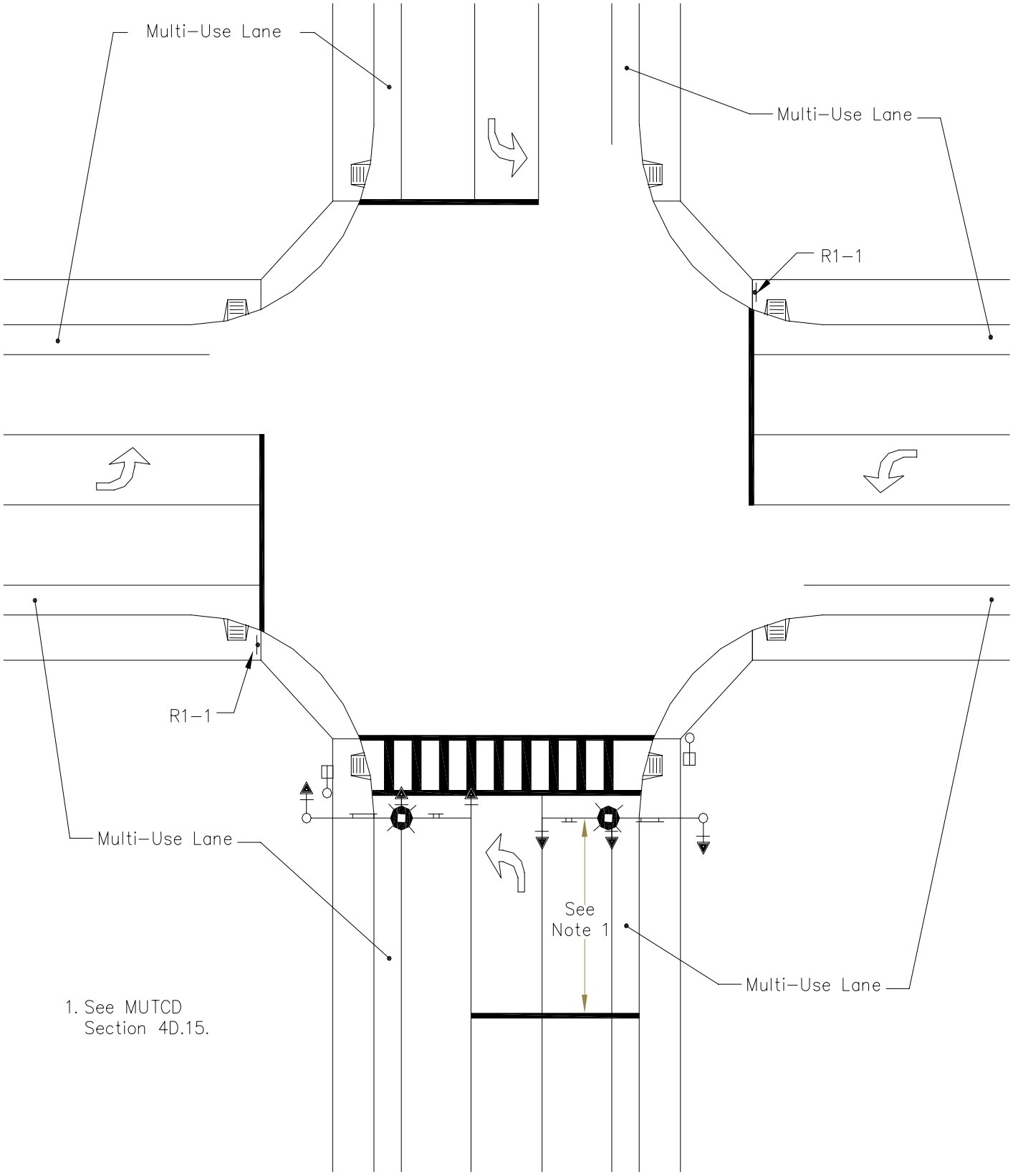
C. Pedestrian Activated Signals

1. HAWK Crossing. A HAWK crossing is a pedestrian-actuated traffic control device, used to alert and stop motorists in order to permit pedestrians to cross the street safely. HAWK crossings are most often used near schools and other high volume pedestrian traffic areas, where a traffic signal is not warranted. In addition to crosswalk markings on the pavement, a HAWK crossing consists of traffic signal poles, street lighting, pedestrian push buttons, and modified "F" signal heads (see Figure 11-1). Pedestrians activate the crossing cycle using a standard pedestrian push button. The pedestrian movement is controlled by standard pedestrian indications that display "Don't Walk", "Walk" and flashing "Don't Walk" symbols. When no pedestrians are present, the pedestrian indications display the "Don't Walk" symbol continuously, until the crossing cycle is activated by a pedestrian. Vehicular traffic signals are active only during the crossing cycle, and go dark once the pedestrian crossing clearance period has terminated.

Figure 11-1
Modified "F" signal head

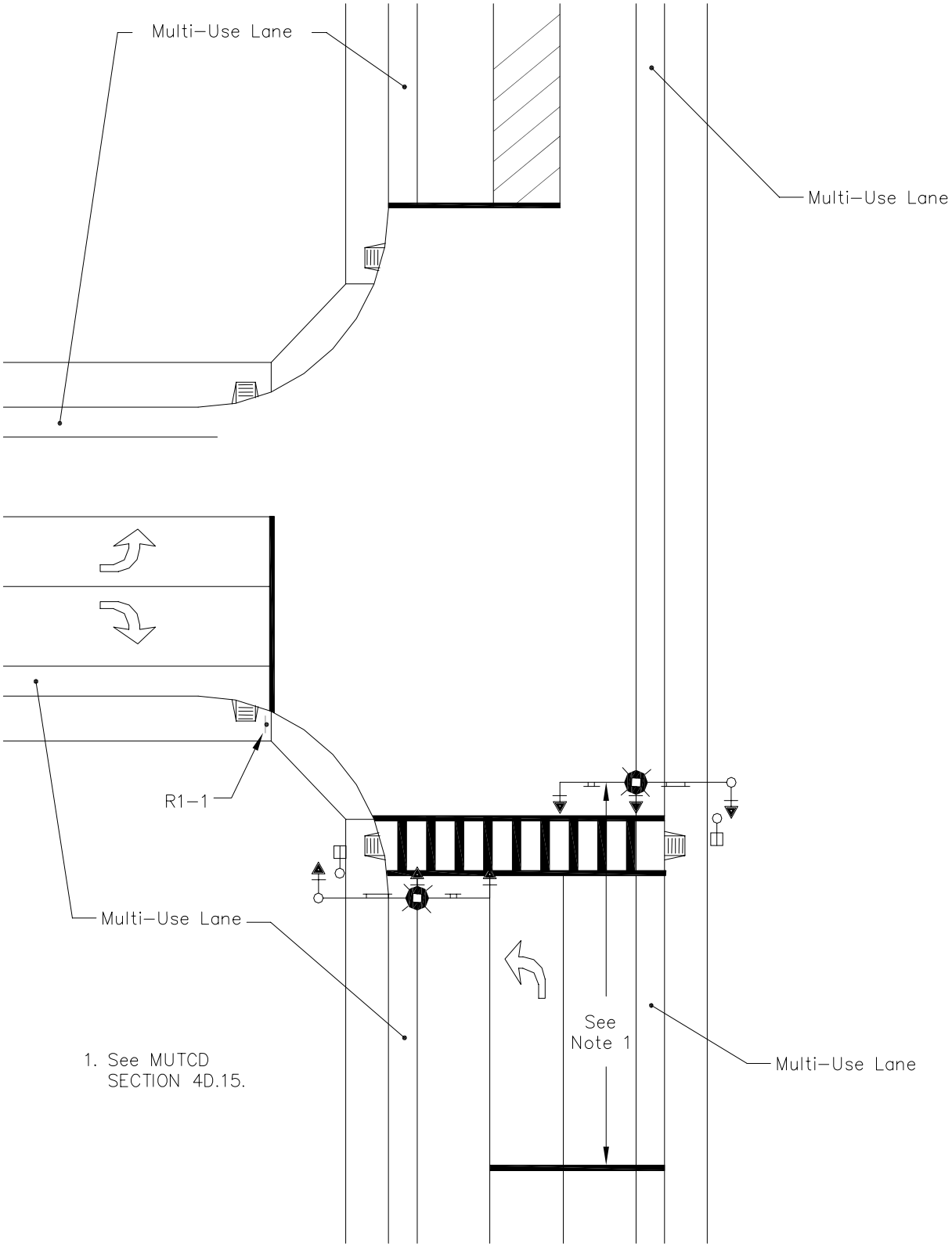


See Figures 11-2 through 11-4 for sample drawings illustrating common HAWK crossings and signal configurations.

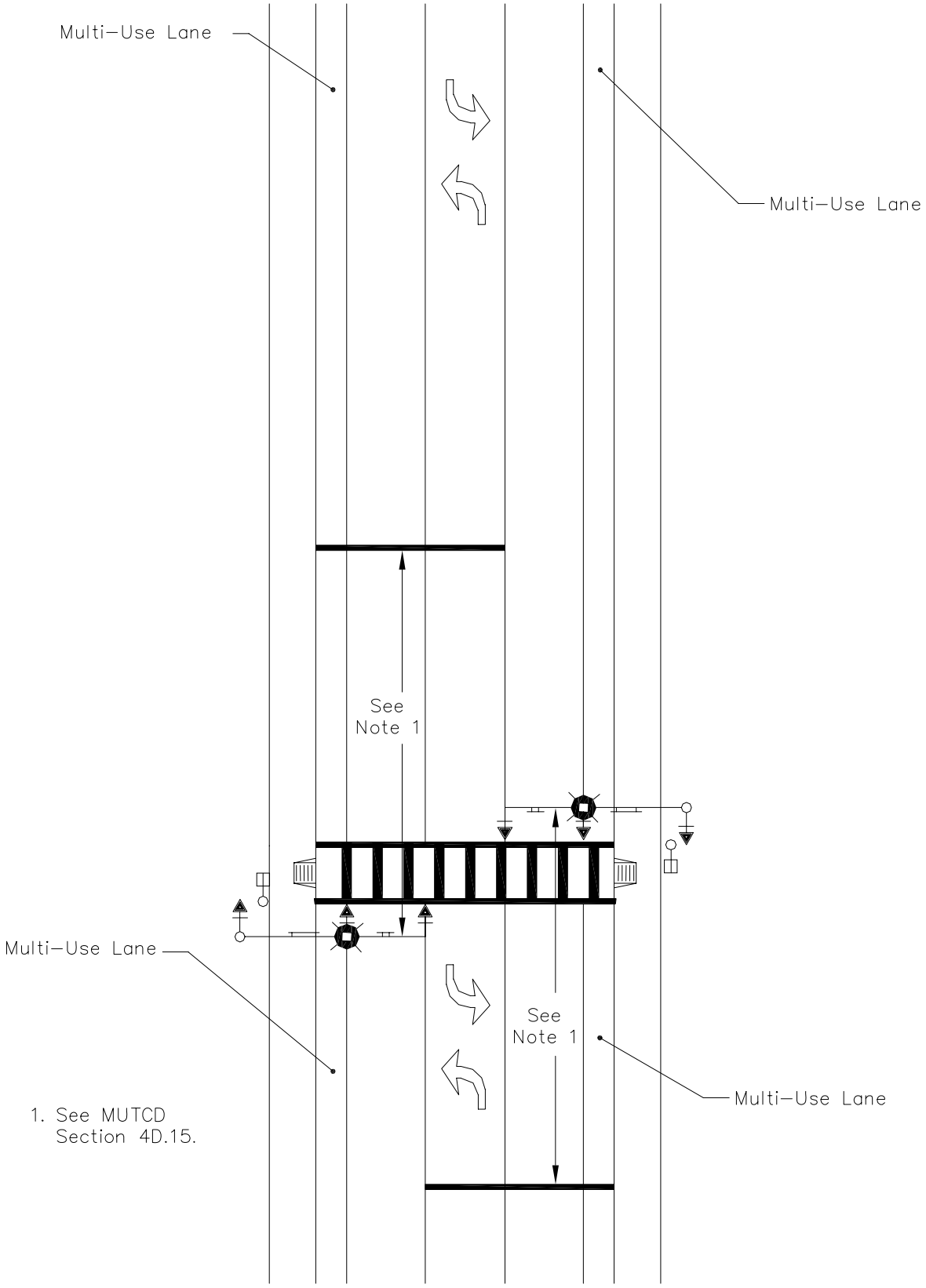


1. See MUTCD Section 4D.15.

ISSUED: 11/2007 **REVISED:**		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL** Other Traffic Signals – (HAWK) Pole Placement Standards & Guidelines 3L Undivided X 3L Undivided		**FIGURE:** 11-2 **PAGE:** 11-3



ISSUED: 11/2007		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL**		**FIGURE:** 11-3
REVISED:		Other Traffic Signals – (HAWK) Pole Placement Standards & Guidelines 3L Undivided X 3L Undivided, T-Intersection		**PAGE:** 11-4



1. See MUTCD Section 4D.15.

ISSUED: 11/2007 **REVISED:**		**PCDOT TRAFFIC SIGNAL DESIGN MANUAL** Other Traffic Signals – (HAWK) Pole Placement Standards & Guidelines 3L Undivided, w/ TWLTL		**FIGURE:** 11-4 **PAGE:** 11-5

APPENDIX A

SAMPLE SIGNALIZED

INTERSECTION DESIGN PLANS

Note:
In this appendix, sample plans have been provided for sheet 3, the "Plan View", and sheet 4, the "Pole Schedule and Multiconductor Cable Schematics Sheet", of the typical traffic signal design plan set.

Please refer to Chapter 1, Section F, "Sheet Assignment", for detailed information about the preparation and composition of a typical plan set.

Sheet 1, the "Cover Sheet", has not been included in this appendix. Refer to the current Pima County Roadway Design Manual for the development of this sheet.

Sheet 2, the "General Traffic Signal Notes and Responsibilities Sheet", has not been included in this appendix. Appendix B lists the notes and responsibilities placed on this sheet. A current "General Traffic Signal Notes and Responsibilities Sheet" may be obtained from the PCDOT/TED in MicroStation format for use by a designer of a traffic signal plan.

Sheet 5, the "Pima County Traffic Signal Detail Sheet", has also not been included in this appendix. A current "Pima County Traffic Signal Detail Sheet" may be obtained from the PCDOT/TED in MicroStation format for use by a designer of a traffic signal plan.

PROPOSED TRAFFIC SIGNAL PHASING

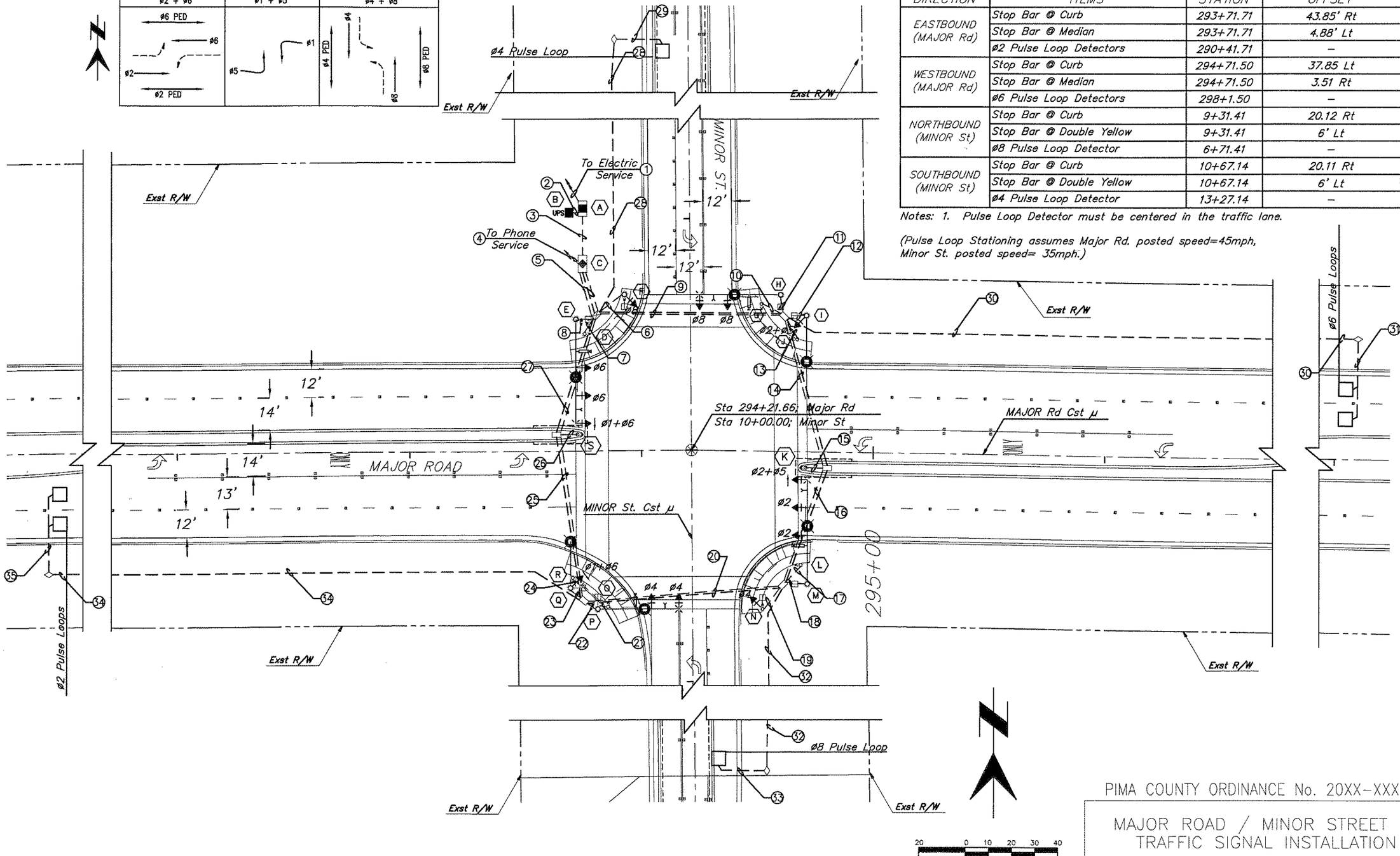
ø2 + ø6	ø1 + ø5	ø4 + ø8
ø6 PED, ø6, ø2, ø2 PED	ø5, ø1	ø4, ø4 PED, ø8, ø8 PED

STOP LINE AND LOOP DETECTOR LOCATIONS

DIRECTION	ITEMS	STATION	OFFSET
EASTBOUND (MAJOR Rd)	Stop Bar @ Curb	293+71.71	43.85' Rt
	Stop Bar @ Median	293+71.71	4.88' Lt
	ø2 Pulse Loop Detectors	290+41.71	–
WESTBOUND (MAJOR Rd)	Stop Bar @ Curb	294+71.50	37.85 Lt
	Stop Bar @ Median	294+71.50	3.51 Rt
	ø6 Pulse Loop Detectors	298+1.50	–
NORTHBOUND (MINOR St)	Stop Bar @ Curb	9+31.41	20.12 Rt
	Stop Bar @ Double Yellow	9+31.41	6' Lt
	ø8 Pulse Loop Detector	6+71.41	–
SOUTHBOUND (MINOR St)	Stop Bar @ Curb	10+67.14	20.11 Rt
	Stop Bar @ Double Yellow	10+67.14	6' Lt
	ø4 Pulse Loop Detector	13+27.14	–

Notes: 1. Pulse Loop Detector must be centered in the traffic lane.

(Pulse Loop Stationing assumes Major Rd. posted speed=45mph, Minor St. posted speed= 35mph.)



PIMA COUNTY ORDINANCE No. 20XX-XXX

MAJOR ROAD / MINOR STREET TRAFFIC SIGNAL INSTALLATION

PLAN VIEW

SCALE: 1"=20' | SHEET TS3 OF TS5

PRISCILLA S. CORNELIO, P.E. DIRECTOR

MAJOR ROAD/ MINOR STREET TRAFFIC SIGNAL

		DATE
DESIGNED	T.E.D. STAFF	11/2007
DRAWN	A. ORTA	11/2007
CHECKED	D. PITTENGER/C. LUTICH	11/2007
PROJ.ENGR.	T.E.D. STAFF	11/2007

NO.	REVISION DESCRIPTION	DIV/SECT.ENGR.	DATE

PIMA COUNTY DEPARTMENT OF TRANSPORTATION

PIMA COUNTY
DEPARTMENT OF TRANSPORTATION
TRAFFIC ENGINEERING DIVISION

W.O. # 4MARMS

1-800-782-5348

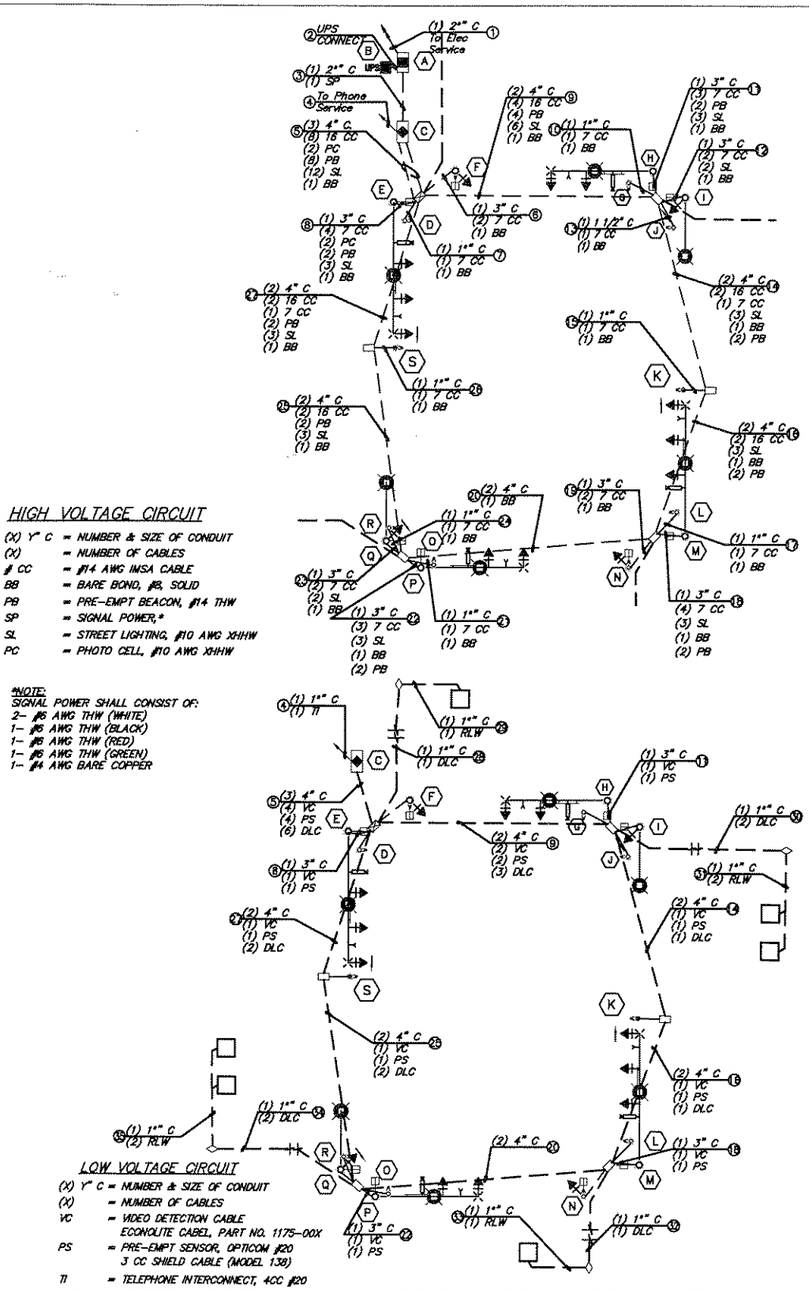
CABINET AND POLE SCHEDULE

CABINET	TYPE	CONTROLLER	AUX CONTROL	REMARKS	LOCATION	STANDARDS
(A)	MYERS 125 AMP 120/240V MUEG16-125WTB	METERED SERVICE PEDESTAL W/2 SINGLE POLE 50 AMP CIRCUIT BREAKERS	(1) 50 AMP SINGLE POLE BREAKER FOR SIGNAL (1) 50 AMP SINGLE POLE BREAKER FOR LIGHTING	SHARE FOUNDATION W/ UPS. FOUNDATION SIZE IS 66"LX36"WX24"D	LOCATE BY ENGINEER IN THE FIELD, MIN 10 FEET FROM FACE OF CURB TO THE STREET SIDE OF FOUNDATION AND MIN 21 FEET FROM NEAR EDGE OF THROUGH LANE	NOTE: LIST ALL REFERENCES TO STANDARD DETAILS THAT APPLY TO EACH CABINET OR POLE. (TYP.)
(B) UPS	AIRPAX DIMENSIONS 392614 ENCLOSE W/2 REMOVABLE SHELVES, OR EQUAL	AIRPAX DIMENSIION, INC. 24M11 W/2-105Ah, GROUP 31 AGM BATTERIES				
(C)	NEMA TS2-1998 TYPE 1 TS2 SIZE 6 DETECTOR RACK CONFIGURATION 1	NEMA TS-2 TYPE 2, ECONOLITE MODEL ASC/2-2100 OR EQUAL	16 CHANNEL MMU. RACK MOUNTED LOOP DETECTORS. NEMA SOLID STATE NEMA LOAD SWITCHES. VIDEO DETECTION AND A THREE POLE STREET LIGHTING CONTACTOR AND THREE 20 AMP CIRCUIT BREAKERS.	-	LOCATE BY ENGINEER IN THE FIELD, MIN 10 FEET FROM FACE OF CURB TO THE STREET SIDE OF FOUNDATION AND MIN 21 FEET FROM NEAR EDGE OF THROUGH LANE	-

POLE		MAST ARM		SIGNALS		LUMINAIRE	PED P.B. TYPE/SIGN	REMARKS	LOCATION FROM ℄ (MAJOR Rd)	STANDARDS
NUMBER	TYPE	SIGNAL	LUMIN.	MTG.	FACE					
(D)(G)(L)(O)	TYPE 1 PED PUSH BUTTON POST	-	-	-	-	-	TYPE I 2" ADA PB & PPB SIGN R10-3b (L)	-	(D) 293+75.46, 50.55' Lt (G) 294+51.89, 63.51' Lt (L) 294+68.65, 48.79' Rt (O) 293+85.69, 67.32' Rt	- -
(E)(M) 12' 12'	R	45'	25'	(3) ASTRO-BRAC (1) XI	(1) Q (2) F (1) PED	400W/120V HPS W/ CUT OFF	-	INSTALL CAMERA ON LUMINAIRE MAST ARM. INSTALL PHOTOCELL ON LUMINAIRE POLE (E).	(E) 293+71.68, 56.95' Lt (M) 294+71.53, 56.99' Rt	- -
(F)(N)	A, 15' (W/17" FRANGIBLE BASE)	-	-	(2) XI	(1) F (1) PED	-	TYPE I 2" ADA PB & PPB SIGN R10-3b (R)	-	(F) 293+92.52, 67.51' Lt (N) 294+52.33, 68.12' Rt	- -
(H)(P) 12'	Q	35'	20'	(2) ASTRO-BRAC (1) XI	(2) F (1) PED	400W/120V HPS W/ CUT OFF	-	INSTALL CAMERA ON LUMINAIRE MAST ARM	(H) 294+60.11, 67.69' Lt (P) 293+81.23, 68.25' Rt	- -
(I)(Q)	2B		20'	(1) V (1) XI	(1) Q (1) PED	400W/120V HPS W/CUT OFF			(I) 294+71.21, 58.85' Lt (Q) 293+68.9, 58.95' Rt	-
(J)(R)	TYPE I PED PUSH BUTTON POST	-	-	-	-	-	TYPE I 2" ADA PB & PPB SIGN R10-3b (R)	-	(J) 294+67.21, 48.59' Lt (R) 293+69.47, 54.5' Rt	-
(K)(S)	TYPE I PED PUSH BUTTON POST	-	-	-	-	-	TYPE I 2" ADA PB & PPB SIGN R10-3b (B)	-	(K) 294+70.80, 6.79' Rt (S) 293+72.41, 7.21' Lt	-

NOTES

1. Astro-Brac mounting assemblies shall be Pelco Astro-Brac part number AB-0116, or equivalent.
2. All luminaires shall have photocell receptacles. All photocell receptacles shall have shorting cap, except for the luminaire with photocell.
3. Pedestrian push button to be at 42 inches above finish grade to center of push button.
4. Furnish and install pedestrian push button sign R10-3b(L) as shown on page 2B-40 of the 2003 MUTCD.
5. Furnish and install pedestrian push button sign R10-3b(R) as shown on page 2B-40 of the 2003 MUTCD.
6. Furnish and install pedestrian push button sign R10-3b. The bi-directional (⟷) arrow used shall be the R10-3b sign shown on page 2B-40 of the 2003 MUTCD.



HIGH VOLTAGE CIRCUIT

(X) Y" C = NUMBER & SIZE OF CONDUIT
(X) = NUMBER OF CABLES
# CC = #14 AWG IMSA CABLE
BB = BARE BOND, #8, SOLID
PB = PRE-EMPT BEACON, #14 THW
SP = SIGNAL POWER,*
SL = STREET LIGHTING, #10 AWG XHHW
PC = PHOTO CELL, #10 AWG XHHW

*NOTE:
SIGNAL POWER SHALL CONSIST OF:
2- #8 AWG THW (WHITE)
1- #8 AWG THW (BLACK)
1- #8 AWG THW (RED)
1- #8 AWG THW (GREEN)
1- #4 AWG BARE COPPER

LOW VOLTAGE CIRCUIT

(X) Y" C = NUMBER & SIZE OF CONDUIT
(X) = NUMBER OF CABLES
VC = VIDEO DETECTION CABLE ECONOLITE CABEL, PART NO. 1175-00X
PS = PRE-EMPT SENSOR, OPTICOM #20 3 CC SHIELD CABLE (MODEL 138)
TI = TELEPHONE INTERCONNECT, 4CC #20
DLC = DETECTOR LEAD IN CABLE, #16 AWG IMSA 50-2-1984
RLW = ROADWAY LOOP WIRE, #14 AWG IMSA 51-5-1985

PIMA COUNTY ORDINANCE No. 20XX-XXX

MAJOR ROAD / MINOR STREET
TRAFFIC SIGNAL INSTALLATION

TRAFFIC SIGNAL POLE SCHEDULE

SCALE: NTS | SHEET TS4 OF TS5

PRISCILLA S. CORNELIO, P.E. DIRECTOR

	DESIGNED	DRAWN	CHECKED	PROJ.ENGR.
DATE	11/2007	11/2007	11/2007	11/2007
	T.E.D. STAFF	A. ORTA	D. PITTENGER/C. LUTICH	T.E.D. STAFF

MAJOR ROAD/ MINOR STREET TRAFFIC SIGNAL POLE SCHEDULE

DIV/SECT.ENGR. | DATE | NO. | REVISION DESCRIPTION

PIMA COUNTY DEPARTMENT OF TRANSPORTATION

PIMA COUNTY DEPARTMENT OF TRANSPORTATION TRAFFIC ENGINEERING DIVISION

W.O. # 4MARMS

1-800-782-5348

APPENDIX B

GENERAL TRAFFIC SIGNAL NOTES

AND RESPONSIBILITIES

TRAFFIC SIGNAL GENERAL NOTES:

1. All equipment / materials and construction shall meet or exceed the requirements contained in the current Pima County / City of Tucson "Standard Specifications for Public Improvements" and "Standard Details for Public Improvements", the Special Provisions and the plans.

2. All pedestrian push button assemblies shall meet ADA requirements. The signs that shall be used are identified in the 2003 MUTCD as R10-3b on page 2B-40.

3. Metro street name signs shall be installed such that the bottom of the sign is no less than 17 feet above the roadway pavement or no less than 16 feet above the finished grade beyond the shoulder, bike lane or multi-use lane.

4. The exact location of each new pole foundation, pull box, controller cabinet foundation, UPS cabinet foundation and electric service pedestal foundation shall be approved by the Engineer prior to installation.

5. The top of the pole foundation shall be level with the finished grade. If the slope or shoulder drops off from finished grade, the contractor shall grade around pole foundation. The top of the foundation shall extend no more than 4 inches above surrounding grade.

6. Only new conduit and cable shall be installed.

7. All conduits shall be cleaned by compressed air and a properly sized conduit piston or mandrel shall be pulled through the conduit prior to cable installation.

8. Conduit installed under existing paved driveways, which are not scheduled to be reconstructed as part of this project, shall be installed by means of boring.

9. ITS / roadway lighting sleeves shall be installed under all intersecting side streets and driveways on all major roadway reconstruction projects, unless directed otherwise by the Engineer. Each end of the sleeve shall be sealed with a Carlon MAEPOX, or approved equal.

10. Pull boxes shall not be installed within concrete curb access ramps. In addition, any pull boxes installed behind curbs shall be installed between the curb and the proposed / future sidewalk or beyond the proposed / future sidewalk. An exception to this note would be pull boxes installed in a median. Any pull boxes installed along an uncurbed roadway shall be installed adjacent to, but not within, the shoulder.

11. A ¾ in. x 10 ft. ground rod shall be installed in the No. 7 pull box (with the extension) adjacent to the controller cabinet. Two ground rod clamps shall be furnished for grounding the ground wire.

12. The high voltage cables should be separated from the low voltage cables as much as possible.

13. A #14 AWG IMSA 19-1-1984 7-conductor solid wire cable shall be installed from each traffic signal terminal strip to the concrete pull box adjacent to the pole foundation leaving three feet of slack for each cable (measured from the top of the pull box) in the pull box.

14. Two #10 AWG-XHHW conductors shall be installed from each luminaire to the concrete pull box adjacent to the pole foundation, leaving three feet of slack for each conductor (measured from the top of the pull box) in the pull box. Route four conductors to the luminaire with the photoelectric cell. An in-line fuse shall be installed for each luminaire in the associated pull box.

15. Poles with pedestrian signals and push button stations shall use one 7-conductor cable for both the push button station and the pedestrian signal. The outer cable jacket shall be removed at the hand hole height. Two conductors shall be routed to the push button station and the remaining conductors shall be routed to the pedestrian signal.

16. All vehicle roadway detection loop cables shall be #14 AWG IMSA 51-5-1985 cable. Lead-In cables shall be #16 AWG IMSA 50-2-1984 cable. No splices shall be allowed in the roadway detection loop cable except at the pull box adjacent to loop.

17. The telephone interconnect cable and detector lead-in cable shall not be spliced.

18. The emergency vehicle pre-emption sensor cable shall be Opticom Detector Cable Model No. 138. The cable shall not be spliced.

19. The Econolite cable (part No. 1175-00X) shall be installed for the video camera, unspliced, from the traffic signal pole hand hole, to the traffic signal controller cabinet. The Auto Scope camera cable shall extend from the mounted camera to the hand hole. The camera cable and home run cable shall be spliced in the pole hand hole with Scotlok UAL connectors with a 3M E9Y crimping tool, or equal.

20. Detection loop saw cuts shall be flushed with water under pressure and then dried with air under pressure.

21. The Tucson Electric Power Company Public Improvement Coordinator (918-8359) shall be contacted by the Contractor to verify the location of the electric service connection at the intersection. The Contractor shall be responsible for excavating and backfilling the trench and installing any necessary sleeves under sidewalks or driveways in which the electric service cable in conduit (CIC) is to be installed by TEP. *[Note: If not TEP, modify name of electric utility and provide the correct number for the utility contact phone number]*

22. The Qwest Public Improvement Coordinator (292-8255) shall be contacted by the Contractor to verify the location of the telephone connection at each intersection.

23. All vehicle and pedestrian indications shall be LED. Signal lenses shall be tinted to the color of the indication.

24. The contractor shall contact Blue Stake at 1-800-782-5348, a minimum of 2 working days prior to any excavation.

25. The contractor shall maintain and allow access to all Pima County Waste Water manholes located within the ROW. Access must be maintained 24 hours per day, seven days per week. No utilities may be placed within six feet of a force main.

26. Any equipment and/or utilities within the project limits that are damaged or destroyed by the contractor shall be repaired or replaced at the sole expense of the contractor.

27. The traffic signal operation at existing signalized intersections shall be maintained throughout the duration of the project. (Optional note).

RESPONSIBILITIES:

1. The contractor shall supply and install the following equipment and materials as specified in the plans: Steel pole anchor bolts (with nuts and washers), concrete pole foundations with reinforcement (where specified), traffic signal controller cabinet(s) with controller(s) and all auxiliary equipment, controller cabinet concrete foundation(s), concrete pull boxes, electrical conduit, ground rods and connectors, bare bond wire and all other conductors, poles, mast arms, traffic signals and mounting assemblies, pedestrian signals and mounting assemblies, pedestrian push button stations with signs, luminaries, photocells, electric service pedestal(s) and concrete foundation(s), video detection system equipment, vehicle detection loops, and all other appurtenances necessary for the operation of the traffic signal installation(s), except as modified in the plans.

2. The contractor shall deliver the controller cabinet(s) with the controller(s) and auxiliary equipment specified in the plans to the PCDOT Maintenance Yard, 1313 S. Mission Road, Bldg. #28 for testing. This shall occur a minimum of two weeks prior to the installation(s) at the intersection(s). Contact Don Pittenger (740-2632) at least 2 working days prior to the delivery of the controller cabinet(s) to PCDOT. The contractor shall pick up and transport the controller cabinet(s) from the PCDOT Maintenance Yard to the intersection(s) after the PCDOT staff has tested the equipment and approved it for installation.

3. The contractor shall install each traffic controller cabinet on its foundation and route all of the conductors into the controller cabinet. The PCDOT staff shall terminate the conductors in the controller cabinet.

4. The contractor shall carefully disassemble and salvage all existing traffic signal and street lighting equipment that is not to remain or be relocated. All of the equipment shall be returned to the PCDOT Maintenance Yard, 1313 S. Mission Rd. The equipment shall be unloaded by the contractor. Contact Don Pittenger (740-2632) at least 2 working days prior to returning the equipment.

5. The contractor shall salvage and replant any landscaping vegetation that may be damaged by construction activities. The contractor shall obtain prior approval from Connie Hutchins (740-5969) before any plants are moved.

6. The contractor shall repair/restore any landscape irrigation components damaged by construction activity to their original condition.

7. PCDOT shall fabricate metro street name signs for this intersection. PCDOT shall provide all mounting hardware and PCDOT shall install metro street name signs.

8. The contractor shall provide all materials and install all traffic control signs and pavement markings required to complete the project.