

This is a draft version. Comments or questions are welcome. Please email any comments to Jesse Sweeten jsweeten@utah.gov. Thank you!

Signalized Intersection Design Guidelines



Utah Department of Transportation
Division of Traffic and Safety

November 2015

TABLE OF CONTENTS

1.0	Overview & Considerations	1
1.1	UDOT Design Project Organization	1
1.2	Signal Warrants	2
1.3	Signal Actuation	2
1.4	Level of Service	3
1.5	Project Design Criteria (PDC)	3
1.6	State Furnished Materials	3
1.7	Bicycles.....	4
1.8	Pedestrian Facilities.....	4
1.9	Lighting	4
1.10	Signal Interconnect (ATMS).....	5
1.11	Local Involvement.....	5
1.12	Site Visit.....	5
1.13	Project Delivery.....	7
1.14	Quality Control / Quality Assurance	9
2.0	General Plan Instructions	10
2.1	Title Block	10
2.2	Plan Sheet Numbering.....	10
2.3	Plan Sheets	12
2.4	Subsurface Utility Engineering (SUE)	14
3.0	Traffic Signal Design	16
3.1	Signal Poles, Mast Arms, and Foundations	16
3.2	Signal Heads	18
3.3	Lane Lines and Striping	28
3.4	Signing.....	29
4.0	Lighting.....	32
4.1	Luminaire Components.....	32
4.2	Luminaire Placement	33

4.3	Luminaire Type	33
4.4	Alternate Mounting Options	34
5.0	Pedestrian Signal Design	35
5.1	Pedestrian Signal.....	35
5.2	Pedestrian Hybrid Beacon Crosswalk or High-intensity Activated Crosswalk (HAWK)	36
5.3	Pedestrian Flashing Beacon Crosswalk.....	36
5.4	Post-Mount Pedestrian Flashing Beacon Crosswalk	36
6.0	Vehicle and Pedestrian Detection	37
6.1	Vehicle Detection Zones	37
6.2	RADAR Detection	39
6.3	Induction Loops & Wireless Sensors	44
6.4	Video Detection	49
6.5	Pedestrian Detection	49
6.6	Pedestrian Access	50
6.7	Bicycle Detection	51
6.8	Emergency Preemption	51
7.0	Advanced Warning Signal Systems	53
7.1	AWS Design	53
8.0	Power Service Connection	57
8.1	Underground Service Pedestal	57
8.2	Uninterruptible Power Supply/Backup System (UPS).....	57
9.0	Signal Circuit Design	58
9.1	Power Source	58
9.2	Signal Heads	58
9.3	Lighting	60
9.4	Detection.....	61
9.5	Conduit	64

9.6	Junction Boxes	66
9.7	Ground Rods & Wires	67
9.8	Controller & Cabinet	67
9.9	Interconnect (ATMS).....	67
10.0	Other Considerations.....	68
10.1	ATMS Improvements	68
10.2	UDOT Traffic Signal Turn-on Checklist.....	68
10.3	Temporary Operation.....	68
10.4	New Signal Activation	68
10.5	Single-Point Urban Interchange (SPUI)	69
10.6	Diverging Diamond Interchange (DDI).....	69
11.0	Questions?	70

Appendix

A.1	Standard Signal Equipment	A.1-1
A.2	Contact List.....	A.2-1
A.3	Information and Downloads	A.3-1
A.4	Left-Turn Phasing at Signalized Intersections.....	A.4-1
A.5	AWS Guidelines.....	A.5-1
A.6	Procurement Sample Signal Plan and Documents	A.6-1

LIST OF FIGURES

Figure 1.1.1 – UDOT Signal Design Organization Chart	2
Figure 2.1.1 – Title Block Example	10
Figure 3.1.1 – 80-foot to 85-foot Mast Arm Foundation Details	17
Figure 3.2.1 – Traffic Signal Heads and Symbols.....	20
Figure 3.2.2 – Example Signal Head Placement for Single Thru Lane without Protected Left-Turn Phasing	23
Figure 3.2.3 – Example Signal Head Placement for Single Thru Lane with Protected Left-Turn Phasing	24
Figure 3.2.4 – Example Signal Head Placement for 2 or More Thru Lanes.....	24
Figure 3.2.5 – Example Signal Head Placement for Dual Left-Turn Lanes	25

Figure 3.2.6 – Example Signal Head Placement for Right-Turn Overlap Phasing.....	26
Figure 3.2.7 – Left Turn Yield on Flashing Yellow Arrow (RS10-21ex).....	27
Figure 3.4.1 – Example Mast Arm Street Signs.....	31
Figure 6.1.1 – Radar Detection Zones.....	38
Figure 6.2.1 – Radar Stop Bar Detection Area	40
Figure 6.2.2 – Radar Stop Bar Detection Placement Options	41
Figure 6.2.3 – Example RADAR Sensor Placement - Skewed.....	42
Figure 6.2.4 – Radar Dilemma Placement Options	44
Figure 6.3.1 – NEMA Phase Detail & Typical Loop/Wireless Sensor Placement	48
Figure 6.8.1 – Typical Mast Arm Components.....	52
Figure 7.1.1 – Side Mounted Advanced Warning Signal	54
Figure 7.1.2 – Overhead Static Advanced Warning Signal Sign.....	54
Figure 7.1.3 – Overhead Blank-out Advanced Warning Signal Sign	55
Figure 9.2.1 – Signal Circuit Cable Example	59
Figure 9.2.2 – Pedestrian Circuit Cable Example	60
Figure 9.3.1 – Lighting Circuit Cable Example.....	61
Figure 9.4.1 – Push Button Circuit Cable Example.....	62
Figure 9.4.2 – RADAR Detection Circuit Cable Example	64

LIST OF TABLES

Table 3.1.1 – Mast Arm Pole and Foundation Requirements	17
Table 9.5.1 – Cable Cross-sectional Area	65
Table 9.5.2 – Conduit Capacity	65

1.0 OVERVIEW & CONSIDERATIONS

The Traffic & Safety Division of the Utah Department of Transportation has prepared this guideline as a tool for uniform understanding of the signal design process. The purpose is to consolidate the current design standards and practices into a single reference point to help foster accurate, efficient, and consistent signal designs.

This guideline is intended to provide general design instruction to be applied in the signal design process. Every intersection will present a unique set of challenges and require a customized design. It is up to you, the designer, to apply sound engineering judgment, with the help of the project team, to provide an optimal design within your project's scope, schedule, and budget.

All design and construction work will follow the latest version of the **UDOT Standard Specifications & Drawings**, which will take precedence over any information presented in this guideline. This guideline will be updated on a regular basis. Check the UDOT website to ensure this is the latest version.

1.1 UDOT DESIGN PROJECT ORGANIZATION

All UDOT design projects require coordination with various individuals within and outside the Department. This guideline specifies multiple individuals to be coordinated with for various needs throughout the signal design process. The Organization Chart shown in Figure 1.1.1 shows relevant positions related to traffic signal design and where the position falls within UDOT's Organization structure. The Project Definition Document (PDD) will define the specific project team and the relevant individuals in the positions shown in the chart. In general, the designer will route coordination through the UDOT Region Project Manager and under the Region PM's direction will coordinate with Region Staff, the Traffic Operations Center (TOC), and with Central UDOT Traffic & Safety.

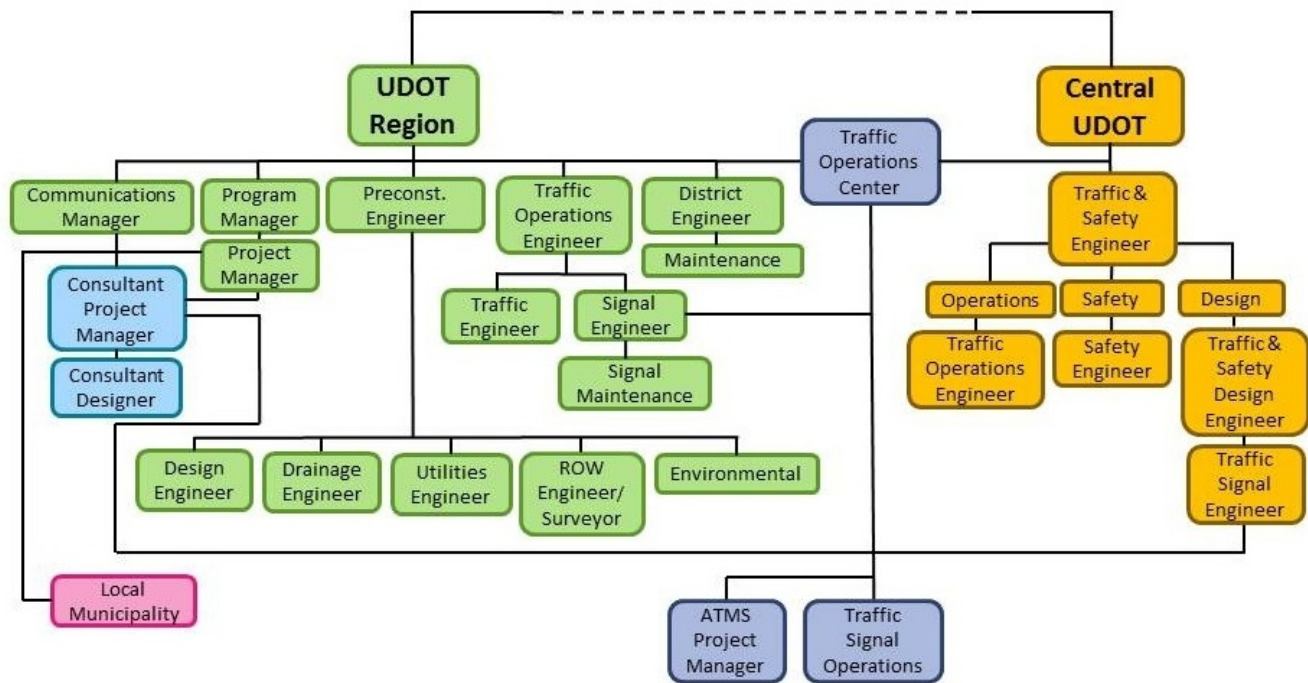


FIGURE 1.1.1 – UDOT SIGNAL DESIGN ORGANIZATION CHART

1.2 SIGNAL WARRANTS

Central Traffic & Safety warrants traffic signals throughout the State. Signal warrant documentation includes a warrant memo with the current directional volume counts including peak hour volumes, warrant analysis, and a field warrant memo with scope outline. Not only do all signals require warrants, but left-turn phasing at signalized intersections requires additional warranting criteria. These criteria are found in the appendix. The warrant information should be presented to the designer before the kickoff meeting. If this information was not provided, contact the Region Project Manager.

1.3 SIGNAL ACTUATION

Design all intersections as fully actuated unless directed otherwise by Region Signal Engineer. Some signalized intersections are coordinated with other signalized intersections on the same corridor. UDOT's preferred actuation signal systems is through RADAR detection. Pavement induction loops may also be used for actuation only where they can be installed in the pavement without pavement cutting. Various actuation devices exist on UDOT facilities. They should be replaced and upgraded to RADAR as project budget and scope allows. The type of signal actuation system(s) to be implemented will be determined by Region Signal Engineer. See Part 6 for more information on signal detection.

1.4 LEVEL OF SERVICE

UDOT's standard is to meet or exceed a Level of Service (LOS) "D" for urban locations and "C" for rural areas. The LOS is based on projected design year traffic volumes. In general, the design year is set at 20 years from the present year. Intersection LOS analysis may be facilitated by using computer programs.

In a number of cases, the desired level of service cannot be achieved with signalized upgrades alone. It may be necessary to add lanes or reconfigure the intersection in order to reach the desired LOS. When it is within the project's scope to perform these improvements, design the project to the LOS standard stated above. This usually occurs when other funds are combined with signal funds. Often signal funds are used to upgrade the signal equipment or add a new signal to an intersection without changing the intersection's geometrics. In these cases it may not be possible to reach the desired LOS. Upgrade the intersection as much as possible within the project's funding and scope.

1.5 PROJECT DESIGN CRITERIA (PDC)

Prepare a PDC form for the project in order to establish the design criteria that will be followed. Prepare the PDC according to the latest guidelines as established in the UDOT Roadway Design Manual of Instruction and the UDOT Design Process Manual. Design criteria are established in the latest adopted applicable AASHTO, FHWA (MUTCD), and UDOT Standards as indicated on the PDC form. Use the PDC form to determine if any substandard criteria are being implemented or perpetuated with the project. These substandard items will need to follow the standard UDOT design exception and waiver procedures and documentation. Complete the PDC early in the process because the design exception and waiver process may take a significant amount of time. Additionally, if the design deviates from other UDOT standards that are not found in the PDC form, a Deviations From Standards document must be submitted and approved.

1.6 STATE FURNISHED MATERIALS

A significant portion of signal equipment is provided by UDOT as "State Furnished Materials." Refer to the **State Furnished Items Form** for the complete list of state furnished items. Part of the design process is determining the state furnished materials that will be needed. Periodic submittal (at each milestone) is required so that future stock needs can be forecasted. Request reviews from the Region Signal Engineer prior to submitting the form. The final state furnished materials should be ordered as soon as possible and usually by the final design. Fill out the State Furnished Items form and submit as instructed on the form. There is a separate form required to order ATMS state furnished items. If the signal project includes ATMS state furnished items, complete the ATMS form and submit it for review to the ATMS Project Manager. Some special orders require 90 days, please order equipment accordingly. Plan on a delay of about 4 to 6 weeks for steel powder coating.

1.7 BICYCLES

UDOT encourages multimodal use of its transportation facilities. Check Utah Collaborative Active Transportation Study (UCATS) and mapping resources such as UDOT's Uplan for planned/existing bicycle routes and facilities. Bicycle detection and pavement markings may need to be implemented as part of the traffic signal at intersections where bicycle facilities exist or there is a high volume of bicycle traffic. If radar detection is used, typically, no additional bike detection is needed. Coordinate with the Region Signal Engineer and the Central Traffic & Safety Traffic Signal Engineer to assess these needs.

1.8 PEDESTRIAN FACILITIES

Crosswalks

Provide pedestrian displays and push buttons at all signalized intersections unless the pedestrian movement is prohibited. Crosswalks, whether marked or not, exist at all intersections. Provide signing if a pedestrian crossing is prohibited. For pedestrian route continuity, the minimum number of crosswalks is two at a "T" intersection and three for "four-legged" intersections.

Pedestrian Signals

UDOT has set forth guidelines to determine when to install pedestrian signals. These signals can be roadside flashing beacons, pedestrian hybrid beacons, and pedestrian traffic signals (Refer to SL-series Standard Drawings for more information). Pedestrian signals are provided for safer pedestrian crossings and visibility to vehicles, and are not necessarily related to motorized vehicle level of service. This guideline provides appropriate information for the design of pedestrian hybrid beacons and pedestrian traffic signals because they use the same design standards, equipment (other than actuation), and construction requirements as traditional traffic signals.

Pedestrian Access Ramps

Pedestrian access ramps are required at all legal crossings to provide accessibility from the raised sidewalk down to the roadway surface. All new sidewalks must comply with Americans with Disabilities Act Access Guidelines (ADAAG) regulations. Existing ramps that do not meet the current standards must be retrofitted to do so unless approved by the Region Traffic Operations Engineer. The Region Traffic Operations Engineer may also specify audible pedestrian push buttons based on pedestrian demographics and the needs of the intersection. Refer to the latest version of GW Series UDOT Standard Drawings and Standard Specifications for the most current guidance offered by the U.S. Access Board. For more information see the Pedestrian Access Ramp Manual <http://www.udot.utah.gov/index.php/m=c/tid=584>.

1.9 LIGHTING

Highway lighting is required at all signalized intersections unless approved by the Region Traffic Operations Engineer, the extent of which depends on several site

specific conditions. Part 4 of this guideline covers this topic in more detail.

1.10 SIGNAL INTERCONNECT (ATMS)

Connect the traffic signal to the existing ATMS network unless otherwise approved by the ATMS Project Manager. UDOT has one of the most advanced traffic signal systems in the country; interconnection allows the Traffic Signals Operations Group to optimize signal timing and operations, collect valuable performance data, monitor operations, troubleshoot problems, and respond quickly to maintenance issues. All signals need to be part of the network. The preferred interconnection method is to integrate the signal into the ATMS fiber optic infrastructure. If fiber is not within a reasonable distance, the signal can usually be connected by ethernet radio. If that is not possible, the design should include ATMS equipment and conduits for future interconnect, including future fiber runs. Integration of the signal equipment into the ATMS network is typically accomplished by an integration consultant; the project budget and schedule should anticipate this work. Coordinate with the Region Project Manager, Region Signal Engineer, and ATMS Project Manager regarding interconnection and ATMS requirements at the beginning of the design process.

1.11 LOCAL INVOLVEMENT

UDOT's traffic signals are often installed at the intersection of state routes and local streets or installed within city boundaries. Coordination needs to take place with the local officials in order to inform them of the upcoming signal project and to collect additional information about the intersection. The local official often has intimate knowledge of the weaknesses and limitations of a given intersection and can be a key asset to improve UDOT's transportation facilities. Many cities have emergency vehicles equipped with emergency preemption devices. If this is the case, preemption detection equipment will need to be incorporated into the signal design. Coordinate the local government's intersection needs with the Region Project Manager and Region Traffic Operations Engineer to assess and, potentially, implement needed improvements into the signal design, such as emergency pre-emption. The cities will need to furnish all pre-emption equipment; UDOT personnel/contractors will install the equipment.

1.12 SITE VISIT

Each intersection has unique characteristics that must be considered for appropriate signal design. When designing a traffic signal, a site visit is recommended during the scoping/kickoff meeting to determine the existing conditions. Return visits may be necessary during the plan development to verify the design conformity. During the visits, consider taking digital photographs and/or video that can be used for meetings, as a record for existing conditions, or to answer questions back at the office. In addition to applicable UDOT personnel and maintenance staff, invite local government representative(s) and representatives from utility companies with facilities in the area.

Existing Facilities

Some designs may require reuse of existing traffic signal facilities such as conduit, foundations, poles, signal heads, cabinet, etc. Make note of the condition of these items. Consult with the Region Signal Maintenance Supervisor to determine what items need replacement. Evaluate the existing condition of the facilities to determine if they are adequate for re-use. Evaluate the existing pedestrian access ramps and pedestrian facilities for compliance with ADAAG. Review existing actuation devices. Observe traffic and pedestrian operations to assess potential needs that have been previously overlooked.

Right-of-Way

Locate right-of-way lines and determine if the signal design will fall within the available area. Right-of-way or easement purchases will be on the project's critical path, therefore pole, cabinet, and junction box locations should be determined as soon as possible. The location of the right-of-way must be indicated on signal plans.

Utilities

Contact Blue Stakes to obtain utility company contact information and request utility maps from each of the companies in the area. Locate existing utility appurtenances in the field (valves, manholes, poles, etc) that correspond with mapping to more accurately determine utility locations. If design components appear to be in conflict with certain overhead or underground utilities, then another site meeting with utility representatives may be required. Pothole utilities as needed to verify locations in underground conflict areas. If the project is under the state procurement contract, then potholing should not be performed during the design phase. The contractor is required to pothole utilities during the construction phase and will make field adjustments to the design, as necessary.

ATMS Facilities

Connecting traffic signals to the existing ATMS facilities and extensive fiber network ensure that UDOT offers a world class signal system. When researching the utility information there are three steps that are required for correctly locating UDOT ATMS networks:

1. Notify Blue Stakes to obtain a UDOT utility contact person,
2. Contact Lynne Yocum, the UDOT Fiber Manager (see Appendix 2 Contact List), and
3. Obtain fiber plans and as-builts on the UDOT Map Portal.

Once this information is gathered, contact the Region ATMS Project Manager (see Appendix 2 Contact List) and request an on-site ATMS field review. The Region ATMS Project Manager will set up the meeting and include the necessary staff.

Power Service Connection

Coordinate with the Region Utility Coordinator/Engineer to schedule a field meeting with the serving power company to verify or identify the power source type and

location. Refer to Part 8 for additional information on power service connections.

Alignment, Clear Zone & Lateral Offset

Check applicable sight lines to assure that available sight distances meet standards for all approaches and turning movements. Verify that motorists can see pedestrians in crosswalks and pedestrian access ramps. Check clear zone and lateral offset distances to roadside and median hazards and verify conformance to AASHTO and UDOT Standards. A mast arm pole foundation should be placed behind the curb and gutter to meet lateral offset requirements.

Slopes & Grades

Make note of slopes and grades both on the road and behind curb & gutter where foundations and junction boxes will be located. Sloped areas behind curb can affect foundation design and elevation such that an upslope may cause the mast arm to be too high and a downslope may require additional foundation height beyond the standard depth. Grades in the roadway such as crowns, overlay buildup, or super-elevations may affect signal head clearances.

Drainage

Evaluate drainage and provide for the removal of any water so a minimum speed of 20 MPH can be maintained through the intersection. Determine if water is ponding at the bottom of pedestrian access ramps. If so, the ped ramp is out of compliance and will need to be redesigned.

1.13 PROJECT DELIVERY

Two main options are available for constructing UDOT traffic signals: standard project advertisement, or State Procurement Contract. Prior to assigning a designer, the Central Traffic & Safety Design Engineer, Region Traffic Operations Engineer, Region Traffic Engineer and Region Signal Engineer should review the proposed project to determine which type of project delivery method should be used. They will also determine if Central Traffic & Safety Project funds are to be used or if a larger project should be submitting for funding by the region.

Advertisement

Advertised projects include design-bid-build, Construction Manager General Contractor (CMGC), and Design Build project delivery methods. This is the standard project delivery method for most UDOT projects. This method should be applied when the traffic signal project consists of one or more intersections, and may require right-of-way adjustments, utility relocations, roadway widening in excess of the procurement maximum contract amount (\$175,000 in construction costs per intersection), or have other significant impacts. Federal projects must follow the advertisement project delivery process. Advertised projects will require complete bid documents, PDBS entries, and an advertisement checklist. The UDOT Plan Sheet Development Standards contain instructions for and examples of advertised signal plans.

State Procurement Contract

For time-critical projects or straight-forward traffic signal installations, UDOT can rely on a State Procurement Contract. This alternative for construction of signal projects should be applied to intersections with minimal issues. Signal procurement projects do not resolve major problems with drainage, grading, roadway rehabilitation or widening, utility relocation, landscaping, and structures. The procurement contractors are electrical contractors and have been selected based on their electrical experience. Most work is expected to fall within their area of expertise.

The contract is limited to signal projects that are \$175,000 or less in construction costs (as of 2015.) Contact Central Traffic & Safety for signal procurement bid item prices to estimate in place of the PDBS estimate. It is important to note that procurement contractors are paid for the work they actually perform rather than quantities from an engineer's estimate that was prepared in the design phase. This virtually eliminates the need for change orders. In procurement, the purpose of preparing an estimate in design is to help ensure the project will fall within allocated funding.

The project will require abbreviated design plans with minimal special provisions, however the process is not as formal as advertisement and adjustments can be made during construction. For state procurement contracts, adjust the design efforts to be commensurate with the abbreviated plan set and use standard procurement bid item names. Generally, procurement plans sets do not need right-of-way, survey control, typical sections, horizontal alignments, summary sheets, and maintenance of traffic sheets. An example of a procurement plan set can be found in the appendix. The pre-selected procurement contractors have installed many traffic signals and are planning on working out some details in the field and do not need all the details provided to them since they have such extensive experience. However, be sure to work out all critical design elements during the design phase in order to avoid costly delays during construction.

Signal procurement projects usually have a limited budget, scope, and schedule whose primary purpose is to install or upgrade a signal. Throughout the initial stages of the design the scopes of these projects have a tendency to expand due to the various needs of the intersection. Coordinate project needs with the Region Project Manager and prioritize as necessary. Attempt to limit the scope as much as possible to keep the project under its planned budget and schedule. If the project has more necessities than the budget and schedule allow, then communicate these needs early in the design process.

Check with the Central Traffic & Safety Design Engineer or the Region Project Manager for direction regarding which type of construction package you will be preparing prior to scoping a project. The signal design process follows UDOT's standard [project delivery network](#). For key steps in the signal delivery process refer to UDOT's website. The actual project flow chart may vary depending on the size and scope of the project.

Survey / Base mapping

In order to further streamline simpler projects, the State Procurement Process may not require a full field survey with existing topography base mapping. In these cases the signal may be designed using to-scale aerial photography as the base map.

Environmental clearance and design exception processes (if needed) are necessary on procurement projects. Even though the state procurement delivery method allows for abbreviated plans and design efforts it does not bypass the Environmental and Design Exceptions process. Environmental clearance through an environmental document, usually a Categorical Exclusion, must be obtained before construction begins. If there is a design exception, waiver, or deviation from UDOT standards it must be documented and approved through the same process as is required with an advertised project.

1.14 QUALITY CONTROL / QUALITY ASSURANCE

Regardless of the project delivery method, the latest [UDOT Quality Control/Quality Assurance Procedures](#) or an alternative approved QC/QA plan must be followed with associated required documentation. The checklists, checkprints, and QA audit form will need to be uploaded to ProjectWise and properly attributed for the QC/QA process to be considered complete.

Comment Resolution Form

A key component of the QC/QA process is the Comment Resolution Form. The form can be obtained from UDOT's QC/QA page link above. Record all of the comments and designer responses on the form. Note all comments made during site visits, review meetings, etc. Have one comment resolution form for the whole project so reviewers, managers, auditors, etc can look back and tell how all the comments were addressed and the final design product was developed. Divide the form by milestone reviews (Scoping, PIH, PS&E, etc.).

Maintenance/Preconstruction Site Visit Certification Form

UDOT has added the Maintenance/Preconstruction Site Visit Form to the advertising checklist. Each project must have a site visit with maintenance and fill out the form. The maintenance staff must sign the form. The purpose of the form is to "Ensure that a site visit and better communication occur between a project's design team and the maintenance stations affected by the project. Maintenance knows the roadway best and their on-site input for projects is crucial to fulfilling two of UDOT's strategic goals: preserve infrastructure and zero crashes, injuries, and fatalities. The form can be obtained [here](#).

2.0 GENERAL PLAN INSTRUCTIONS

Follow the latest UDOT Plan Sheet Development Standards found on [UDOT's CADD Downloads Website](#).

The following are general instructions to be used as a guideline in laying out plan sheets. Signal sheets should be in a common scale that best suits the intersection.

2.1 TITLE BLOCK

The four lines in the title block contain the following information:

The **first line** of each title block identifies the project name.

The **second line** of each title block identifies the project location

The **third line** of each title block is the project number and PIN

The **fourth line** identifies what information the sheet contains.

Fourth line examples:

ROADWAY

SIGNAL

SIGNAL CIRCUIT

SHEET NO SS-01A	PROJECT	RECONSTRUCT TWO SIGNALS ON SR-71 IN SLC			UTAH DEPARTMENT OF REGION XXX DE
		SR-71 (700 E) & 1300 S			
	PROJECT NUMBER	S-ST99(224)	PIN	11705	APPROVED
	SIGNING				PROFESSIONAL ENGINEER

FIGURE 2.1.1 – TITLE BLOCK EXAMPLE

2.2 PLAN SHEET NUMBERING

Sheet numbering includes a letter code that identifies the type of sheet. The appropriate code letter is placed before the consecutive sheet numbering, e.g., RD-01, RD-02, RD-03, etc. Include only codes applicable to the signal project and eliminate all others that are not needed.

Sheets beginning with a “1” (e.g. title, 1-A Index to Sheets, 1-B Abbreviations and Legend, etc.) do not require a sheet identification code.

Follow the latest UDOT CADD Standards Guidelines when setting up a plan set. A signal project is different from a regular design project in that it is organized by intersection. Therefore, all plan sheets for the first intersection will be identified as “-

01A”, such that sheets would be ordered UT-01A, RD-01A, SS-01A, SG-01A, etc. The second intersection in the plan will follow as “-01B”, as in UT-01B, RD-01B, etc. Group all sheets beginning with “1”, TS, DT, SM and TC together at the beginning of the plan set and show in the order below.

<u>ID Code Letter</u>	<u>Sheet Name</u>
1	Title
1-A	Index to Sheets
1-B	Abbreviations and Legend
HC	Horizontal Control
CR	Cross Reference
SC	Survey Control
TS	Typical Sections
DT	Details – which may include minor structures if no structure number is required
SM	Summary (not for signal summaries)
RD	Roadway
RP	Roadway Profile
RMV	Removal
UT	Utility/Topography
RR	Railroad
GR	Grade
DR	Drainage (Drainage Details may be placed on DRDT or DT sheets)
IS	Irrigation
EC	Erosion Control
LS	Landscape
WM	Wetland Management
SS	Signing (Sign Details may be placed on SSDT sheets or DT sheets)
SP	Striping
SG	SIGNAL – SG-xx for Signal plan sheets SG-Sxx for Signal Schedule
	When a project has more than one signal intersection, individual intersections are numbered with a letter at the end, such as the first intersection would be: SG-01A thru SG-09A and the second intersection would be SG-01B thru SG-09B, etc.
LT	Lighting (use LTDT for lighting detail sheets)
ATMS	Advance Traffic Management System – ATMS-xx for ATMS plan sheets ATMS-Sxx for ATMS Schedule
RW	Right of Way

2.3 PLAN SHEETS

For procurement plans sets it is important to remember to keep the number of plan sheets to a minimum. Use the plans to convey the most pertinent design information to the contractor. Keep in mind that the contractors on the procurement contract are very experienced signal installers and will often adjust the design in the field based on the conditions they encounter. An overabundance of plan sheets and design effort is a waste of the department's limited signal funding.

Every project will have a title sheet (Sheet 1). Often, especially on procurement projects, the index to sheets table will be placed on the title sheet. Otherwise the Index to Sheets will be made its own sheet (1-A). On procurement projects, there may be a short list of limitations to convey to the contractor. These limitations should be placed on the title sheet as well. If the limitations are extensive, then a 00555M spec could be prepared and included with the plans. No other special provisions are typically needed with a procurement project.

List the applicable supplemental drawings with the index to sheets. Depending on the size and scope of the signal project there may also be an abbreviations and legend sheet, horizontal control sheet(s), cross reference sheet(s), and/or survey control sheet(s). Procurement projects do not typically include summary sheets or maintenance of traffic (MOT) sheets. Summary sheets are required on advertised projects.

Depending on the project scope and delivery type, the following plan sheet series may be required for every signal location in the project:

Utilities (UT)

Identify the Topography, Utilities, Right-of-Way, existing signal pole locations, existing signal equipment, and items to be removed, reconstructed, or relocated. Check overhead clearance for mast arms and lighting extensions. See Part 2.3 of this guideline. Utilities can be located on other sheet types such as Roadway.

Roadway (RD)

Include roadway related items such as sidewalks, ped ramps, pavement work, flatwork, etc. Also include roadway related removals. If the removals are extensive, they can be separated out and placed on Removal (RMV) sheets. Procurement projects usually do not have enough roadway and removal work to necessitate the separation of these sheets.

Signing and Striping (SS)

Include all pavement markings and material types, signing, and lane widths. Label the striping taper rates. The signing and striping design may be placed on the Roadway (RD) sheets.

Signal (SG)
(See Appendix for Sample Plan)

Describe the traffic signal design. Include the length of the mast arms, the location of the traffic and pedestrian signal heads in relation to the lane lines.

Identify light pole and luminaire locations. Show utilities that may conflict with pole placement. Identify induction loop or RADAR placement. Include a phasing diagram, if applicable. If there is an existing signal show the existing poles to be removed with a note. Verify the constructability between the new and old signal equipment.

Signal Circuit (SG)
(See Appendix for Sample Plan)

Combine or separate the various circuit diagrams for clarity. In general, all the circuit diagrams can be shown on a single sheet. Describe the layout of signal circuits by showing the following for each type of circuit (as applicable):

Signal Circuit: poles, mast arms, heads, signal conduit size and number, junction boxes, cabinet, underground service pedestal, power conduit, signal wiring information, and power source.

Pedestrian/Push Button: poles, ped heads, ped conduit size and number, push button conduit size and number, junction boxes, and wiring information.

Detection Circuit: poles, mast arms, luminaires (if detection is mounted on luminaire), detection devices, detection conduit size and number, preemption circuit, junction boxes, cabinet, and wiring information.

Lighting Circuit: poles, luminaires, lighting conduit size and number, junction boxes, cabinet, underground service pedestal power conduit and wiring, and lighting wiring information.

Future Use Conduit: poles, future use conduit size and number, junction boxes, cabinet, underground service pedestal, and wiring (pull wire) information.

Signal Schedule (SG-S)

Fill in the signal schedule sheets with the items and quantities of items needed on the project. The latest version of these sheets can be obtained on UDOT's website. Review the notes on the sheets to ensure they comply with the project and adjust as necessary. (In the past these notes have not been allow to be changed. However, it is better for the contractor if these notes are changed to reflect their specific project.)

ATMS (ATMS)

Describe the ATMS layout and details used to interconnect the traffic signals. Follow the Advanced Traffic Management System (ATMS) plan guidelines as presented in the UDOT Plan Sheet Development Standards.

2.4 SUBSURFACE UTILITY ENGINEERING (SUE)

Each existing utility should be labeled once per utility per sheet. Utility labels include the utility owner and description. The description includes the utility size, material, type, and SUE quality level. For example a 10" high-pressure gas line owned by Questar with a SUE quality level B would be labeled "Questar 10" HP Gas, QL-B."

The SUE quality level relates to the expected accuracy of the locations on the utility lines based on how the locations of the lines were determined. The ASCE established the following quality levels in the ***Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data***:

Quality Level D. QL-D is the most basic level of information for utility locations. It comes solely from existing utility records and mapping or verbal recollections.

Quality Level C. QL-C involves surveying visible above-ground utility facilities (e.g., manholes, valve boxes, etc.) and correlating this information with existing utility records (QL-D information). *This level is sufficient for all signal procurement projects.*

(Approval is needed from the Signal Program Manager before any SUE work is estimated beyond this level from a consultant.)

Quality Level B. QL-B involves the application of appropriate surface geophysical methods to determine the existence and horizontal position utilities. QL-B data is often obtained by surveying bluestaked utility lines.

Quality Level A. QL-A, also known as "potholing," is the highest level of accuracy presently available. It provides information for the precise plan and profile mapping of underground utilities through the actual exposure of underground utilities, and also provides the type, size, condition, material and other characteristics of underground features. Exposure is typically achieved through hand digging or Hydro-Vacuuming. *(All contractors are required to do this before any underground work. Essentially, potholing in design has to be re-done in construction.)*

For procurement plan sets, it is not necessary to pothole to obtain QL-A utility locating during design. QL-C and QL-D are sufficient. The contractor will perform potholing during construction to avoid utility conflicts. The placement of the signal equipment and other improvements can be field adjusted during construction.

For design-bid-build projects, QL-B and QL-A may be necessary. If the QL-C and QL-D mapping indicate that a utility conflict may be present then higher quality SUE, such as potholing, will be necessary to determine if there is a conflict. In cases where a conflict is found the design will need to be adjusted or the utility relocated. Coordinate with the Region Project Manager and Region Utility Engineer to determine what type of SUE efforts should be employed and how to address utility conflicts.

3.0 TRAFFIC SIGNAL DESIGN

3.1 SIGNAL POLES, MAST ARMS, AND FOUNDATIONS

Pole Numbering

Pole numbering starts with the northwest corner pole as “P1”, regardless of the intersection orientation on the sheet, and continues clockwise around the intersection. Each pedestrian signal pole or supplemental traffic signal pole will count in the numbering and should be labeled likewise.

Pole Placement

Signal poles should be located as close to the center and back of pedestrian ramps as possible, considering underground and overhead utilities. Do not place two signal poles within 10 feet of each other, if possible. Push buttons must be no greater than 10 feet from the point where the pedestrian access ramp centerline meets the top back of curb (TBC) line. If this 10-foot distance can't be met, a supplemental pedestrian pole may be required. If no pedestrian access ramps are required, place the pole a minimum 6 feet from TBC.

Overhead clearance is very important where 30-foot or 40-foot luminaire extensions are used. Maintain minimum clearance from primary conductors to luminaire or luminaire arm. Contact the local power supplier for required safe working clearances.

Foundation Elevation

On projects that require survey, specifying the correct foundation elevation will likely be critical to assuring proper signal head height in the final constructed product. Visit the site and make note of any unusual slopes where foundations will be placed, and any unusual superelevations or high crowns in the roadway. If this will be a new pavement section, compare TBC elevation to roadway centerline elevation before specifying the foundation elevation.

To assure the proper combination of signal head and foundation height, as a general guideline, set the foundation elevation at the roadway centerline elevation, at a 2% slope higher than the adjacent TBC, or at the same elevation as back of sidewalk, whichever is highest. Should this result in more than 1 foot of foundation above grade, add a special provision that requires 12 feet (or deeper for longer mast arms) of foundation below grade and an appropriately lengthened rebar cage. It is preferred to set the top of the foundation flush with the finished grade. The foundation may be set a maximum of 18 inches above the finished grade. If the pole foundation is within the roadway clear-zone, it needs to be 4 inches or less above finished grade to the top of the base plate or it becomes a roadside hazard requiring a clear zone waiver.

Set the foundation elevation to ensure a minimum of 17.5 feet and maximum 19.5 feet clearance from the bottom of the head assembly and the finished roadway surface. Be sure to consider all directions of traffic. Especially in skewed intersections, the

higher roadway finished surface may be where the signal head hangs over traffic from the crossing direction.

Foundation and Mast Arms

Standard mast arms come in 5-foot increments from 30 feet to 85 feet. Additionally, UDOT has differing signal pole type, size, bolting and foundation requirements, depending on mast arm length. The signal pole and foundation specifics are categorized by mast arm length as shown in Table 3.1.1 below. Signal Pole foundation details for 80-foot to 85-foot mast arms can be seen in Figure 3.1.1 below.

TABLE 3.1.1 – MAST ARM POLE AND FOUNDATION REQUIREMENTS

Mast Arm Length	Signal Pole (Type)	Foundation (ft dia x ft deep)	Number of Bolts	Bolt Circle (dia)
30 ft to 55 ft	Type A (curved)	3 x 12	4 Bolts	23-inch
60 ft to 65 ft	Type B (straight)	3 x 12	4 Bolts	23-inch
70 ft to 75 ft	Type B (straight)	3 x 14	4 Bolts	23-inch
80 ft to 85 ft	Type C (straight)	4 x 14	6 Bolts	26-inch

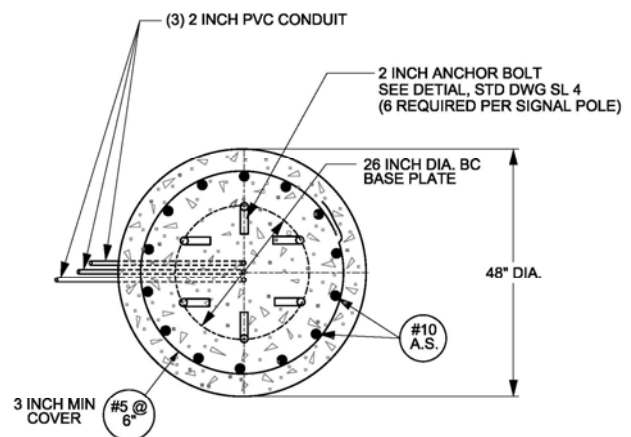
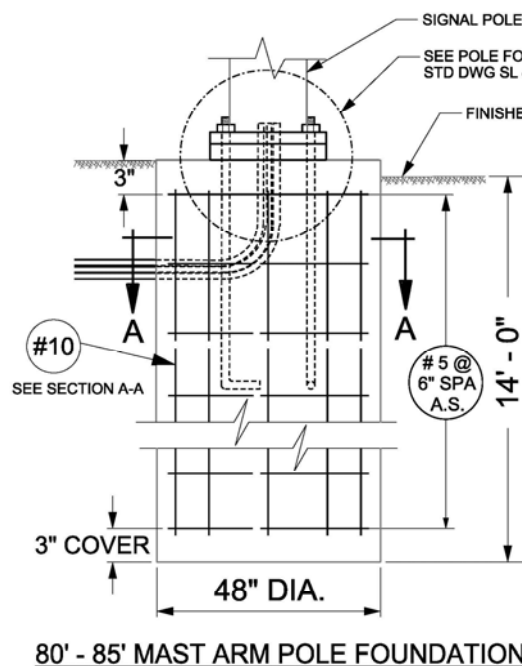


FIGURE 3.1.1 – 80-FOOT TO 85-FOOT MAST ARM FOUNDATION DETAILS

It is recommended to orient mast arms perpendicular to lane striping on non-skewed and slightly skewed intersections. For intersections with more pronounced skewing the orientation of the mast arms will need to be designed to optimize detection (see Vehicle and Pedestrian Detection Part 6.0) and placement of signal heads.

General Pole and Mast Arm Design Notes

- When specifying dual mast arms, the common signal pole type has a maximum arm length of 45 feet. Dual mast arms of up to 55 feet can be used with special-order arms and signal pole. Refer to Appendix 1 for more information.
- Types A and B signal poles require the same 23-inch anchor bolt circle with four anchor bolts. When specifying a 70- or 75-foot mast arm, the foundation will require a depth of 14 feet. Refer to Standard Drawing SL 4 for details.
- When specifying an 80- or 85-foot mast arm, the foundation will require six anchor bolts on a 26-inch bolt circle (4-foot diameter foundation), extra depth, and reinforcing steel. See Figure 3.1.1 for details.
- When specifying a 25-foot mast arm, note that it will be a 30-foot arm field cut to 25 feet.
- Mast arms for approaches with future projected left turn warrants should have extra length for future placement of Type III or type VI signal heads.
- An adapter plate is needed when an existing signal pole foundation is used with a different anchor bolt pattern. (Ask the Region Signal Engineer to verify.)
- The maximum loading for mast arms is shown on the SL Series of the Standard Drawings. Do not exceed the maximum loading for the mast arms without approval as indicated on the Standard Drawings.
- Specify a pole cap for all signal poles that do not require a luminaire extension.

Non-Mast Arm Poles

Often, the mast arm pole is not in a location where a ped head, a push button, or near side signal head is needed. In these situations a 5.5-foot, 11-foot, or 15-foot pole can be used. These poles have a smaller 24-inch diameter, 36-inch deep foundation. The 5.5-foot pole is used for pedestrian push buttons only. The 11-foot pole is used for pedestrian push buttons, and pedestrian heads. The 15-foot pole is used for pedestrian push buttons, pedestrian heads, near-side signal heads, and detectors.

3.2 SIGNAL HEADS

Proper placement of signal heads over the roadway dictates the length of mast arm used and, to some extent, the location of the pole foundation. Signal heads are to be installed with mounting brackets and louvered back plates (except Type V heads). Retroreflective tape must be installed on signal head back plates that are constantly illuminated and always in use (such as traffic signals at intersection). Signal heads on Reduced Speed School Zone, flashing beacons, or pedestrian hybrid beacon assemblies that are not always in use must not include retroreflective tape to avoid drawing driver attention when they are not activated.

Signal Head Types

Pedestrian Signal Head: Generally referred to as a “ped head,” this signal head must be countdown style in all applications.

- | | |
|-----------|---|
| Type 0: | One-section head with red, yellow, or green indications. It can be a ball or arrow indication. |
| Type I: | Three section head with red, yellow, and green round ball indications. This head is typically used for thru movements. |
| Type II: | Three section head with a red round ball indication, plus yellow and green arrow indications. This head is typically used at T-intersections with no pedestrian conflicts. |
| Type III: | Three-section head with red, yellow, and green arrows. This head is used for protected-only turn movements. |
| Type IV: | Four-section head with red, yellow, and green round ball indications, plus one green arrow in the lowest section. This head is typically used for split phases and freeway ramps. |
| Type V: | Five-section head with red, yellow, and green round ball indications, plus one yellow and one green arrow. This head can be either stacked vertically or set in a “doghouse” type formation, and is typically used for protected/permissive turn movements on existing signals that lack adequate arm length for a Type III or Type VI head. |
| Type VI: | The “Flashing Yellow Arrow” four-section signal has one red arrow, two yellow arrows, and one green arrow in a vertical stacked formation. This head is used for protected/permissive left turn movements. The green arrow provides a protected left turn from oncoming traffic while the lower yellow arrow will flash to indicate that left-turning traffic must first yield to oncoming traffic and pedestrians before turning. The upper yellow and red arrows are steady and function in their traditional manner. |
| Type VII: | Four-section head with two adjacent red, one yellow, and one green round ball indications set in a “T” type formation. This head is used |

when increased emphasis to the red indication is desired.

Hybrid Beacon: This head is used for pedestrian hybrid beacon crosswalk signals. Three-section head with two adjacent red and one yellow flashing ball indications set in an inverted triangle type formation. It is associated with the Hybrid flashing beacon assembly which consists of two hybrid beacons on either side of mast arm mounted sign.

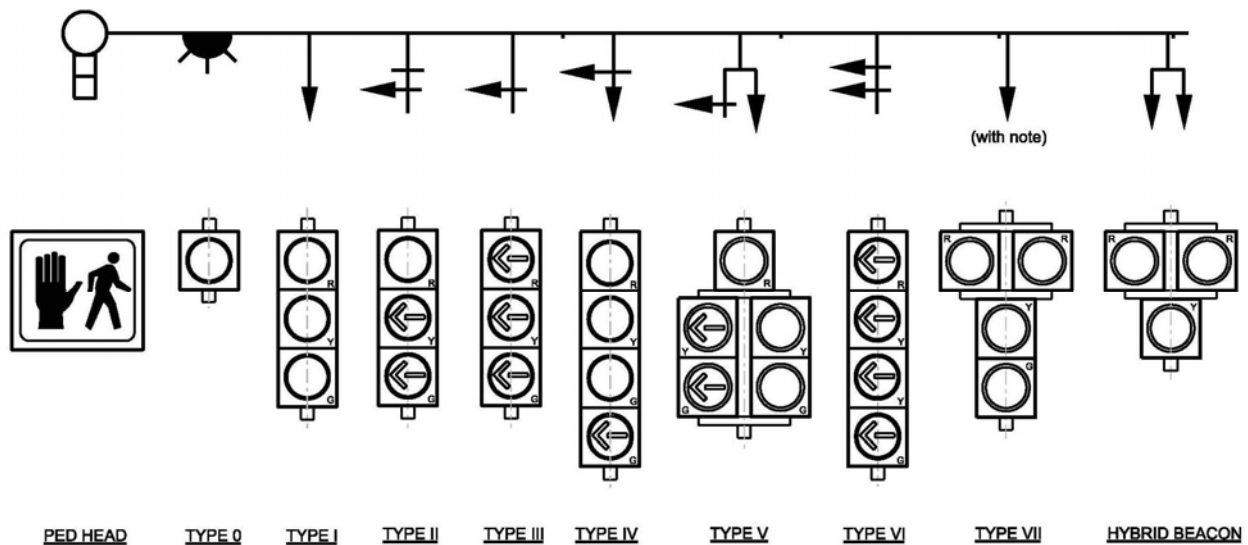


FIGURE 3.2.1 – TRAFFIC SIGNAL HEADS AND SYMBOLS

Traffic Signal and Ped Head Placement

- Provide at least two signal heads for the thru movement. If there is no thru movement, then provide two signal heads for the major movement. Every intersection leg must have at least two red ball indications. If there are no thru movements, the major and minor turn movements should have type I or type II signal heads, depending on pedestrian crosswalks.
- Place the signal heads no closer than 8 feet apart. Refer to Standard Drawing SL 1A and SL 1B for standard head mounting locations. In cases where a signal head is over each lane, center signal heads over lanes.
- Do not locate a signal head over a shoulder stripe or curb line.
- Do not center a type I or type V head over a left turn lane.
- Note that signal heads will be mounted on bracket mounts to mast arms per Standard Drawing SL 2.

- Provide a minimum 17.5-foot and maximum 19.5-foot clearance from bottom of signal head, back plate, or bracket to roadway surface. Do not have more than 2/3 the height of the signal head above the mast arm. Signal heads mounted too far over the mast arm tend to get twisted by the wind.
- Signal heads should be located a minimum 50 feet and maximum 150 feet from the stop bar. A supplemental nearside signal head is required where signal heads are located more than 150 feet from the stop bar, and may also be needed if intersection geometry causes occlusion. Use a 15-foot traffic pole if nearside signal head isn't placed on the mast arm pole. Although MUTCD allows 180 feet beyond the stop bar before a near side signal head is required, approval from the Region Traffic Operations Engineer is needed to go beyond 150 feet without a nearside head.
- Place ped heads on traffic signal poles in any case where traffic queued at the stop line will not occlude the pedestrian's line of sight. Otherwise, specify an 11-foot traffic pole to carry both ped head and push button.
- Region Signal Engineers prefer ped heads to be installed on the traffic signal mast arm poles whenever possible and not on separate 11-foot or 15-foot traffic poles. A 5.5-foot pedestrian pole should be installed when mounting the push button on the mast arm pole does not meet ADAAG criteria.

Thru Movement Signal Head Placement Options

- For single lane with no Type III or VI protected left – Place two heads with the left most thru signal head 1 to 2 feet to the inside of the double-yellow line. Separate the heads by 8 feet.
- For single lane with Type III or VI protected left – Place left thru signal head so that it is at least 8 feet from the protected left head and 8 feet from the right thru signal head.
- For two or three lanes – Center a signal head over each lane even when there is no Type III or Type VI left-turn head.
- For four lanes – Center a signal head over each lane.

Left-Turn Signal Head Placement Options (when left turn warrants are met – see Appendix for Left-Turn Phasing Guidelines)

- Protected/Permissive Left (modification on existing signals) – Place the Type V signal head over the double-yellow line. Specify a mast arm mounted “yield on green” sign (R10-12).

- Single Protected Left or Type VI Protected/Permissive Left – Place the signal head regulating the left-turn movement over the center of the opposing left-turn lane. Specify a mast arm mounted “yield on flashing yellow arrow” sign when Type VI signal heads are used. Type VI signal heads are preferred over Type V when a mast arm of appropriate length is available. Whenever Type VI heads are used sign RS10-21ex is required. See Figure 3.2.7 for sign RS10-21ex details.
- Dual Left – Place two Type III signal heads centered with each respective turn lane.

Right-Turn Signal Head Placement Options (when approved by Region Traffic Operations Engineer)

- Right Turn Overlap with Type V head – Place the Type V signal head aligned with the solid white line between the thru and right turn lane. The green ball indication takes the place of the Type I head in the thru lane just left of the right turn lane. The right side green arrow will point to the right and show green when the opposing street’s lefts are in the green phase. Specify the mast arm sign R3-4 (No U-turn) for the adjacent/conflicting left/u-turn lane.
- Right Turn Overlap with Type VI head – Place the Type I signal head in the center of the thru lane. Place the Type VI head to be aligned with the center of the right turn lane, this head will hang over the shoulder. Specify the mast arm sign R3-4 (No U-turn) for the adjacent/conflicting left/u-turn lane. In cases where there are dual right turn lanes, install a Type VI signal head centered over each lane.

See Figure 3.2.2 through Figure 3.2.6 below for head placement examples.

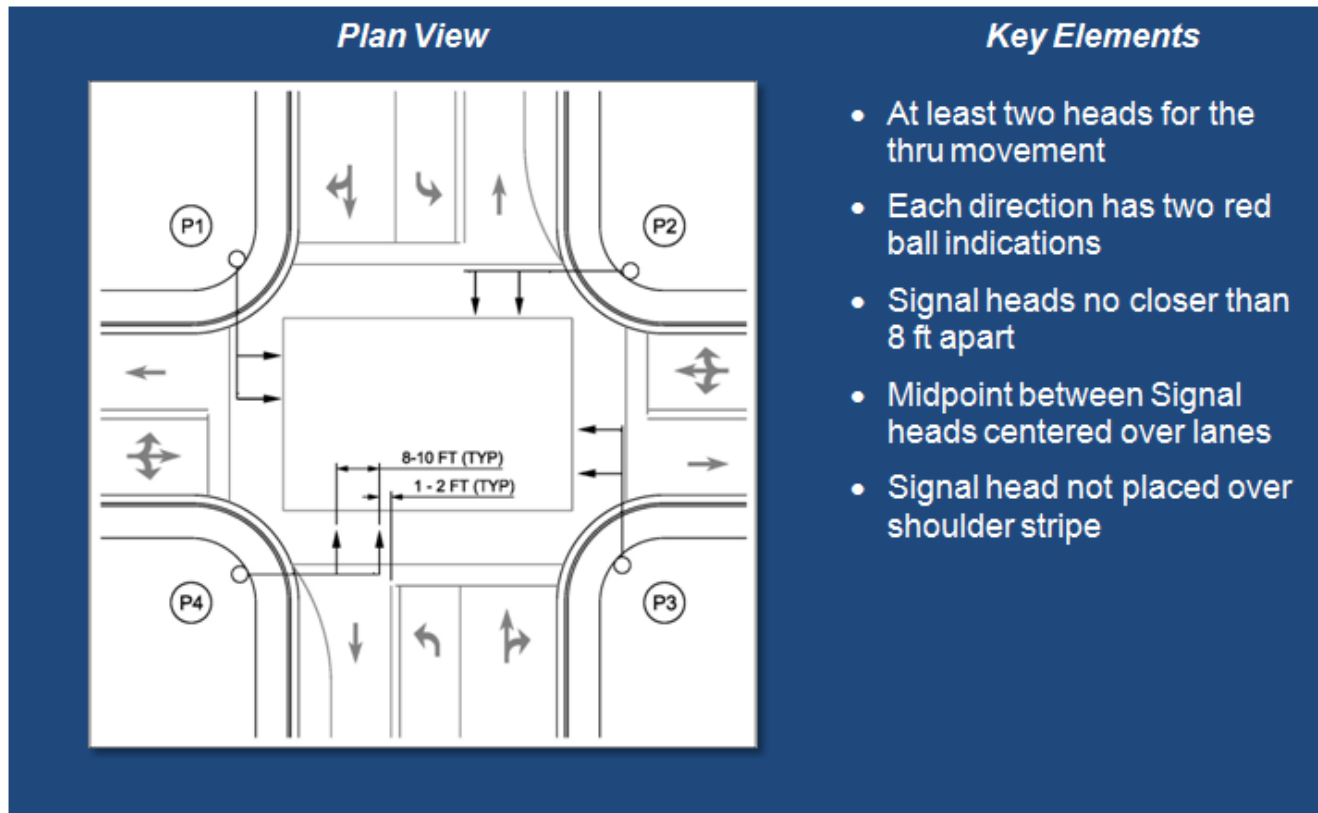


FIGURE 3.2.2 – EXAMPLE SIGNAL HEAD PLACEMENT FOR SINGLE THRU LANE WITHOUT PROTECTED LEFT-TURN PHASING

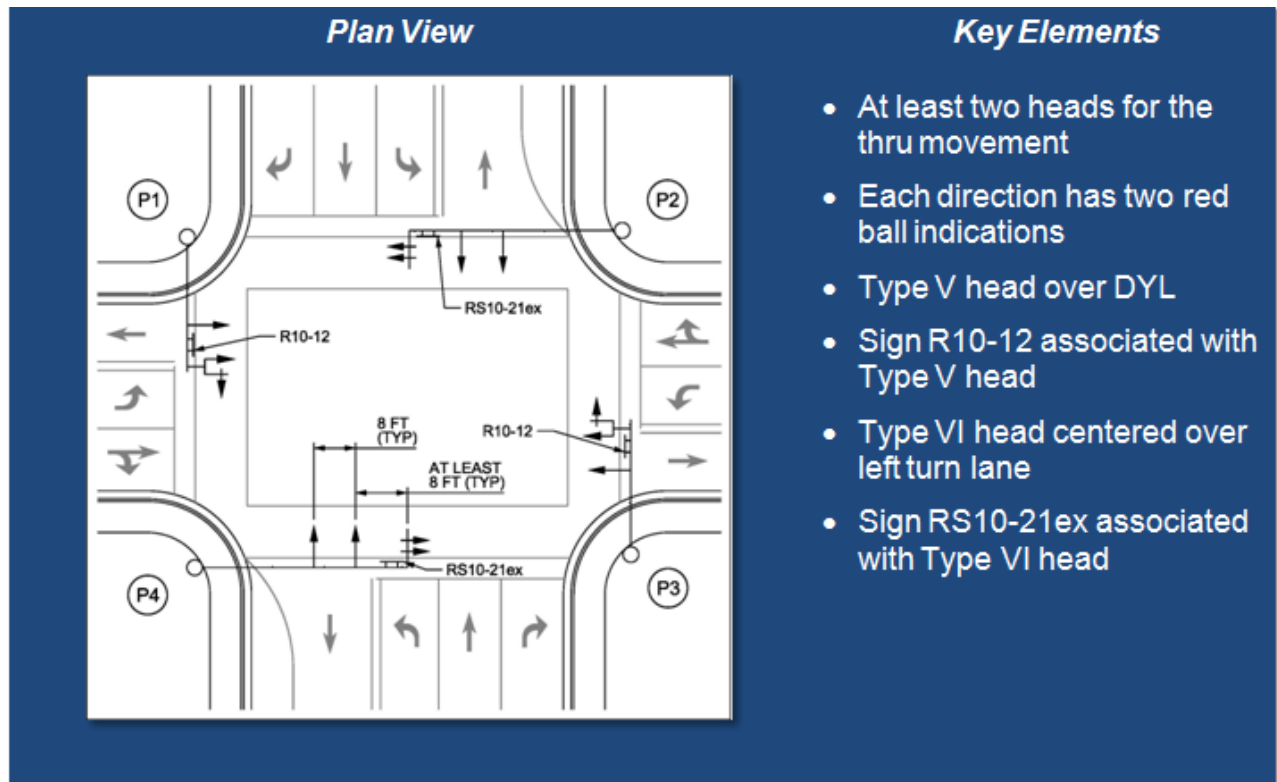


FIGURE 3.2.3 – EXAMPLE SIGNAL HEAD PLACEMENT FOR SINGLE THRU LANE WITH PROTECTED LEFT-TURN PHASING

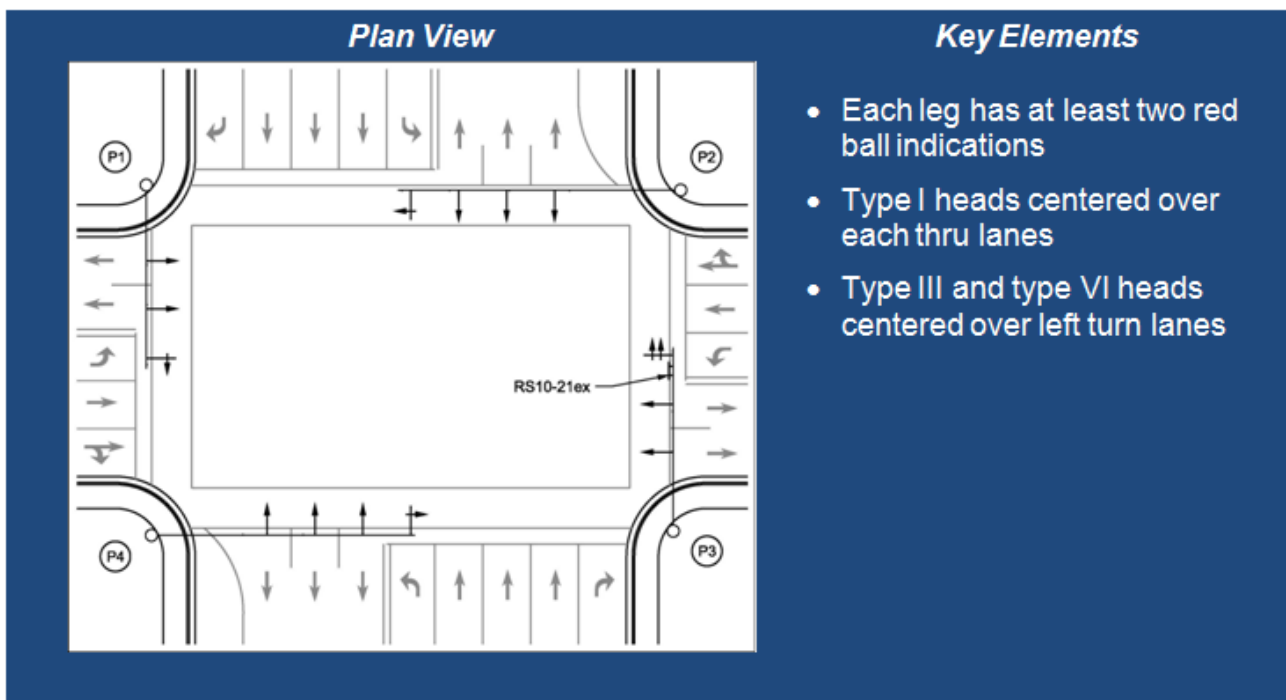


FIGURE 3.2.4 – EXAMPLE SIGNAL HEAD PLACEMENT FOR 2 OR MORE THRU LANES

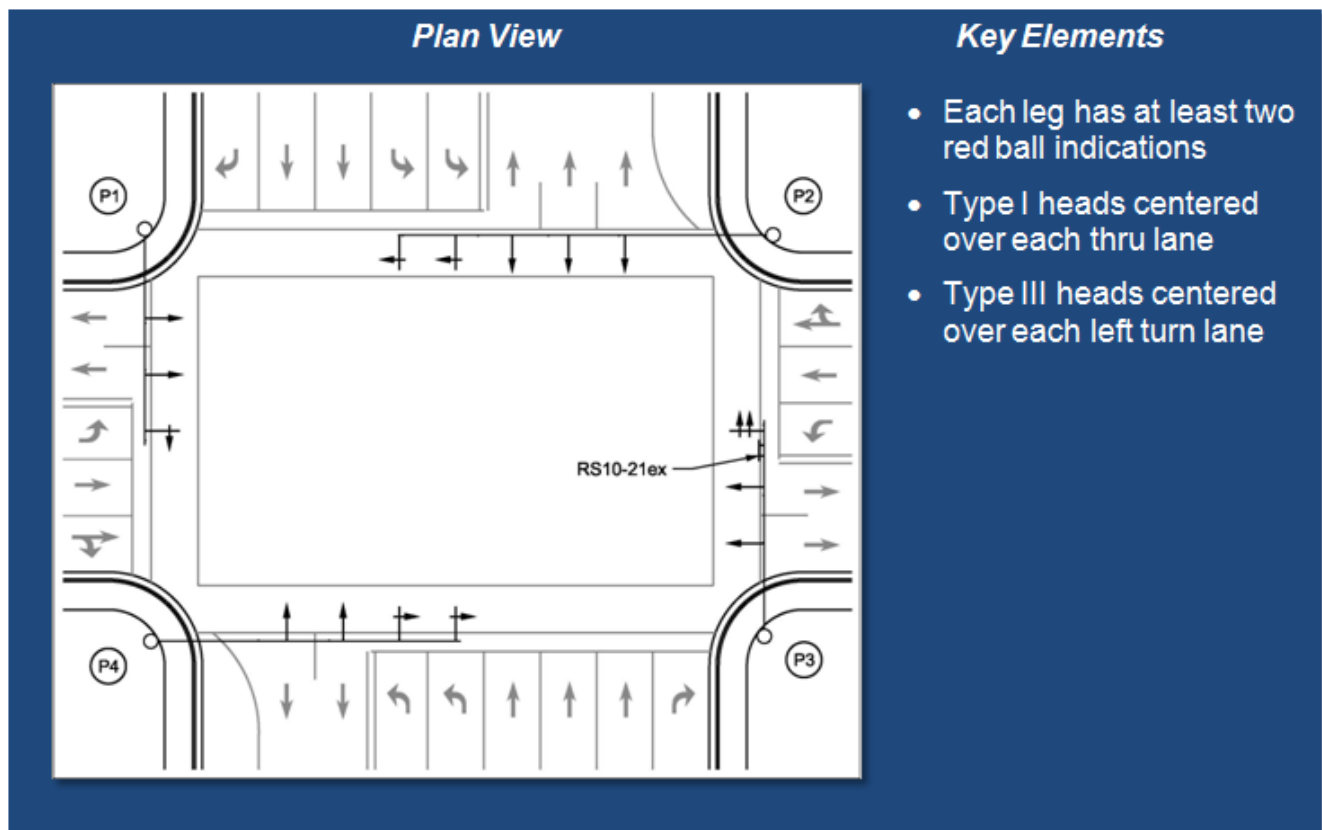


FIGURE 3.2.5 – EXAMPLE SIGNAL HEAD PLACEMENT FOR DUAL LEFT-TURN LANES

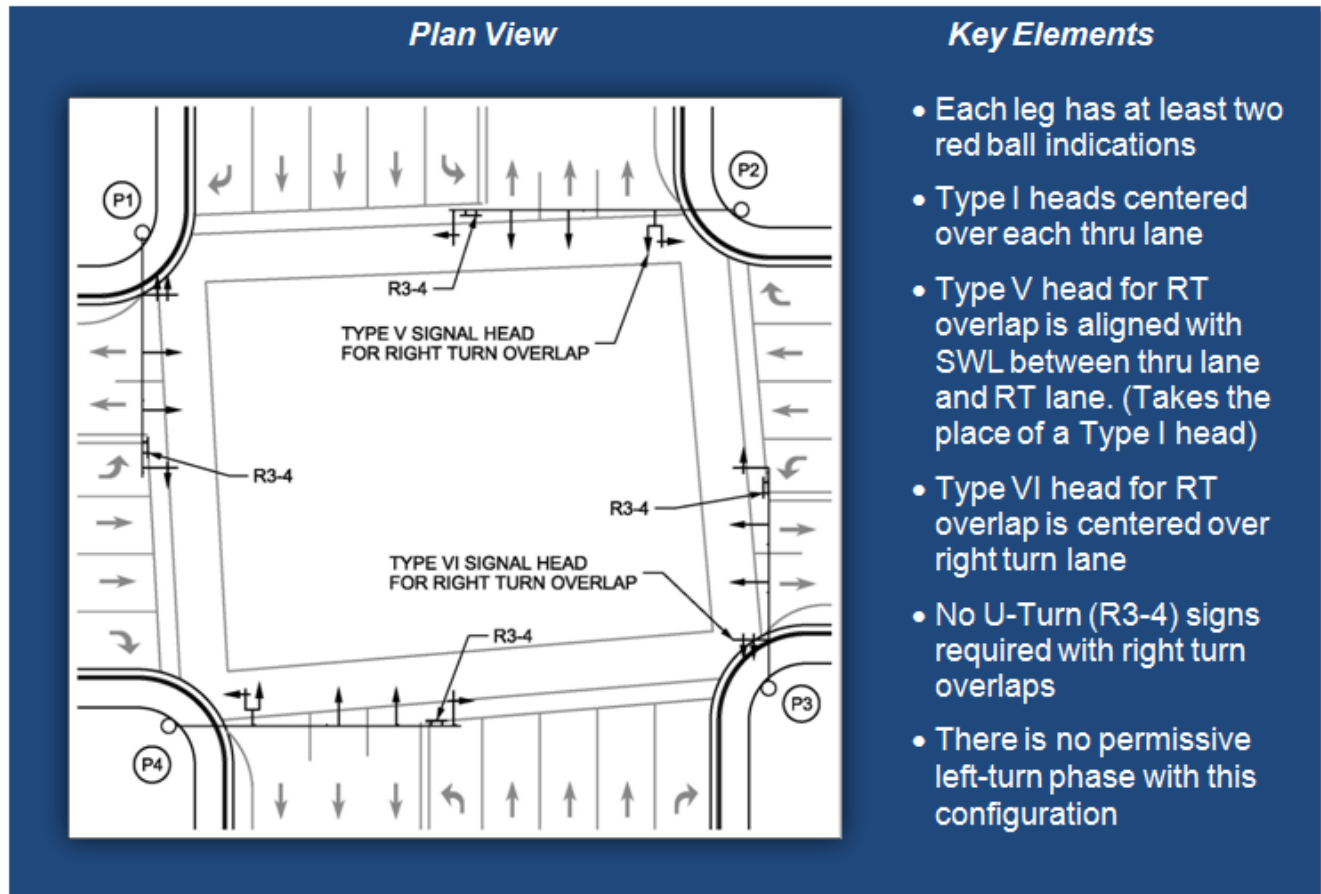


**FIGURE 3.2.6 – EXAMPLE SIGNAL HEAD PLACEMENT FOR
RIGHT-TURN OVERLAP PHASING**

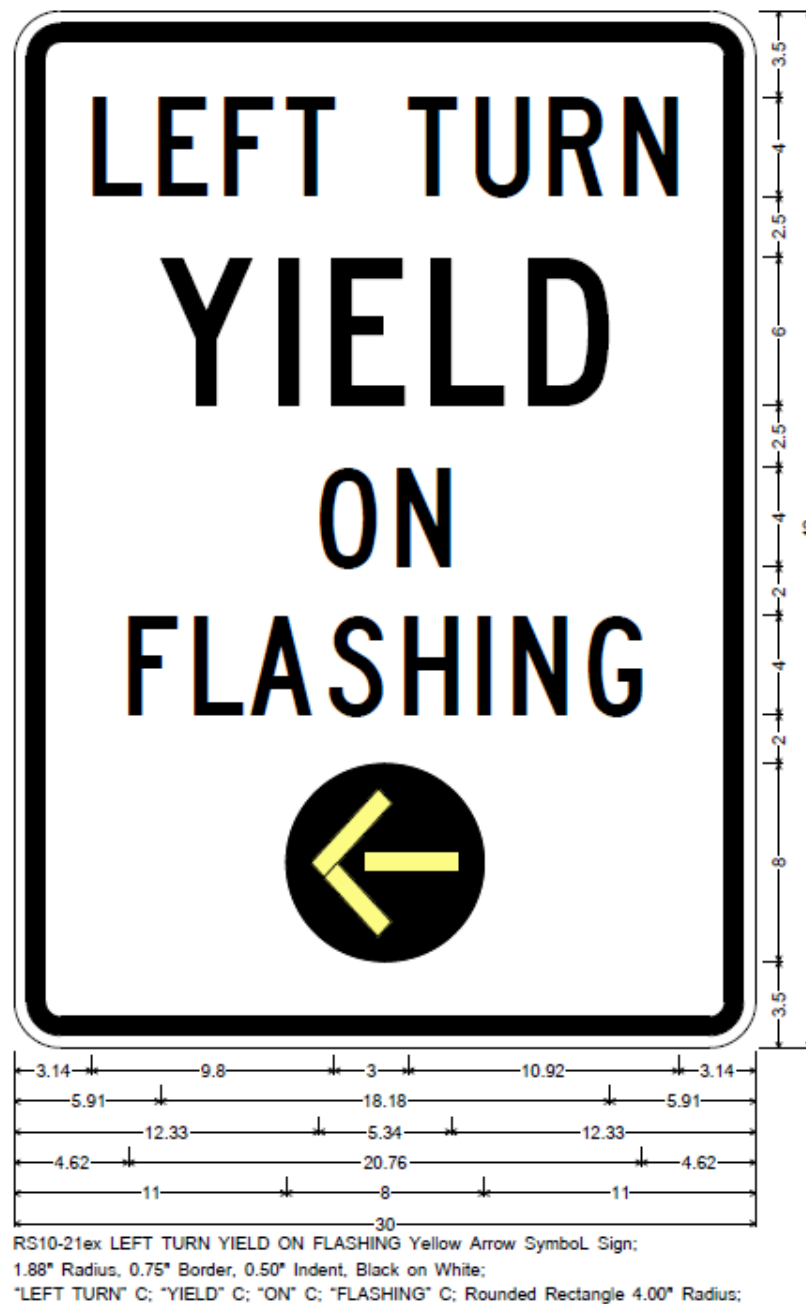


FIGURE 3.2.7 – LEFT TURN YIELD ON FLASHING YELLOW ARROW (RS10-21EX)

LED Modules

Specify LED modules for all traffic and pedestrian signal heads. If intersection has relatively new signal equipment that will remain in service, retrofit the existing heads with new LED modules or salvage the existing to the region. Check with the Region Signal Maintenance Supervisor regarding replacement of existing LED modules.

3.3 LANE LINES AND STRIPING

Pavement Markings

Establish pavement markings according to the UDOT Standard Drawings. Show lane striping and pavement messages for the intersection and clearly identify the dimensions and distances required for proper installation. Specify the material to be used (paint, tape, or thermoplastic) and confirm with the Region Traffic Engineer. Match existing pavement marking materials unless instructed to do otherwise by the Region Traffic Engineer. Call out any pavement marking removals to avoid motorist confusion once the intersection is open to traffic. Show the existing markings in a gray scale and new striping in full scale (black) on the striping sheets. For clarity and reference, show the final marking configuration in gray scale on the signal plan sheets.

Stop Line

Specify a 12-inch stop line at intersections with crosswalks. When there is no crosswalk, specify a 24-inch stop line for better visibility.

Turn Lanes

Width – Provide 12-foot wide left-turn lanes unless an alternate width is approved by Region Traffic Operations Engineer. If this is not possible, discuss the issues with the Region Traffic Engineer. Provide a minimum 16-foot receiving lane width for single left-turn movements (measured from the tangent section of lip of curb & gutter). Provide 30 feet combined receiving lane width for dual left-turn movements. Maintain the receiving lanes for 50 feet before tapering back to normal lane widths. Provide minimum 10-foot wide right-turn lanes or as established in the PDC document.

Alignment – Align the opposing left-turn lanes through an intersection to enable the driver to see past the vehicle in the opposing left-turn lane. If there is no opposing left turn movement install a striped or raised median. Dedicated turn lanes should not continue through the intersection as thru lanes. Turn lanes should not encroach on thru lane alignment.

Truck Turning Templates – Use turning templates to check the typical type of vehicle, bus or truck using the intersection. UDOT typically utilizes the WB-67 for the design vehicle when analyzing turn movements. If another vehicle template is used provide justification. Analyze turning movements to verify safe clearance of turning vehicles. Provide printed copies at the Plan-in-Hand Meeting.

Length – Design the length of the turn lanes to accommodate the queue volume and deceleration without backing traffic into the thru lane. When a raised island is required, design tapers and storage to be as long as practical to not affect the efficiency of the thru movement. Coordinate with the Region Traffic Engineer to determine required storage length. When a signal is being upgraded or replaced, it is common to relocate the stop bar. In these situations, attempt to, at a minimum, replace the existing storage length with the new striping configuration.

Coordinate with the Region Traffic Engineer if the storage length is reduced to assess any traffic operations issues that may arise.

Bicycle Markings

Coordinate with the UDOT Bicycle Pedestrian Coordinator and the Central Traffic & Safety Engineer to assess bicycle needs. Provide bicycle detection and associated pavement markings as required in the UDOT Standard Drawings.

3.4 SIGNING

Inventory existing ground- and mast-arm-mounted signs and verify adherence to current UDOT and MUTCD standards. UDOT currently requires ASTM type IX or better sheeting for all signs. The installation of a new traffic signal may require the installation of new signing or the removal of existing signing along the approaching roadway(s). Ensure that existing signing does not conflict with new signing. Coordinate with the Region Traffic Operations Engineer for additional signing, such as guide signing, requirements and needs.

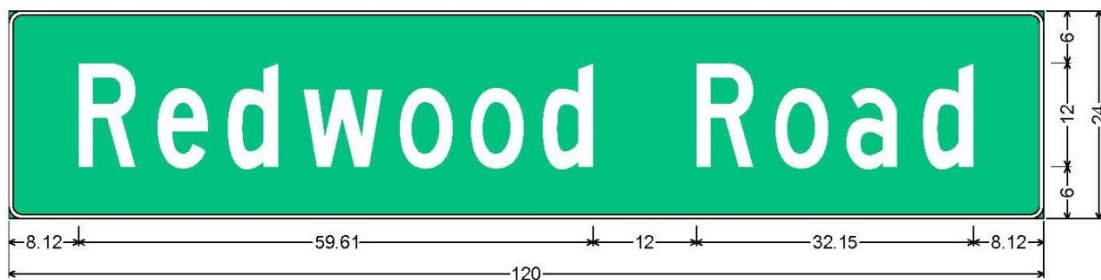
Mast-Arm-Mounted Street Name Signs

- Follow the latest version of the **UDOT Sign Manual**.
- Place mast-arm-mounted signs according to the SL Series Standard Drawings. The sign placement shown in the standard drawings has been approved by the state furnished steel manufacturers to withstand expected wind loading on the mast arm and pole. (See SL Series Standard Drawings.)
- Dimension signs in 6-inch increments. Typically, street name signs are 18 inches or 24 inches tall with a width depending on name length. Do not exceed a mast arm sign area of 20 square feet when the sign is placed between the innermost signal head and the signal pole. When the sign is placed between signal heads, do not exceed a mast arm sign area of 12.5 square feet. Do not exceed maximum mast arm loading requirements. (See SL Series Standard Drawings.)
- Use initial upper-case letters and lower-case letters in street names, for example “300 South” or “Bangerter Hwy” (per MUTCD).
- Use 12-inch sign text for street signs. 8-inch text may be used in order to prevent exceeding the maximum sign area shown in the SL Series Standard Drawings.
- If the street has two names, put the most commonly referred to name in 12-inch text above the secondary name in smaller text on a 24-inch tall sign. (See Figure 3.4.1)

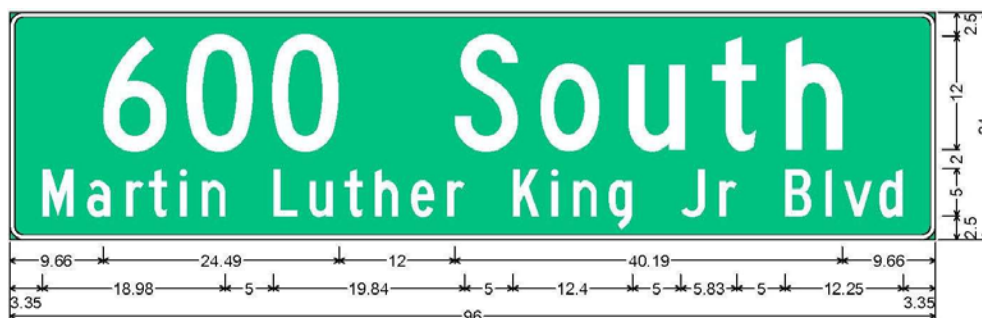
- Cross Streets may be designated with different street names on each side of the state highway. Effort should be made to show only one street name for the cross street at the intersection. When a numerical designation is part of a coordinate system, the coordinate designation will take precedence over all other street names. When the Region Traffic Engineer approves the use of both names, use 6-inch text on a 24-inch sign, with arrows indicating the direction.
- Place the US Route Shield or State Route Beehive on the sign to the left of the street name (see Figure 3.4.1)



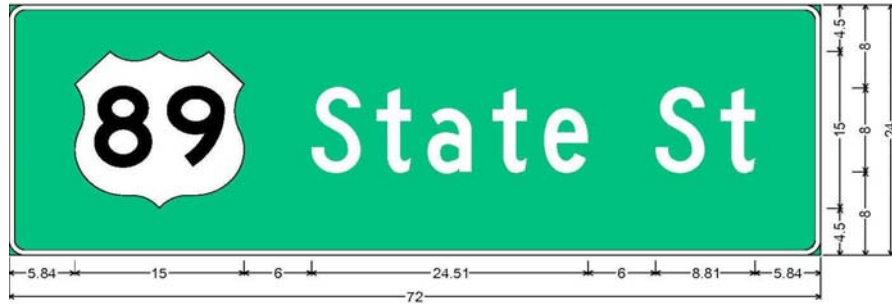
24th St with SR-53 Beehive: This 12 square feet sign may be mounted between the signal heads



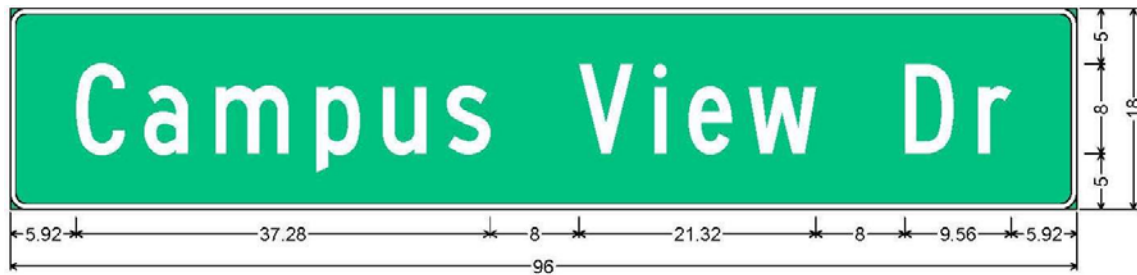
Redwood Road Sign with 12-inch lettering: This 20 square feet sign must be mounted between the innermost signal head and the pole



600 South Sign with Street Name: This 16 square feet sign must be mounted between the innermost signal head and the pole



State Street Sign with US-89 Shield: This 12 square feet sign may be mounted between the signal heads



Street Sign: This 12 square feet sign may be mounted between the signal heads

FIGURE 3.4.1 – EXAMPLE MAST ARM STREET SIGNS

4.0 LIGHTING

Highway lighting is required at all signalized intersections, the extent of which depends on several conditions. When designing lighting for a given intersection, consider the following:

- Volume of pedestrian traffic
- Location within a commercial, residential, or rural environment
- Existing highway lighting systems
- Lighting needs for CCTV cameras
- Overhead utility conflicts
- Roadway configuration

These considerations will be factors in the selection of lamp wattage and placement. With the design, be sure to balance illumination needs with the surrounding environment. If highway lighting is provided along the corridor, provide 50% greater illumination at the intersection. Refer to the UDOT Standard Specifications and UDOT SL Series Standard Drawings for additional information.

4.1 LUMINAIRE COMPONENTS

Poles

UDOT's standard luminaire can be attached to the top of a Type A, Type B, or Type C mast arm poles or it can be placed on a stand-alone highway luminaire pole. Note that Type B and Type C mast arm poles are 5 feet taller than Type A, thereby increasing the height of a luminaire on Type B and Type C poles by 5 feet.

Extension

For Type A mast arm poles a 7'-9", or 17'-9" luminaire extension will provide 30-foot, or 40-foot luminaire height, respectively. For Type B and Type C poles 2'-9" and 12'-9" extensions can be used for a 30-foot, or 40-foot luminaire height, respectively.

	2'-9"	7'-9"	12'-9"	17'-9"
Type A	25	30	35	40
Type B	30	35	40	45
Type C	30	35	40	45

Highway luminaire poles do not require an extension.

Arm

The luminaire arm hangs out over the roadway. The arm length is how far the arm extends from the pole or extension. The arm length can be 10 feet, 15 feet, or a 2-

inch tenon mount fixture with a vertical attachment.

Vertical Attachment

The vertical attachment is an optional component that is used with a 2-inch tenon mount fixture in lieu of a luminaire arm. The vertical attachment is 5.5 feet in height.

Decorative Lighting

Decorative lighting is sometimes required by city ordinance or for other aesthetic considerations. Meet the minimum requirements of the Highway Lighting Standard Specification and follow UDOT Policy 06-06: Highway Lighting when using decorative lighting on state highways. Because this is a betterment, the City will have to fund the betterment and an agreement will need to be prepared.

4.2 LUMINAIRE PLACEMENT

Overhead clearance is very important where luminaires are placed. Maintain minimum clearance from primary conductors to the luminaire. Contact local serving power company for required safe working clearances.

- Use 15-foot luminaire arm length if possible. A 10-foot luminaire arm or 5.5-foot vertical extension may be needed for smaller intersections, for utility conflicts, or to match existing luminaires.
- If possible, provide at least two luminaires per intersection for minor intersections and at least four for major intersections.
- Highway lighting pole foundations extend 8 feet into the ground so be aware of subsurface utilities.
- Provide additional highway lighting along the highway corridor as directed.
- Luminaire arms may be oriented at any angle from the mast arm. They are typically oriented parallel to or at 45° or 90° from the mast arm for aesthetic reasons.

4.3 LUMINAIRE TYPE

- Use full cut-off LED cobra head luminaires with Type II distribution, 240 Volt single-phase, and 4000K-4500K apparent color temperature.
- Use 9,000 Lumen fixtures (Type A) for rural areas and residential neighborhoods.
- Use 14,500 Lumen fixtures (Type B) for major intersections and commercial or industrial areas.

4.4 ALTERNATE MOUNTING OPTIONS

- When overhead utility conflicts are evident, consider a 5.5-foot vertical extension with a vertical adaptor for a horizontal 2-inch tenon mount fixture.
- In protected gore areas or islands, a 180° dual arm luminaire may be a viable alternative.
- Luminaire arms mounted on utility poles are usually installed by others through an agreement with the utility company.

5.0 PEDESTRIAN SIGNAL DESIGN

If crosswalk markings are warranted, then pedestrian signals may be considered and are subject to the pedestrian signal warranting procedure as shown on Standard Drawing DD 19. A crossing may warrant a pedestrian traffic signal, pedestrian hybrid beacons (HAWK), overhead mounted flashing beacons, or side mounted flashing beacons.

Coordinate with the Region Traffic Engineer as to what type of crossing markings are to be used. If the crossing is on a designated school route, use school crossing markings. Crosswalks can be placed at intersections or at midblock crossings. Signalized midblock crossings must be a minimum distance from a controlled intersection as defined in the standard drawings and UDOT's Access Management Policy R930-6. A Deviation from UDOT Standards would be required if it was determined that the signalized crossing is placed less than the minimum distance from an intersection. Refer to UDOT Standard Drawings SL 17A-17E for more details.

5.1 PEDESTRIAN SIGNAL

Pedestrian traffic signals are design using the same parameters as a traffic signal except there is no vehicle detection. Refer to the standard drawings for more information. General design parameters are as follows:

- Provide a Type I head centered in each thru lane
- Place a mast arm mounted pedestrian warning sign (W11-2) between signal heads. A single mast arm sign pedestrian warning sign is sufficient for up to three thru lanes. For four or more thru lanes provide a second W11-2 sign.
- No heads are required in TWLT lanes
- Solid double yellow line for 50 feet on either side of crosswalk
- Review ADA compliance of ped ramps and upgrade if necessary
- Place 24-inch stop bar 50 feet in advance of crosswalk
- Sign no parking zones 50 feet before and 20 feet after crosswalk
- Provide pedestrian heads and detection
- Provide vehicle detection if directed by Region Traffic Engineer

5.2 PEDESTRIAN HYBRID BEACON CROSSWALK OR HIGH-INTENSITY ACTIVATED CROSSWALK (HAWK)

The pedestrian hybrid beacon is, as its name suggests a hybrid between a pedestrian traffic signal and a pedestrian beacon. The hybrid beacon assembly consists of an arrangement of three Type 0 heads (two red and one yellow) centered over the thru lanes with a RS10-23a mast arm sign between the heads.

5.3 PEDESTRIAN FLASHING BEACON CROSSWALK

The pedestrian flashing beacon crosswalk provides two yellow Type 0 flashing beacons 12 feet apart centered over the thru lane with a pedestrian warning sign between them (W11-2). A type 0 head is also placed on the pole facing the crosswalk. Yield lines rather than stop bars are required. At midblock crossing use "Yield Here to Pedestrians" Sign (R1-5) at the yield lines on multilane approaches. Overhead flashing beacons rather than post-mount beacons are typically applied where the posted speed is greater than 35 MPH or on multilane roads.

5.4 POST-MOUNT PEDESTRIAN FLASHING BEACON CROSSWALK

The pedestrian flashing beacon crosswalk provides two yellow Type 0 flashing beacons placed on a static roadside pedestrian warning sign (W11-2 & W16-7P). A rectangular rapid flashing beacon can be used in place of the type 0 heads. An additional Type 0 head is also placed on the pole facing the crosswalk. Yield lines rather than stop bars are required. Post-mount flashing beacons are typically applied where the posted speed is less than 35 MPH, and a single lane approach.

6.0 VEHICLE AND PEDESTRIAN DETECTION

Traffic signal detection is required at all new installations. Currently UDOT's preferred method of actuation is RADAR. RADAR detection, also referred to as "NIDS" (non-intrusive detection systems) or "Wavetronix." RADAR is easy to design and install and provides an unobstructed view to vehicles. It uses electromagnetic waves so in difficult weather, changing lighting, shadows from vegetation or buildings, and other environmental conditions it can detect vehicles. These sensors are virtually maintenance free as they never need cleaning. It comes in several forms and can be applied for dilemma zone detection, stop line and queue detection, and general vehicle counting. These systems consist of pole-, luminaire-, or mast-arm-mounted sensors and a controller mounted to the inside wall of the signal cabinet. When a signal is being upgraded or rebuilt the designer should evaluate during the site visit what type of detection is currently being used. If RADAR is not being used the plans should callout for this to be upgraded to include RADAR.

6.1 VEHICLE DETECTION ZONES

General detection zone requirements as measured from the stop bar are as follows:

- **Stop Bar Detection** – 0 feet – 20 feet detects the first vehicle in the queue.
- **Queue Detection** – Designed to detect 3rd vehicle back and its leading edge is placed 50 feet back.
- **Extend Detection** – 50 feet in each thru lane. This application is for signal green time extension on low-speed approaches. The extend zone is usually applicable with low speed facilities with loop detection.
- **Dilemma Zone** – Based on the speed of the individual vehicles, the distance from the intersection where a driver will have difficulty deciding whether to stop or proceed if a yellow phase begins.

Coordinate with the Region Signal Engineer to determine which detection zones to include on each leg of the intersection. Figure 6.1.1 shows detection zones associated with RADAR detection. In designing effective vehicle detection, the main factors to consider are speed, approach types, i.e. arterial/major versus residential/minor roadways, and whether or not left turn phasing has been warranted. The following are typical intersection scenarios and the recommended detection combinations for each:

Thru Lanes

- Speed limit $\geq$ 40 MPH Stop bar detection, RADAR dilemma zone detection.
- Speed limit < 40 MPH: Extend detection in each thru lane.

- Speed limit < 40 MPH: Stop bar detection for all thru lanes.

Left Turn Lanes

- Protected/permissive left turn: Both stop bar and queue detection.
- Protected left turn: Stop bar detection.

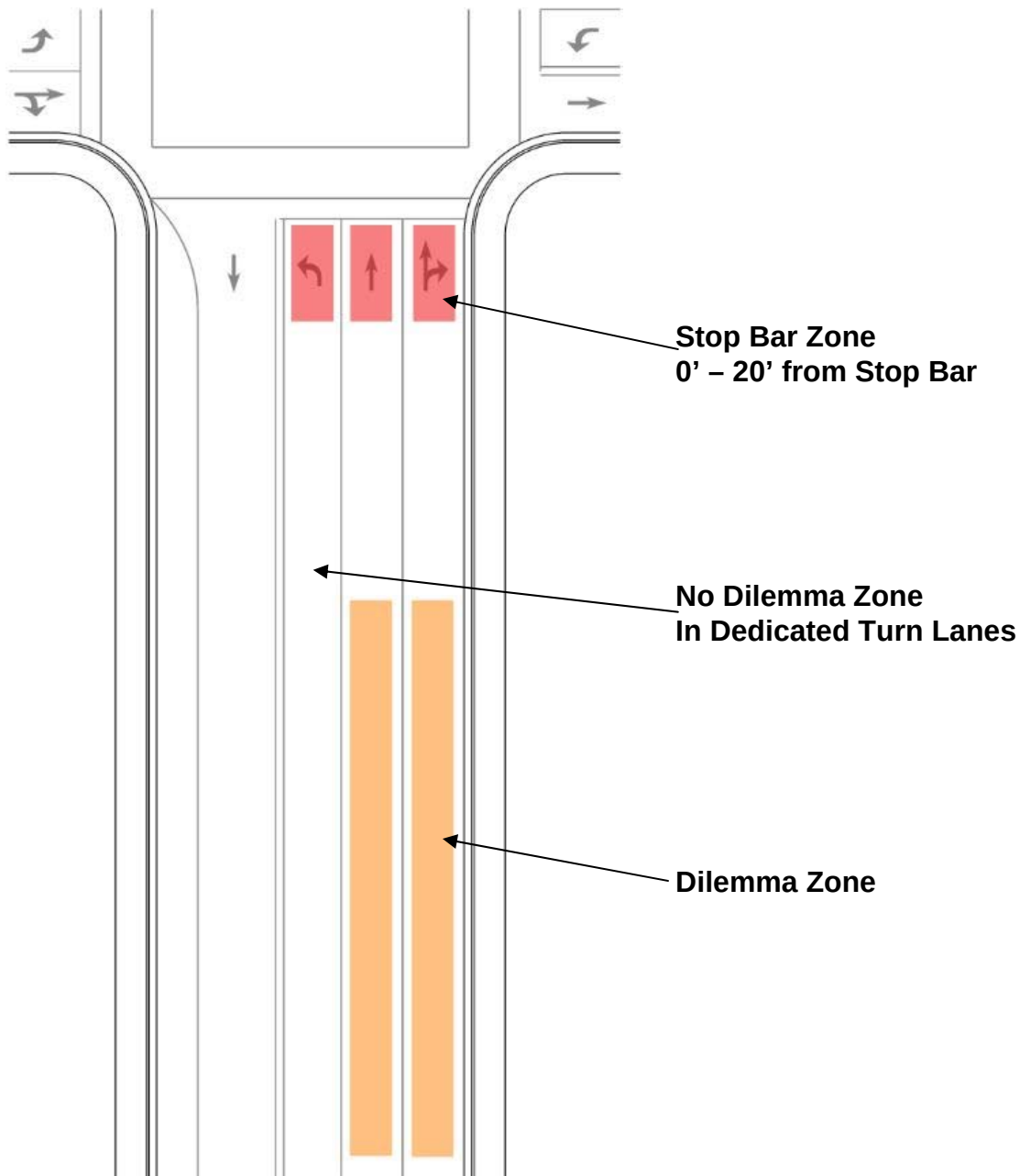


FIGURE 6.1.1 – RADAR DETECTION ZONES

6.2 RADAR DETECTION

Stop Line & Queue Detection

Stop line & queue RADAR vehicle detection is an effective detection alternative. UDOT uses the Wavetronix Matrix system which offers the advantage of flexibility because detection areas can be added or adjusted for size and area by simple commands on a portable electronic device with internet capabilities. However, unlike video detection, the system is not affected by insufficient lighting or adverse weather conditions such as snow, wind, or sun glare.

The Matrix system should be specified on new signal projects that do not include a mill & fill or pavement section replacement. For upgrades or pole relocations on existing signals, evaluate the existing detection system and verify any addition the Matrix system with the Region Project Manager, Region Signal Engineer, or Central Traffic & Safety Design Engineer.

Detection Area:

The Matrix sensor has a 140-foot radius quarter-circle detection area with the sensor being located at the circle's center point (see Figure 6.2.1). In the Wavetronix software, individual detection zones as well as lane lines and the stop bar can be drawn within this area. When specifying this technology, be sure the sensor can be mounted such that all stop bar and queue zones will fall within the quarter-circle area. The detection of the queue zone is often overlooked especially in skewed intersections. Additional detection devices may be required to cover the queue zone.

In general, it is preferred to orient the mast arms perpendicular to the striping. However, there are times when a more efficient detection zone can be achieved by having the mast arms skewed in relation to the striping.

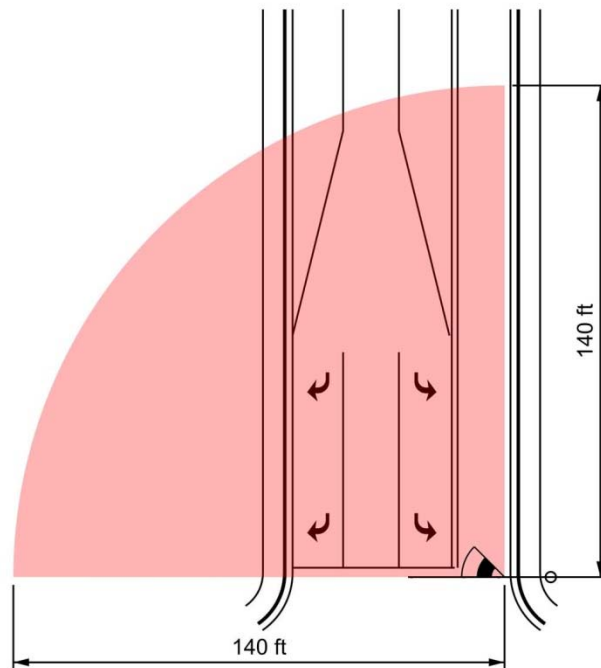


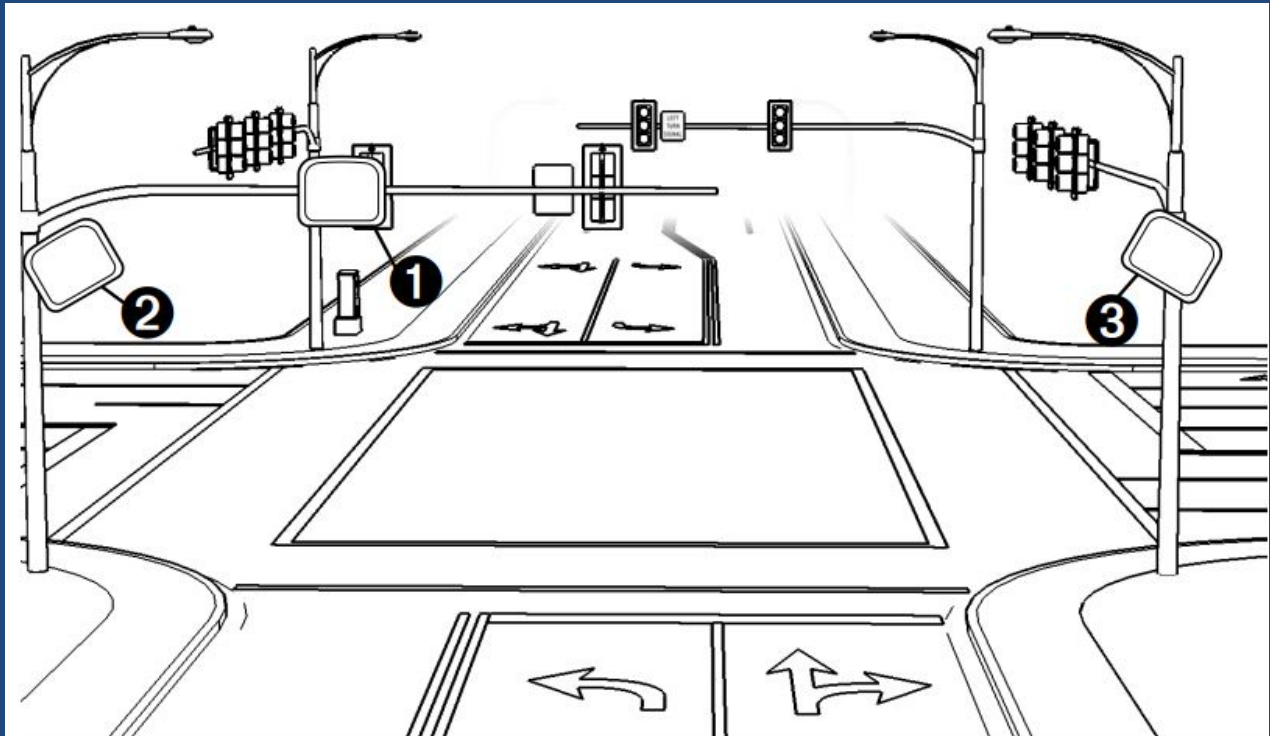
FIGURE 6.2.1 – RADAR STOP BAR DETECTION AREA

Sensor Placement:

The sensor will be affected by occlusion from mast arms, power poles, trees, etc. Fortunately, it can be placed in a variety of locations and still provide effective vehicle detection. The general rules for locating a sensor are as follows:

- Mount 15 feet to 25 feet, 20 feet optimally, above the roadway surface
- Mount at least 20 feet offset from the detection zones
- Locate so as to avoid occlusions
- Orient such that the detection area covers a few feet in front of the stop bar

The preferred mounting location is on the backside of the opposing direction's mast arm. If the stop bar is located after the opposing direction's mast arm the following mounting locations may be used: the opposing direction's signal pole just under the mast arm, or on a luminaire extension adjacent to the detection area. In most situations, the Matrix system is located at least 20 feet offset from the first lane of desired detection on the backside of the mast arm. Actual sensor placement onsite will be field located with the aid of the Region Electronics Supervisor. See Figure 6.2.2 for typical Wavetronix Matrix sensor placement locations.



- 1 **The back side of mast arm** – This location allows the sensor to be placed near the lanes of interest; this is the preferred location for stop bar detection. Mount the sensor near the end of the mast arm to reduce the possibility of the mast arm or departing traffic occluding approaching vehicles.
- 2 **The far side of approach** – The sensor is usually mounted on a corner vertical mast pole or strain pole. If the sensor is mounted on a vertical pole with a mast arm, you can usually avoid occlusion by mounting the sensor away from or below the mast arm.
- 3 **The near side of approach** – This mounting location is typically best if detecting the left turn lane is less important. This location also allows you to mount the sensor high enough to avoid occlusion.

Source: "SmartSensor Matrix User Guide," www.wavetronix.com, 2011. Web. 26 Mar. 2015.

FIGURE 6.2.2 – RADAR STOP BAR DETECTION PLACEMENT OPTIONS

If the opposing direction's mast arm is farther from the intersection than the detection area's stop, the sensor offset will need to be increased to provide adequate coverage in front of the stop line. Use a to-scale, quarter-circle template to assure the sensor location will properly cover the detection area. If the intersection is skewed care must be taken that there are not blind spots in the stop bar detection. Figure 6.2.3 is an example of a skewed intersection with adequate stop bar detection.

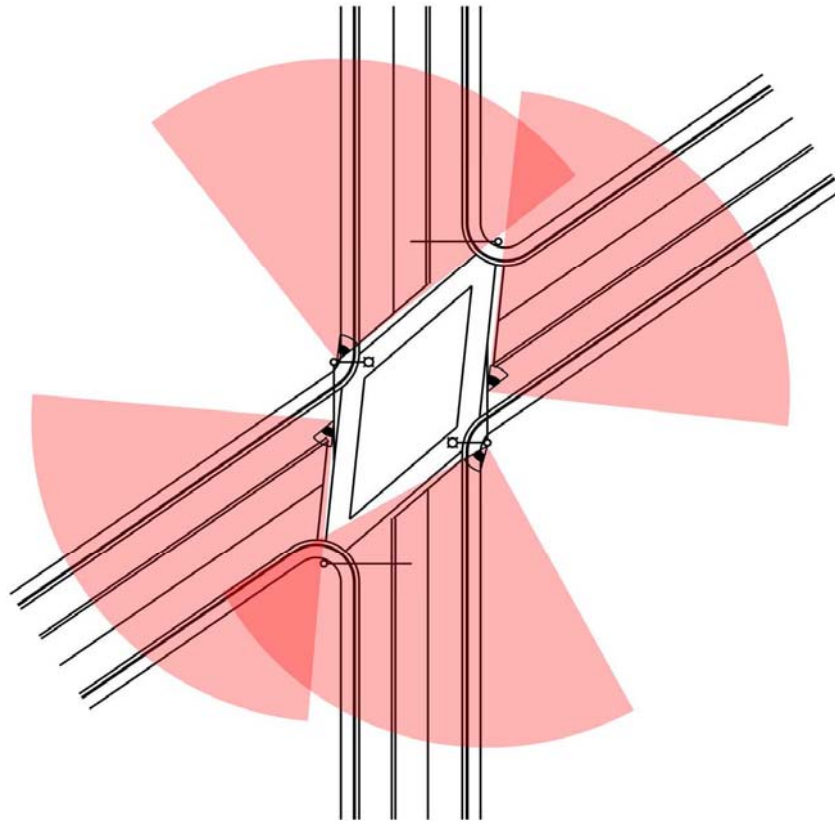


FIGURE 6.2.3 – EXAMPLE RADAR SENSOR PLACEMENT - SKEWED

Splice Box Placement:

In most cases the RADAR cable will require a splice between the sensor and the controller cabinet because the cable connector has only a 100-foot pigtail length. The splice box will be located inside the lower hand hole on the same signal pole on which the sensor is mounted. If the sensor is particularly close to the cabinet such that 100 feet of cable is adequate, a splice box will not be needed.

Dilemma Zone & Extend Detection

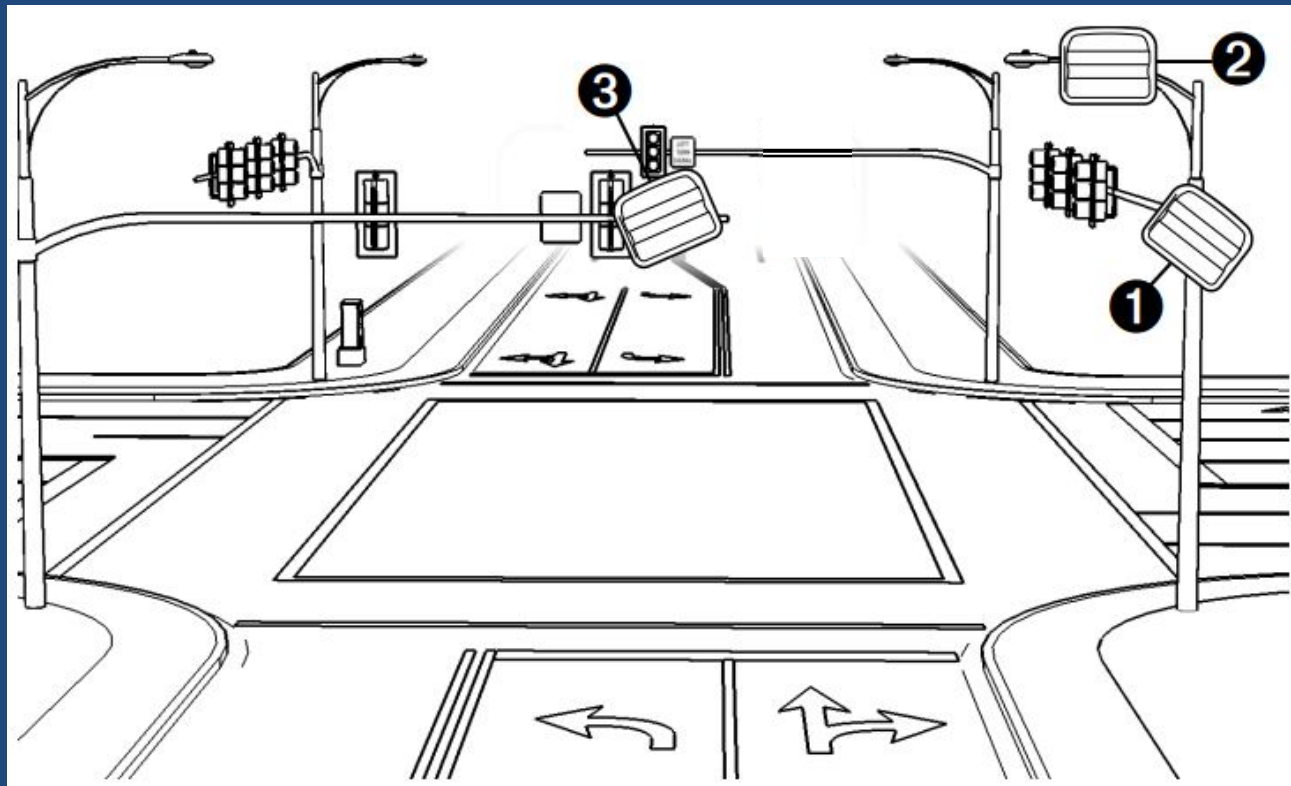
Dilemma zone RADAR detection is required on any State route with a speed limit of 40 MPH or higher and is encouraged for speeds of 30 MPH and higher for additional performance measures and safety. UDOT uses the Wavetronix Advance system, which can detect moving traffic up to 800 feet away and should cover most dilemma zone applications. The Advance system automatically detects vehicle speeds and determines the dilemma zone for each vehicle. Region Signal Maintenance personnel will set zones during the signal's initial activation.

In applications of speeds less than 40 MPH, this same RADAR system can be used

for extend detection to monitor traffic flow approaching the intersection.

Sensor Placement:

The preferred mounting location for a sensor is no more than 50 feet offset from the detection area. However, the sensor is affected by occlusions from trees, wires and utility poles. Occlusion can often be prevented by placing the sensor on the backside and end of the opposing traffic's main arm, or consider a separate pole located no greater than 100 feet upstream of the intersection. See Figure 6.2.4 for typical RADAR Dilemma placement options.



- 1 **On a vertical pole** – This mounting location is often a vertical pole near the stop bar. These poles often extend as high as 30 feet or more, allowing the sensor to be mounted high enough to reduce occlusion.
- 2 **On a luminaire** – This mounting location will often reduce the offset and increase the mounting height (a maximum of 40 feet is recommended). This location is not recommended due to bucket truck height limitations.
- 3 **The backside of the opposing mast arm** – By mounting at this location, opposite the signal heads for the opposing direction of travel, the sensor can be placed near the lanes of interest. The minimum mounting height is 17 feet, but higher mounting is recommended to minimize occlusion. A vertical extension can be used; the extension should have the ability to freely rotate the sensor for alignment. The sensor should be mounted as far out on the mast arm as possible to avoid potential occlusion.

Source: "SmartSensor Advance User Guide." www.wavetronix.com, 2011. Web. 26 Mar. 2015.

FIGURE 6.2.4 – RADAR DILEMMA PLACEMENT OPTIONS

6.3 INDUCTION LOOPS & WIRELESS SENSORS

Pre-manufactured induction loops are the most accurate and reliable among detection technologies, and therefore remain often specified. However, induction loops require

extensive underground wiring and therefore are the most damaging when installed in existing roadway surfaces. Due to potential surface damage from saw-cuts and trenching, the Department only allows installation of loops under new roadways where loops and lead-ins can be placed in the base course before paving, or where loops can be saw-cut or trenched into place during at least a 3-inch deep rotomill and overlay.

Induction Loop Basics

A **pre-manufactured loop** is either a 6-ft x 6-ft square or 6-foot diameter circle with four No. 14 AWG wires (IMSA Spec 51-3) protected by high pressure/temperature conduit that is injected with water-blocking material. The wire is untwisted around the loop which creates the electro-magnetic field by which vehicles are detected.

The **lead-in** is the continuous wiring between the loop in the street and the junction box. This wire is splice-free from start to finish and is the same single conductor No. 14 wire that makes up the loop, extended to the edge of the road for connection. However, the lead-in will have at least 3 twists per foot from the loop to the junction box.

The **home run** is that portion of the detection system that connects the detector loop lead-in from the junction box to the signal cabinet. Home runs consist of twisted pair, two-conductor No. 14 shielded wire (Spec. IMSA 50-2). Each detector group will have a separate homerun cable and amplifier channel in the signal cabinet. The junction box lead-in-to-home-run connections are the only traffic signal field wire splices allowed.

A **detector group** consists of a maximum 4 loops. If a detection zone requires more than 4 loops, divide the groupings so that both loops in a single lane go to the same home run.

NOTE: Saw-cutting loops into new or existing pavement surfaces is **not allowed**. Induction loops must only be specified when placing a new pavement section or in rotomill and overlay application. The loops may be saw-cut into a milled surface and prior to placement of the asphalt overlay.

Wireless Sensors

Wireless sensors are no longer recommended by UDOT for new construction, but are often encountered in older traffic signal systems. Wherever possible, wireless sensors should be replaced with RADAR detection. Specify wireless sensor detection only under the approval of the Region Signal Engineer and Central Traffic & Safety Design Engineer.

The wireless sensor, also known as a “magnetometer” and commonly referred to as a “puck,” is a magnetic sensor that uses low-power radio technology to create a wireless vehicle detection system. This system uses in-pavement-mounted magnetic sensors to detect the presence and movement of vehicles. Each sensor has roughly the same

detection characteristics as a 6-ft x 6-ft induction loop.

This technology has the advantage that each sensor requires only a 4-inch core hole in the center of the lane and is thereby less damaging to the road surface as traditional saw-cut loops. The sensors can be installed in a fraction of the time required for saw-cut loops, thus requiring less traffic control and shorter duration of lane closures. Additionally, individual sensors can be added to the system for queues or other detection as required.

In addition to the sensors, the system requires a signal-pole- or mast-arm-mounted access point that must be within 150 feet and be in line-of-sight with the sensors. This device is wired to the signal cabinet and therefore is typically mounted on the nearest mast arm or luminaire extension to the cabinet. Sensors beyond distance or sight limitations will require a mast-arm- or luminaire-extension-mounted repeater nearby that is in line of sight with the access point. Repeaters, like the sensors, are powered by long-life batteries and therefore require no wiring or junction boxes, and may be placed up to 1000 feet from the access point.

Loop Locations

An induction loop location is measured from the stop bar edge closest to the loop to the loop's leading edge. See Figure 6.4.1: NEMA Phase Detail & Typical Loop Placement for illustration. General loop placement for detection zone as measured from the stop bar is as follows:

- **Stop Bar Detection** -- Place one loop at 3 feet and a second loop at 15 feet.
- **Queue Detection** -- Place one loop at 50 feet and a second loop at 60 feet.

Placement Considerations

- Pay special attention to intersections with non-standard geometry such that loops may operate in the "non-lock" mode.
- Apply good engineering judgment for additional loops where vehicles may be prone to stop ahead of the stop bar.
- If a detector loop location is in conflict with a manhole, water valve, etc., adjust the loop placement forward or backward in the shortest direction from the optimum position.

Additional Induction Loop Design Criteria

- As mentioned previously in "Induction Loop Basics," saw-cut loops in new or existing pavement surfaces are not allowed. Consider specifying trenched in loops prior to milling and paving, or saw-cutting loops into the rotomilled surface.
- Specify queue-loops when the 5-year traffic projection indicates left-turn phasing will be warranted. Left turn signal heads will only be installed when

warrants are met.

- Induction loops for a single intersection leg will only require one type I junction box. Locate the junction box between the front and back loop locations so that lead-in lengths are minimized.

Relating Detector Loops to Signal Phasing

UDOT has adopted the National Electrical Manufacturers Association (NEMA) traffic signal phase conventions. The standard NEMA detector loop numbering associates each detector to its signal phase. Figure 6.31 illustrates the NEMA assignment and UDOT conventions to be used.

When the **major street runs north and south**, **phase 2** is assigned to the northbound thru traffic and the associated detector loops.

When **east/west is the arterial**, **phase 2** is assigned to the westbound thru traffic (all phases are rotated counter-clockwise 90 Degrees).

When **both roads are major highways**, phase 2 is assigned to the northbound traffic.

- Through phases are numbered clockwise with even numbers.
- Left-turn phases are numbered clockwise with odd numbers, starting with the movement that is opposite phase two.

When dedicated left-turn phases are used, the NEMA phase preceding each thru movement is used for the left turn (leading left-turns). For example, phase 1 will be assigned to the left-turn movement opposing phase 2.

Detector Loop Numbering

Syntax to be used: **(P)(U)-(n)(z)**.

P = NEMA phase number

U = loop use (alphabetic)

Loop use (U) options:

T = Thru or Right movement

L = Left movement

Q = Queue zone

n = number for the loop in that grouping

z = home run group alphabetical identification

Start the numbering at the stop bar, nearest the centerline, ascending toward the curb and increasing in value away from the intersection for each phase of the leg. The first loop of a group takes number 1 (one) and the Home Run Alpha Designation (a,b,c,...) for the group it is in. The left-turn and through movements for each leg will have an "a" home run. Refer to Figure 6.3.1 for a sample NEMA diagram.

Example: Single intersection leg, one left-turn lane with queue detection and 2 thru lanes with all loops in same grouping, phases 1 & 6:

Phase 1, front stop bar loop = 1L-1a
 Phase 1, second stop bar loop = 1L-2a
 Phase 1, front queue loop = 1Q-1b
 Phase 1, second queue loop = 1Q-2b
 Phase 6, lane 1 front stop bar loop = 6T-1a
 Phase 6, lane 2 front stop bar loop = 6T-1b
 Phase 6, lane 1 second stop bar loop = 6T-2a
 Phase 6, lane 2 second stop bar loop = 6T-2b

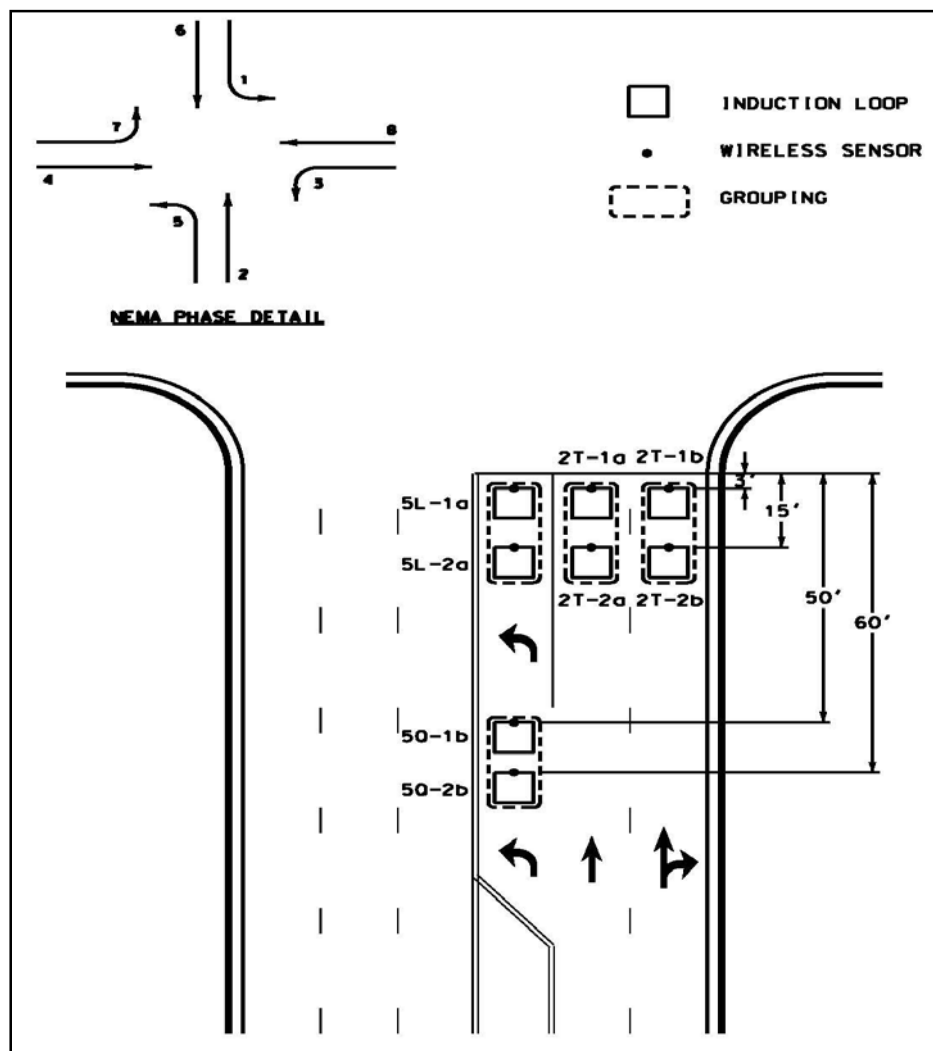


FIGURE 6.3.1 – NEMA PHASE DETAIL & TYPICAL LOOP/WIRELESS SENSOR PLACEMENT

6.4 VIDEO DETECTION

Video detection is no longer a standard vehicle detection option for State-owned signals due to accuracy and maintenance issues. However, in some specific cases, video detection can be used as a temporary or permanent replacement for induction loops. Video still offers the advantage of flexibility because, like RADAR, detection areas can be added or adjusted by simple commands on a computer screen. Unfortunately, video detection continues to have significant disadvantages because it can be affected by adverse weather conditions, sun glare, shadows, and snow or grime on the lens, which results in diminished detection accuracy. Specify video detection only under the approval of the Region Signal Engineer and Central Traffic & Safety Design Engineer.

Camera Placement

Check for anything that might block the field of view or impact vehicle tracking such as trees, overhead wires, and commercial light sources. Locate the camera on the mast arm so that it is centered at the dividing line between opposing left and thru lanes. This will ensure that the camera does not pick up thru traffic as a left turn call and vice versa.

Video Detection Zones

Video detection should not be used to monitor vehicle presence at distances greater than 250 feet. The general rule is that you can reliably detect 10 feet for every 1 foot above the pavement surface the camera is placed, to a maximum distance of around 250 feet. For detection distances greater than 250 feet from the video camera, or for dilemma zone detection, use RADAR detection.

Detection zones do not need to be shown on the detector circuit sheet because Region Signal Maintenance personnel will set zones during the signal's initial activation.

NOTE: An intersection with five or more lanes generally will require two cameras for proper detection. Place the second camera two to three lanes away from the first camera.

Detection Zone Lighting

Ensure adequate lighting is available to allow the video detection to function properly.

6.5 PEDESTRIAN DETECTION

Pedestrians are detected by push button. UDOT's standard push button assembly can be found in the standard drawings. Audible pedestrian button assemblies are also an option. Pedestrian demographics dictate the use of audible buttons. The drawback to audible signals is that they could be an annoyance to nearby homes and businesses. Coordinate with the Region Traffic Operations Engineer to determine if

audible push buttons should be used. Audible pedestrian push buttons are obtained through state furnished materials.

A few factors must be considered when placing a pedestrian detection button because they will affect pole location, number of poles, and/or pedestrian access ramp design.

Standard requirements for ped buttons:

- Height: 42 ± 2 inches above the pedestrian ramp landing ($\leq 2\%$ grade in all directions)
- Maximum horizontal reach from landing: 10 inches
- Maximum horizontal distance to front-center roadside edge of ramp: 10 feet (measured from the center of the curb cut)

Pole Location & Number of Poles

Typically, the pedestrian frame, which holds the directional crossing sign and ped button will be mounted on the mast-arm signal pole. The horizontal distance from the frame mounting point to the front-center roadside edge of the ramp is 10 feet or less. If not, consider locating a 5.5-foot ped pole for mounting the ped button at a closer distance, but still adjacent to the landing/turning space. This pole will be labeled on the design sheets with a "P" number just like the other poles.

6.6 PEDESTRIAN ACCESS

Refer to the signal warrant memo for pedestrian patterns and volumes. Should pedestrian access be required for the project, design facilities in accordance with Standard Specification 02771 and Standard Drawings GW 5A through D, SL 7, and SL 17 A through E. If existing pedestrian access ramps are proposed to remain in place, perform an evaluation to assure each one conforms to ADAAG requirements as outline in the GW 5 series Standard Drawings.

Pedestrian Ramp Design Factors

Due to factors such as slopes or limited space, a ped ramp may require an unusual design to best meet ADA specifications. As a result, the location of the ped button will need to correspond to the location of the pedestrian access ramp

Examples of what to account for in pedestrian detection location:

- Use of curb walls to create the necessary 4-ft x 4-ft turning space can result in excessive reach to signal-pole-mounted buttons. This can be resolved by having the curb wall either interface the center of pole foundation, or go around the back of the foundation. This requirement should be called out on both the RD and SG sheets.

- Ped access ramps that need slope transitions in order to achieve the necessary turning space, but the transitions end up where the signal pole is located or where a ped pole was planned. During the initial site visit, consider the potential obstacles that may affect ped ramp design. Consider creating a detail sheet for a custom ped ramp design including ped pole location if a standard ped ramp design is not adequate. This can be due to constricted right-of-way or existing slope restrictions. Refer to this DT sheet on both RD and SG sheets. **Even with unusual pedestrian access ramp designs, it is often not necessary to create ped ramp details for signal procurement contracts.** In these situations it is often sufficient to ensure the feasibility of a ped ramp and its location and the procurement contractor will construct it to meet requirements in the field.

6.7 BICYCLE DETECTION

Bicycle detection can be achieved by specialized loops, video, radar detection or even cyclist push buttons. Project special provisions may be necessary to implement bicycle detection. Provide necessary pavement markings to inform cyclists of detection locations. The type of bicycle detection will be specified by the Region Traffic Engineer.

6.8 EMERGENCY PREEMPTION

Emergency preemption is a type of infrared or GPS detection that allows local emergency services to override the signal time to give themselves a green phase. The preemption detection device is typically mounted on top of the mast arm. Coordinate with local officials and with the Region Traffic Operations Engineer to determine if and where preemption is needed. If it is determined that the City wants it they need to furnish all equipment and UDOT personnel will install it.

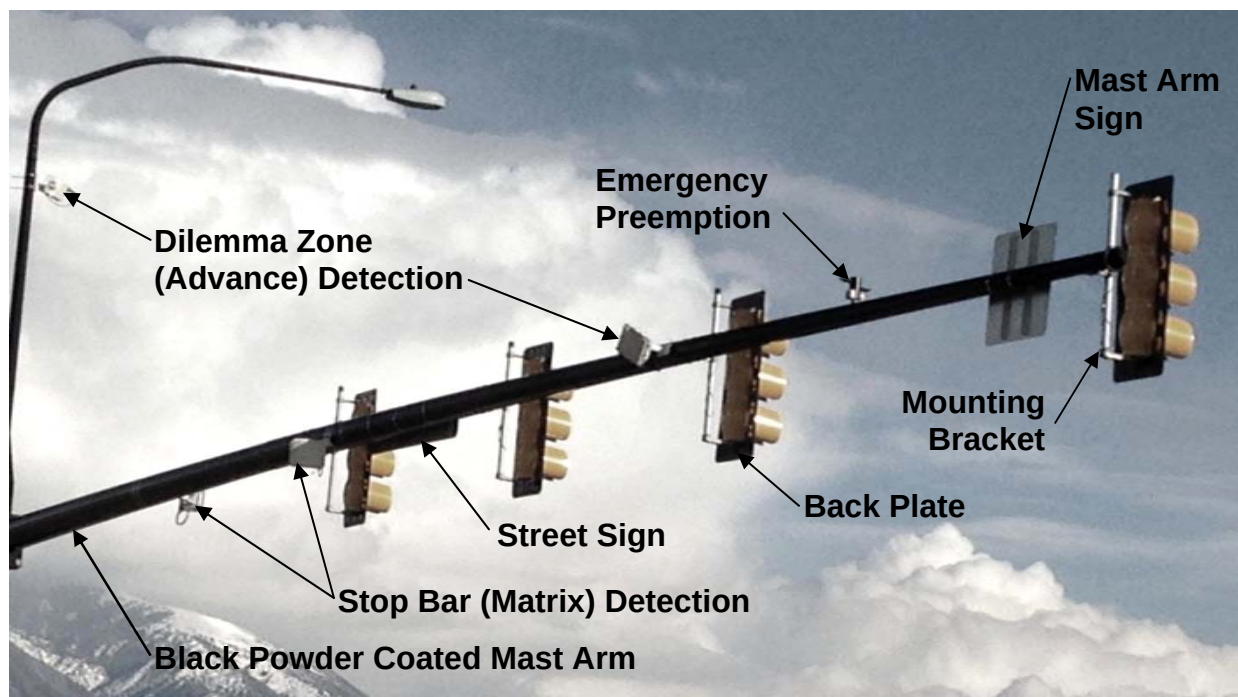


FIGURE 6.8.1 – TYPICAL MAST ARM COMPONENTS

7.0 ADVANCED WARNING SIGNAL SYSTEMS

An advance warning signal (AWS) may be warranted in association with high-speed signalized intersections to warn drivers in advance of the end-of-green phase approaching the signalized intersection. The warranting process for an AWS is found in the AWS Guidelines in the appendix. AWS systems are not necessary or appropriate at all signalized intersections as they may contribute to over-signing and will lose their effectiveness if they are overused.

Warranting for AWS systems is done through Central Traffic & Safety's standard warranting process and follows the AWS Guidelines flow chart. This chart takes into consideration the following warranting criteria: limited sight distance, posted speed limit, history of severe crashes, whether the intersection is isolated from other intersections, heavy vehicle traffic, and approach grade.

7.1 AWS DESIGN

Options

UDOT allows three different AWS system options:

- (A) Side Mounted
- (B) Overhead Static Sign
- (C) Overhead Blank-out sign

Examples of these options are shown in Figures 7.1.1, 7.1.2, and 7.1.3, respectively. The Region Traffic Operations Engineer will determine which option to employ.

The side mounted option is primarily used on single lane approaches. This option requires the use of highway luminaire pole in order to place the advance detection device at the required height.



FIGURE 7.1.1 – SIDE MOUNTED ADVANCED WARNING SIGNAL

The overhead static sign is the preferred option because it offers high visibility and relatively low maintenance. It can be employed on single- and multi-lane roadways. The static sign with flashers is placed on a traffic signal pole with appropriately sized mast arm.

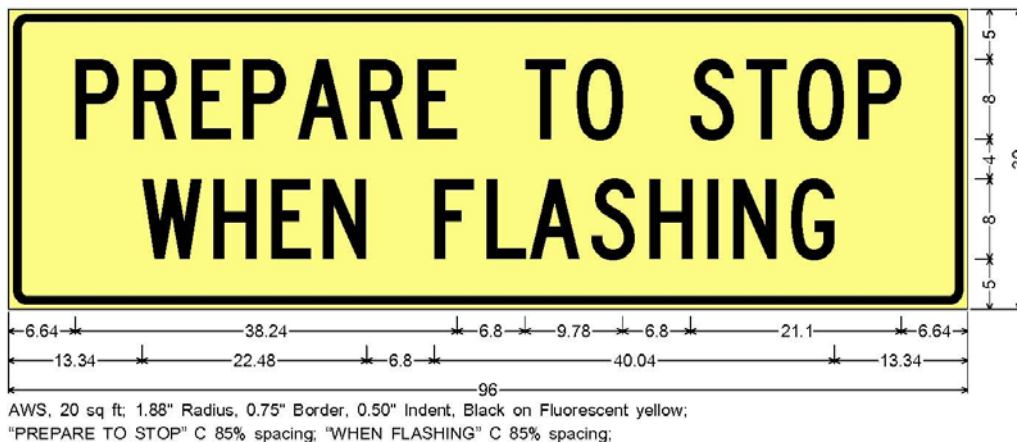


FIGURE 7.1.2 – OVERHEAD STATIC ADVANCED WARNING SIGNAL SIGN

The overhead blank-out sign option is the most expensive and most difficult to maintain option. It, also, can be used on single- and multilane roadways. The weight of the blank-out sign requires it to be placed on a type C signal pole with a 4-ft x 14-ft foundation (See figure 3.1.1). It will require a mast arm that will fit on a type C pole and cut to the needed size.



FIGURE 7.1.3 – OVERHEAD BLANK-OUT ADVANCED WARNING SIGNAL SIGN

Location

Refer to the Advance Warning Signal System Standard drawing for information on how to place an AWS system. Studies have been conducted to determine how far upstream an AWS should be located. The AWS standard drawing provides the equations necessary to determine the distance from the intersection to the AWS. The location will need to be increased for downhill approaches. Obtain approval for the location of all AWS systems from the UDOT Traffic Operation Center and the Region Traffic Engineer.

Verify placement to provide at least two seconds of sight distance on approach and adjust if needed. The overhead AWS assembly may need to be oriented with a skew to the roadway in order to provide optimal visibility. Typically, the AWS assembly is located over the travel lanes so that the outermost yellow flashing beacon is centered over the edge of the outside through lane. This location can be adjusted to provide optimal visibility and budgetary constraints. Be mindful of the roadside clear zone when locating the AWS pole. It will need to be located outside the clear zone or protected by a crash-worthy barrier system. Also ensure lateral offset requirements are met in urban settings.

Detection & Connection

Advance detection is required for an AWS to detect vehicles traveling towards the intersection and prior to the AWS. Therefore, a radar unit should be mounted on the mast arm or signal pole where the AWS sign is mounted. The radar unit will detect vehicles on approach to the signal and provide necessary feedback back to the traffic signal. In order for the overall signal system to function properly, advance detection is required the same distance from the intersection in the both directions. For this reason, it is often advisable to place AWS in both directions.

The advance detection at the AWS acts as the dilemma zone detection for the

signalized intersection. It is not necessary to have dilemma detection at the intersection's signal and the AWS. Therefore, only stop bar detection will be required at the intersection, where an AWS is present.

At a minimum, provide two 2-inch conduits from the intersection signal cabinet, one for the signal wire and the other for the advanced detection cable. Provide a type II junction box near the AWS foundation unless directed otherwise by the Region Signal Engineer. Coordinate other cable and conduit needs such as lighting, ATMS, and future use.

8.0 POWER SERVICE CONNECTION

Contact the Region Utility Coordinator/Engineer to request a work order from the local serving power company and arrange a site meeting to verify the power source type and location. On the signal plans, list the work order number (if applicable) and name and phone number of the individual with whom the connection will be arranged. Also, identify the location of the power source graphically on the plans and indicate whether it is a pole or ground-mounted transformer. The service power source can be from an underground sleeve, a pole mounted transformer, or a ground-mounted transformer. Refer to Standard Drawings SL 3 for details.

Coordinate with the region regarding lighting agreement requirements with the local municipality. The local municipality will be responsible for utility bills related to intersection street lighting power and maintenance. List the contact person's name and phone number on the plans.

Remember to contact the Region Utility Coordinator/Engineer periodically during the design phase to coordinate the project service needs, and to assure work estimates have been approved.

8.1 UNDERGROUND SERVICE PEDESTAL

The underground service pedestal should be located on either side of the controller cabinet, preferably on the same corner where the power source is located. Refer to Standard Drawings SL 3 for pedestal details and to Standard Specification 02892 for Power Source specifications.

8.2 UNINTERRUPTIBLE POWER SUPPLY/BACKUP SYSTEM (UPS)

For critical or special operation intersections, an underground service pedestal with battery backup may be employed. This type of pedestal is commonly referred to as an underground service pedestal with Uninterruptible Power Source or just simply a "UPS" pedestal. UPS systems will be installed at the discretion of the Region Signal Engineer and the Region Traffic Operations Engineer. The region should coordinate with the Traffic Operations Center to determine if UPS systems should be employed on a particular signal. The Traffic Operations Center has developed an Emergency Response Plan that may be used as a guideline for the use of UPS systems.

9.0 SIGNAL CIRCUIT DESIGN

Circuit conduits should extend across two different legs from the type III junction box near the signal cabinet. Cross the major street on one leg and the minor street on two.

The figures in this section are for instructional purposes only and are not meant to be included in plan sets. Cables rather than conduits are shown.

9.1 POWER SOURCE

Provide 120/240 Volt single phase power to the underground service pedestal. Contact the local serving power company for wire and conduit requirements from the power source to the underground service pedestal. Make note of these requirements on signal sheets where appropriate. If the power company provides a work order number provide it on the signal plan sheet.

Controller Cabinet Power

Specify 2 single-conductor copper cable type RHH-USE2-RHW2 wires and bare copper ground wire, No. 6 AWG minimum. Cabinet 120 Volt power is supplied directly from the service pedestal via the signal Type III junction box.

9.2 SIGNAL HEADS

Signal Circuits

Specify 7-conductor No. 14 AWG, Stranded Cable, IMSA 20-1 (120 Volts). Provide a separate 7-conductor for protected left phase/flashing yellow signal heads and for nearside heads.

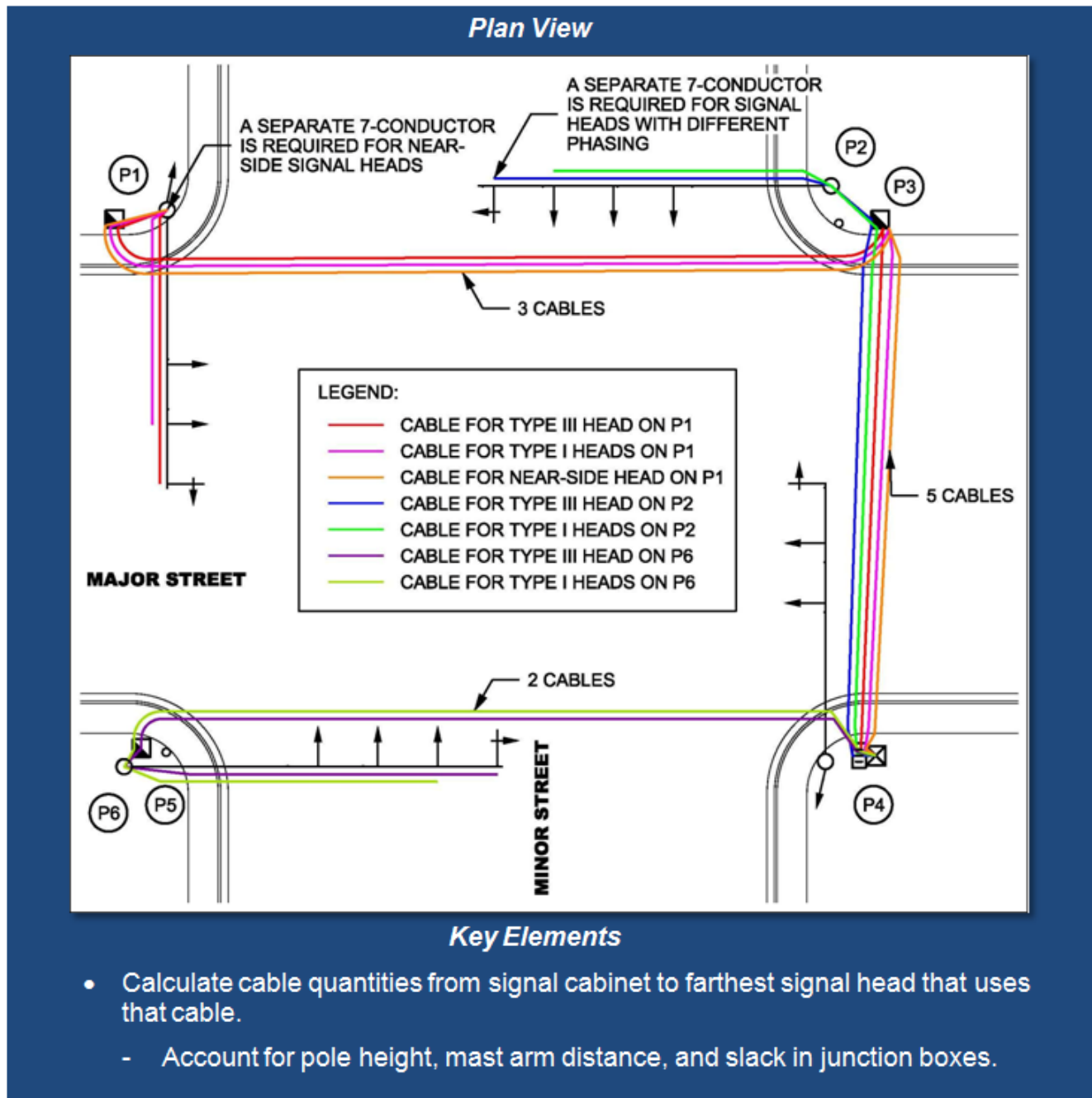


FIGURE 9.2.1 – SIGNAL CIRCUIT CABLE EXAMPLE

Pedestrian Circuits

Specify 7-conductor No. 14 AWG, stranded cable, IMSA 20-1 (120 Volts).

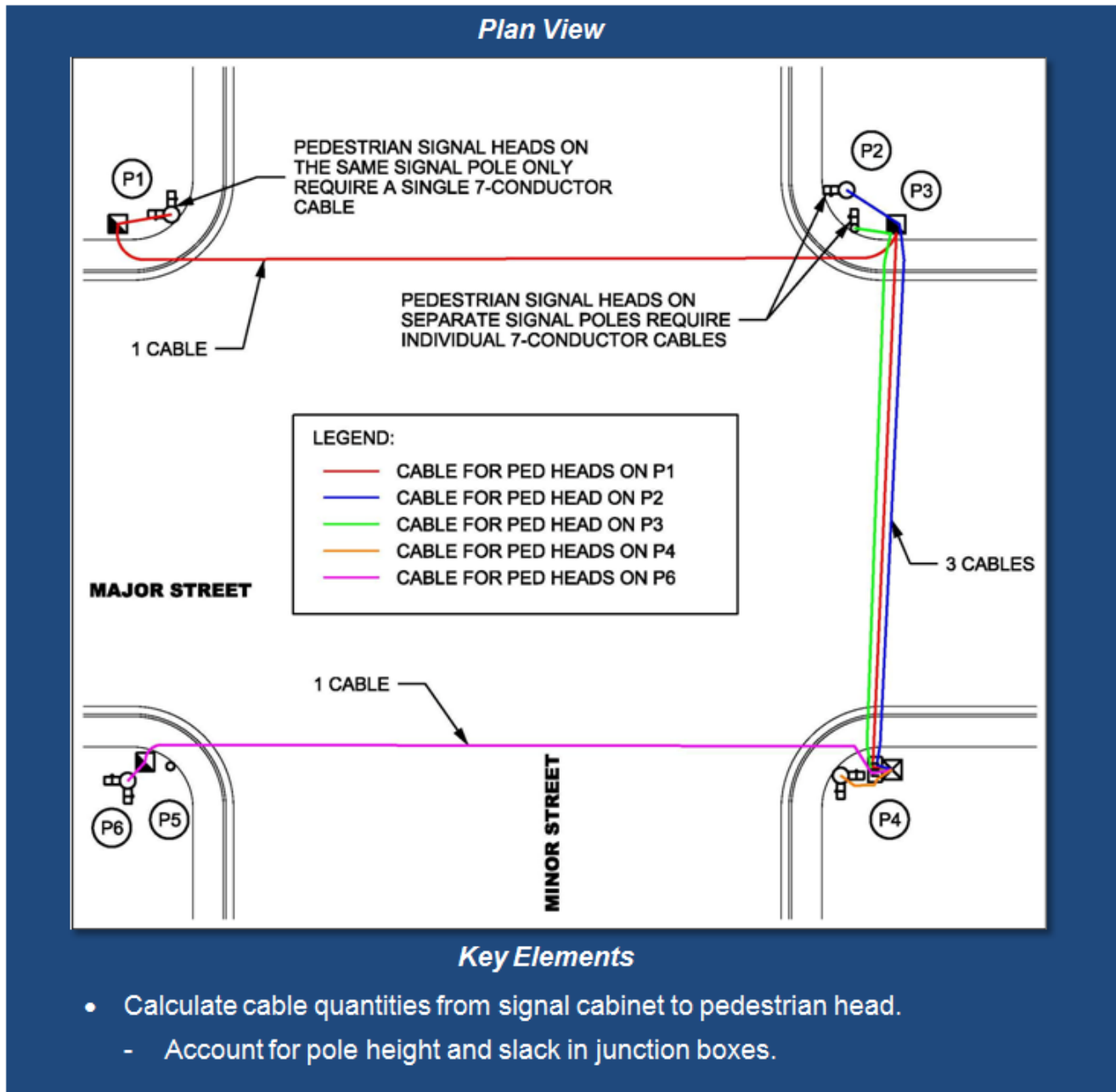


FIGURE 9.2.2 – PEDESTRIAN CIRCUIT CABLE EXAMPLE

9.3 LIGHTING

Specify 2 –single-conductor copper cable type RHH-USE2-RHW2 wires and bare copper ground wire, No. 6 AWG minimum, IMSA 51-1. Larger wire must be used when voltage drop calculations show drops greater than 5% of supply line voltage.

Street lighting 240 Volt power is supplied directly from the service pedestal to the nearest street lighting junction box.

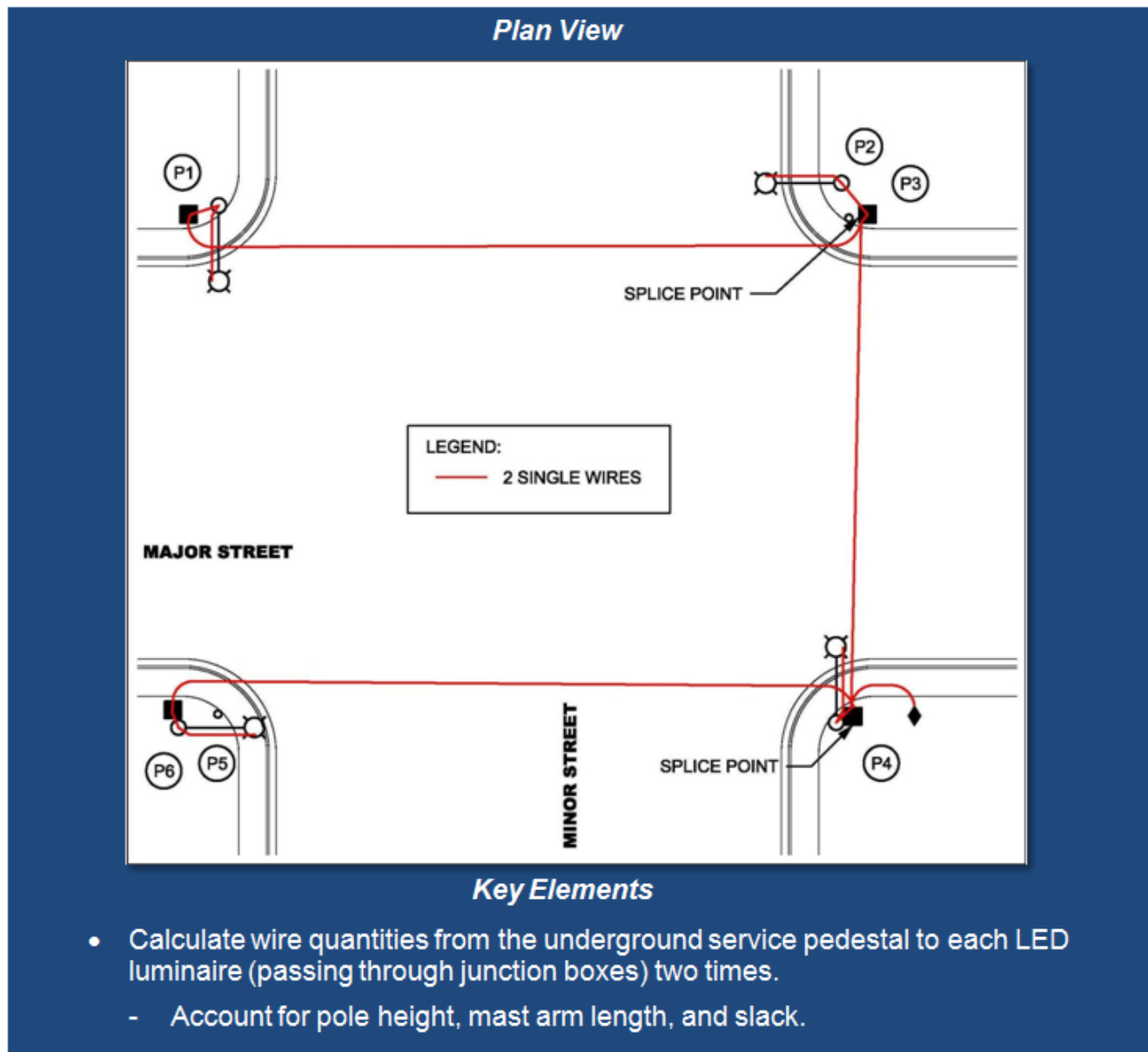


FIGURE 9.3.1 – LIGHTING CIRCUIT CABLE EXAMPLE

9.4 DETECTION

Pedestrian Push Button

Specify 4-conductor No. 14 AWG, stranded cable, IMSA 20-1 (low voltage).

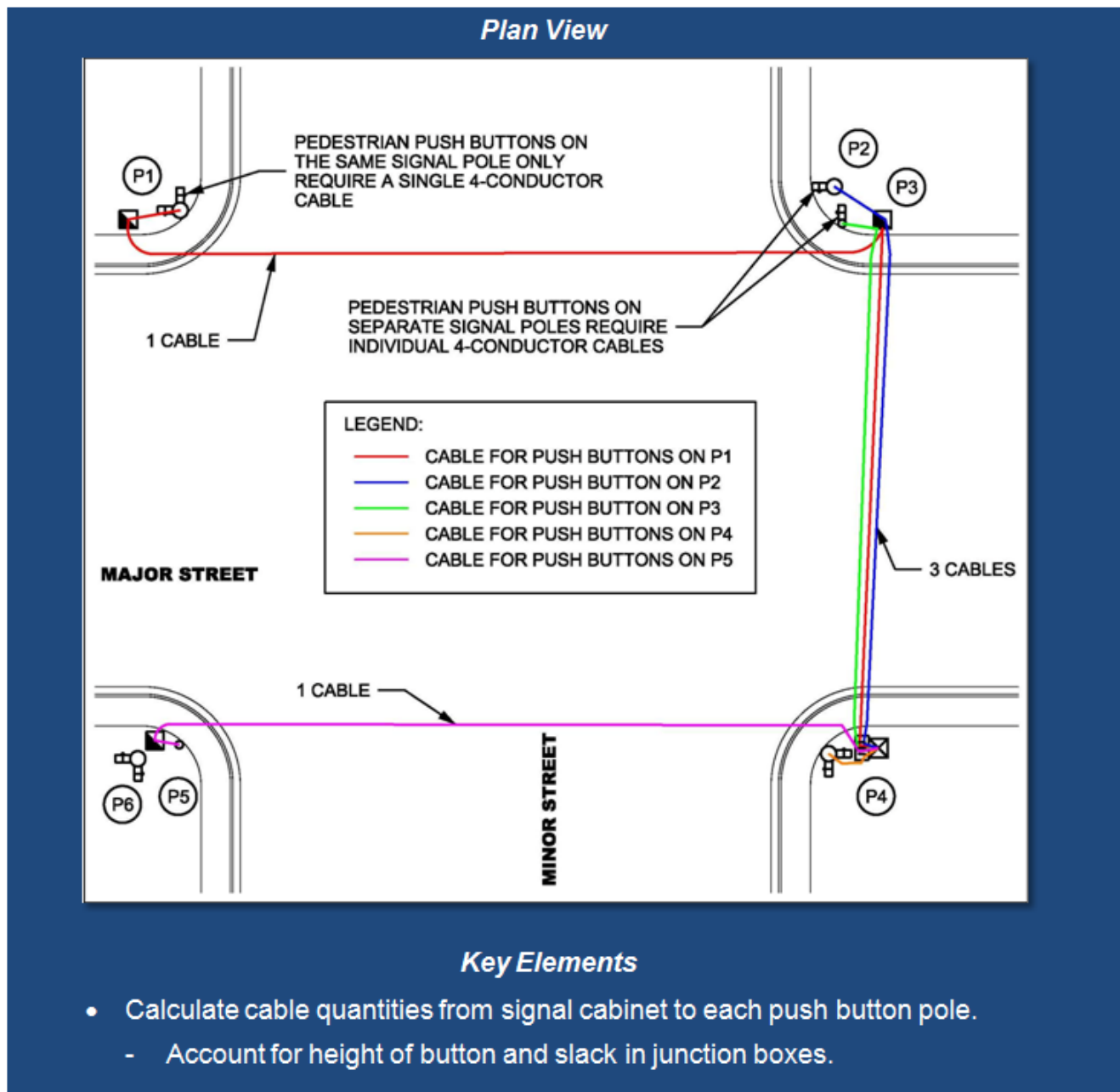


FIGURE 9.4.1 – PUSH BUTTON CIRCUIT CABLE EXAMPLE

Induction Loop Home-Run

Specify 2-conductor No. 14 AWG, shielded and stranded twisted pair, IMSA 50-2 (low voltage). Label each end of home run.

Pre-manufactured Induction Loop Wire

Specify IMSA 51-7 (low voltage).

Wireless Sensors

Specify IEEE 568B cable with RJ45 connectors for connection of the Access Point to the cabinet.

RADAR Detection – Stop Bar or Dilemma Zone

Specify contractor-furnished, manufacturer-approved, color-coded 6-conductor cable from splice box to signal cabinet. RADAR detection cable has 2 twisted pair RS-485, 22 AWG wire for communication, and one twisted pair 20 AWG wire for power. Wavetronix part number WX-SS-705 or approved equivalent (low voltage).

Video Cable Requirements for Peek and Iteris Hardware

Belden 8281 or equivalent coaxial cable (video), Spec. RG-59. Use for field run less than 1000 feet from pigtail connection at base of signal pole to controller cabinet.

Video Cable Requirements for Traficon Hardware

Combined video coaxial/power cable provides splice free connection from camera to controller. State Furnished cable comes in 250-foot, 500-foot, and 1000-foot spools. Specify the required length when placing State Furnished Material Requisition.

Video Cable Requirements for Econolite Hardware

6-pair twisted No. 18 AWG, shielded cable Spec. IMSA 60-6 for video signal (low voltage).

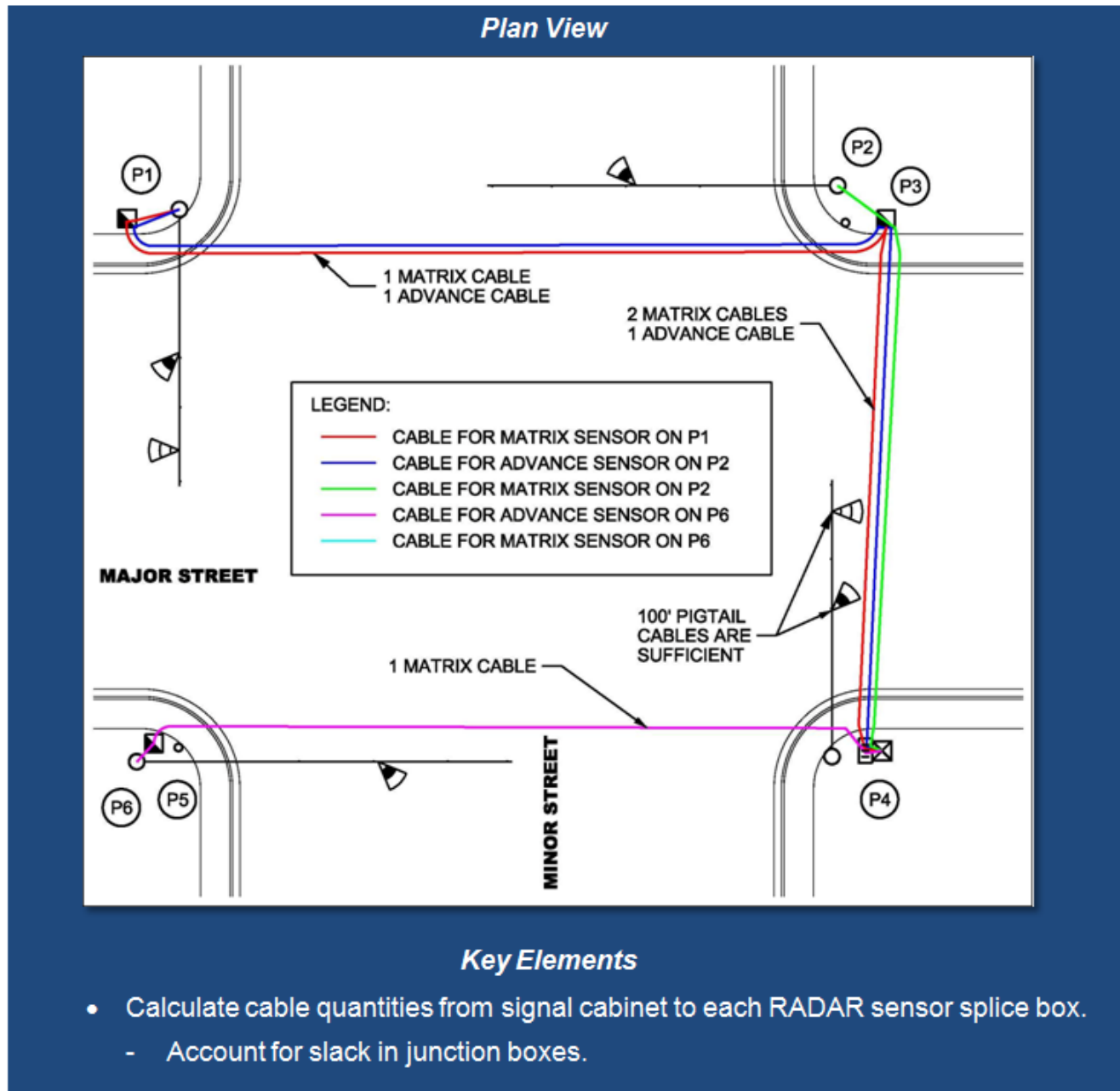


FIGURE 9.4.2 – RADAR DETECTION CIRCUIT CABLE EXAMPLE

9.5 CONDUIT

Use schedule 40 PVC or SDR-11 HDPE conduit UL Listed electrical conduit for underground signal installation. PVC is commonly used in trenching and HDPE in boring applications. Use galvanized rigid steel (GRS) UL Listed electrical conduit for above ground applications. Special considerations for fiber-optic cable installation are needed (see Part 9.9 below, or refer to the contact list for further details). Never specify conduit diameter size less than 2 inches for signal and lighting cables.

Choosing the Right Conduit

The National Electric Code (NEC) requires no more than 40% of a conduit be filled with wire and cable. The cross-section of the wire (single conductor) or cable (multi conductor) varies depending on the type of insulation specified. Listed below are cross-sectional areas for the typical cables used, and the allowable area at 40% capacity for various conduit sizes.

Example: Choose the conduit size required to accommodate 12 detector loop home runs. The area of a 2-conductor No. 14 cable is selected and multiplied by 12 to obtain a total cable area of 1.08 sq. inches. Therefore the 2-inch PVC conduit is selected as the appropriate size.

TABLE 9.5.1 – CABLE CROSS-SECTIONAL AREA

Wire Spec.	Cable Size	Cross-Sectional Area (sq. in.)
RHH-USE2-RHW2	No. 2	0.19
RHH-USE2-RHW2	No. 4	0.14
RHH-USE2-RHW2	No. 6	0.11
IMSA 50-2	2-Cond. No. 14 Twisted Pair	0.09
IMSA 20-1	3-Cond. No. 14 Stranded	0.11
IMSA 20-1	4-Cond. No. 14 Stranded	0.13
IMSA 20-1	7-Cond. No. 14 Stranded	0.17

TABLE 9.5.2 – CONDUIT CAPACITY

Conduit Size (in.)	40% of Sched. 40 Rigid PVC & HDPE Capacity (sq. in.)
2	1.3
2 ½	1.8
3	2.9
3 ½	3.8
4	5.0

Choosing the Number of Conduits

A standard intersection will require a minimum six 2-inch conduits per roadway crossing. The circuits within the conduits are arranged as follows:

Conduit 1:	Signal head, ped head circuits
Conduit 2:	Lighting circuit
Conduit 3:	Push button circuit
Conduit 4:	Detection circuit
Conduit 5:	Future use
Conduit 6:	Future use

In some cases, an intersection will have extra items such as nearside signal heads or supplementary vehicle detection. Be sure to compare wire and cable sizes and quantities versus conduit area. Some crossings may need additional or larger conduit to handle the amount of wire and/or cable. In other cases, an intersection will not have all of the first four circuits on each roadway crossing. When this occurs, assign more conduits as future use to maintain six conduits per roadway crossing.

Shared Usage

- Traffic signal heads, pedestrian signal heads, and video detection operate at 120 Volts and may share conduit.
- Detection and pedestrian push button are low voltage circuits and may share the same conduit.
- The local municipality will own the lighting circuit, therefore lighting conduit or junction boxes cannot be shared with any other circuit.

Future Use

Specify two future-use conduits, 2 inches in diameter, placed between all pole junction boxes and the controller cabinet. Place the future-use conduits on top of the other conduits in the trench. Include one continuous No. 14 AWG copper THHN pull wire in each future-use conduit. This wire is used to pull future wire and can also be used to locate the underground conduit run.

9.6 JUNCTION BOXES

Specify only heavy-duty polymer concrete (PC) junction boxes for signal and lighting installations. Place an individual Type II-PC junction box at the base of each signal pole and a Type III-PC junction box at the controller cabinet. The signal pole junction box may be eliminated when the controller cabinet junction Box is near the pole location. Specify a Type I-PC junction box for each luminaire pole or extension.

The signal circuit type II-PC junction box is shared with signal, pedestrian, and detection circuits however the conduits are not shared. These separate circuits are identified on the plans with the appropriate legend. The lighting circuit will always have its own conduit and junction boxes.

9.7 GROUND RODS & WIRES

Ground rods will be a 10-ft x 3/4-inch copper-coated steel UL Listed and installed at each junction box and underground service pedestal that contains cables with 120-Volt circuits or greater.

UDOT requires a single AWG No. 6 bare copper ground wire in ANY conduit containing a 120-Volt or higher circuit, and for each signal and lighting pole. This wire is grounded at each junction box along the associated circuit (lighting, signal, and power circuits). Refer to UDOT Standard Drawings SL series for details.

9.8 CONTROLLER & CABINET

Controllers are "TS2 Type 1" and cabinets "TS2 Size 6."

9.9 INTERCONNECT (ATMS)

All traffic signals should be connected to UDOT's ATMS fiber optic network. Coordinate with the ATMS Project Manager early in the project to determine project specific interconnect features. If fiber optic infrastructure is not available radio interconnect should be examined.

In general, use 1-D MD-7 conduit to accommodate fiber optics with Type II-PC junction boxes with 35 feet of slack at pull locations. Splice locations require Type III-PC junction boxes with 100 feet of cable slack. Specify the correct number of fusion splices and the appropriate type of splice enclosures. Space junction boxes at 300 feet +/- intervals. Use large radius sweep bends (3 feet minimum) for fiber optic cable. Install a locator wire placed in a 1-inch PVC conduit. Refer to Standard Drawing AT 6 and AT 7A.

The interconnect from the ATMS fiber splice junction box to the controller cabinet is commonly referred to as a "fiber drop." Provide a single 3-inch conduit from the splice junction box to the signal cabinet. Orient the direction of the 3-inch conduit stub in the cabinet foundation to accommodate fiber-optic installation. Refer to Standard Drawing SL 8.

Interconnect Cable

No. 19 AWG, 6 pair, Spec. IMSA 60-6 (low voltage).

Pre-terminated fiber optic cable, 6 SMF minimum.

10.0 OTHER CONSIDERATIONS

10.1 ATMS IMPROVEMENTS

It is increasingly common to include ATMS improvements with an upgraded or new signalized intersection. In addition to the signal interconnect described in Part 9.9, ATMS improvements may include CCTV cameras, non-intrusive detectors, variable messages signs, etc. Coordinate ATMS needs with the Region Project Manager and the ATMS Project Manager. ATMS designs are based on the AT-series standard drawings and the Standard and Supplemental Specifications (the ATMS related standard specifications number 13431 through 13595).

10.2 UDOT TRAFFIC SIGNAL TURN-ON CHECKLIST

UDOT has prepared a Traffic Signal Turn-on Checklist that is the contractor's responsibility to complete prior to turn on. The checklist can be obtained online at <http://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:2960>. Place a limitation of operation in the project plan and documents requiring the completion of the checklist. The example procurement plan set has this limitation on the title sheet. For projects with a 00555M special provision, place the limitation there. Language for this requirement can be obtained from Central Traffic & Safety.

10.3 TEMPORARY OPERATION

When modifications are made to an existing signalized intersection, care must be taken to provide for temporary power and signal control as necessary. Phasing of the new construction and demolition of the existing signal conduit and wiring must be given due consideration to insure proper function until it is no longer needed.

When alterations to the existing signal phasing or function or traffic lane assignments are proposed, an approved temporary signal operation/phasing plan is required.

Consider the use of contractor-supplied, temporary, aboveground detectors (video, radar, etc.) for maintenance of traffic during construction.

Changing over from an existing traffic signal to new equipment will require aid of uniformed policemen. Include a note in the signal sheets that the contractor must make all necessary preparations to minimize the signal shut down time. Clearly define the temporary traffic control limitations and assign liquidated damages for non-compliance as appropriate.

10.4 NEW SIGNAL ACTIVATION

When turning on a signal for the first time in a newly signalized intersection, consider the following methods to alert the public of this signal going into operation:

- Use portable Variable Message Signs (VMS) 24 to 48 hours prior to activation, warning of the impending change.
- Notify the local news media, if deemed necessary.
- Utilize local law enforcement to draw attention to the change.

10.5 SINGLE-POINT URBAN INTERCHANGE (SPUI)

Each SPUI has many unique features, which must be examined case by case for an effective signal layout. The following are some general recommendations for under- and over-freeway, single- and dual-lane SPUI configurations:

- Off-Ramp Left Turn Movement – Provide advance signals placed on the right-side island. Place this signal head as far back up the ramp as practical without confusing the right-turning vehicles. Use circular indications in all sections and do not use programmable heads.
- Off-Ramp Left-Turn Signals – Provide red, yellow, and green arrows tilted at 45 degrees up from horizontal.
- Left-Turn Movements onto the Freeway – Use red, yellow, and green arrows tilted up at 45 degrees from horizontal.

Interchange lighting should be placed in the SPUI to ensure the entrances to freeway on-ramps are well lit and visible from the stop bar.

A qualified structural engineer should design the overhead signal bridge structure. Standard tenons are used to mount the signal heads to the signal bridge. Include a detail of the signal bridge and identify the tenon locations to insure proper signal head placement in relation to the traffic lanes. Back plates for the signal heads will be necessary but may be influenced by the size and height of the support structure.

10.6 DIVERGING DIAMOND INTERCHANGE (DDI)

A Diverging Diamond Interchange is a relatively new interchange that is a unique challenge to driver expectation so proper signalization is vital to its safety and functionality. Refer to [UDOT's DDI Guideline](#) for specific design information.

11.0 QUESTIONS?

Please contact the Division of Traffic & Safety if you have any questions regarding this guideline or how it applies to the project that you are working on (refer to Contact List in the appendix). We encourage the designer to contact us early in the design process to discuss standard UDOT intersection design and specific issues regarding your project. Early interaction expedites the design process and helps lead to the successful completion of the project.



APPENDIX

Appendix 1 Standard Signal Equipment A.1-1

Appendix 2 Contact List A.2-1

Appendix 3 Information and Downloads A.3-1

Appendix 4 Left-Turn Phasing at Signalized Intersections A.4-1

Appendix 5 AWS Guidelines A.5-1

Appendix 6 Procurement Sample Signal Plan and Documents A.6-1

APPENDIX 1 STANDARD SIGNAL EQUIPMENT

Signal Pole Options	Mast Arm Options												
	25'	30'	35'	40'	45'	50'	55'	60'	65'	70'	75'	80'	85'
Type A for Curved Mast Arms (15' height, 23" diam, 4-bolt foundation)	X*	X	X	X	X	X	X						
Type B for Straight Mast Arms (20' height, 23" diam, 4-bolt foundation)				X**	X**	X**	X**	X	X	X	X		
Type C** for Straight Mast Arms (20' height, 26" diam, 6-bolt foundation)												X**	X**
Type DC for Dual Curved Mast Arms (15' height, 23" diam, 4-bolt foundation)	X*	X	X	X	X								
Type DS** for Dual Straight Mast Arms (20' height, 23" diam, 4-bolt foundation)				X**	X**	X**	X**						
Foundation (ft x ft)	3x12	3x12	3x12	3x12	3x12	3x12	3x12	3x12	3x12	3x14	3x14	4x14	4x14

* Field Cut ** Special Order

Luminaire Poles and Extensions:

Mounting Height:	25', 30', 35', and 40'
Arm Length:	10' and 15'
180° dual arm:	10' and 15'
Vertical extension for Mongoose luminaire	
Pole cap, if no luminaire extension on signal pole	

Mast Arm Mounted Signs:

R10-12 (Protected/Permissive – Type V)	W x H 24" x 30"
RS10-21ex (Protected/Permissive – Type VI)	30" x 42"
R3-5 (Protected – Type III)	24" x 30"
Street Name Signs	20 ft ² max

Ground Rods:

Junction boxes and USP

10' x 3/4" diameter

Anchor Bolt with Hardware (four required per pole, six required for Type C signal poles)

Signal Poles

2" dia. x 66" bolts

45' CCTV Poles

1.5" dia. x 54" bolts

30' & 40' Luminaire Pole

1" dia. x 36" bolts

Ped Poles

1" dia. x 36" bolts

APPENDIX 2 CONTACT LIST

DIVISION OF TRAFFIC AND SAFETY

Traffic & Safety Engineer	Robert Miles	(801) 965-4273	robertmiles@utah.gov
Traffic & Safety Design Engineer	Jesse Sweeten	(801) 965-4924	jsweeten@utah.gov
Traffic Operations Engineer	John Leonard	(801) 965-4045	jleonard@utah.gov
Safety Engineer	Scott Jones	(801) 965-4285	wsjones@utah.gov
Bicycle and Pedestrian Coordinator	Evelyn Tuddenham	(801) 964-4564	etuddenham@utah.gov

REGION ENGINEERS**Region One**

Traffic Operations Engineer	Darin Frstrup	(801) 620-1607	dfrstrup@utah.gov
Traffic Engineer	Paul Egbert	(801) 620-1622	pegbert@utah.gov
Assistant Traffic Engineer	Todd Finlinson	(801) 620-1619	tfinlinson@utah.gov
Traffic Signal Engineer	Carrie Jacobson	(801) 620-1673	cjacobson@utah.gov
Utility Leader	Tucker Doak	(801) 620-1660	tdoak@utah.gov

Region Two

Traffic Operations Engineer	Patrick Cowley	(801) 975-4827	patrickcowley@utah.gov
Traffic Engineer	Jeff Lewis	(801) 887-3759	jefflewis@utah.gov
Assistant Traffic Engineer	Amber Mortensen	(801) 887-3624	akmortensen@utah.gov
Assistant Traffic Engineer	Brady Hale	(801) 887-3693	bhale@utah.gov
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Traffic Engineer	Griffin Harris	(801) 222-3401	gharris@utah.gov
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Utility Leader	Josh Glazier	(801) 222-3412	joshglazier@utah.gov

Region Four

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Traffic Engineer	Anne Ogden	(435) 893-4715	anneogden@utah.gov
Assistant Traffic Engineer	Nathan Merrill	(435) 691-1757	nmerrill@utah.gov
Traffic Signal Engineer	Adam Lough	(801) 718-4326	alough@utah.gov
Utility Leader	Gernice White	(435) 893-4764	gernice@utah.gov

TRAFFIC SIGNAL SYSTEM INSPECTION/MAINTENANCE SUPERVISION

Region One	Dale Lake	(801) 791-0270	dlake@utah.gov
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Region Two	Shaun Montgomery	(801) 514-9283	smontgomery@utah.gov
Region Three	Grant Jackson	(801) 227-8040	grantjackson@utah.gov
Region Four, Cedar, St. George	Lee Thompson	(435) 590-9976	lthompson@utah.gov
Region Four, Other	Graig Ogden	(435) 201-4465	gogden@utah.gov

STATE FURNISHED MATERIALS

SFM Manager	Phil Pettersson	(801) 419-1462	ppettersson@utah.gov
Warehouse Manager	Greg Palmer	(801) 965-4258	gregpalmer@utah.gov

SIGNAL SYSTEM COORDINATION

Statewide Coordination	Mark Taylor	(801) 887-3714 marktaylor@utah.gov
Statewide Signal Engineer	Matt Luker	(801) 887-3627 mluker@utah.gov

ATMS PROJECT MANAGEMENT

Region One	Matthew Smith	(801) 887-3716 matthewsmith@utah.gov
Region Two	Chris Siavrakas	(801) 718-0019 csiavrakas@utah.gov
Region Three	Brad Cameron	(801) 887-3719 bcameron@utah.gov
Region Four	Matthew Smith	(801) 887-3716 matthewsmith@utah.gov
Fiber Manager	Lynne Yocom	(801) 887-3780 lyocom@utah.gov

APPENDIX 3 INFORMATION AND DOWNLOADS

All standard drawings, specifications, and signal design and material requisition information is available at the UDOT website:

<http://www.udot.utah.gov/main/f?p=100:pg::::1:T,V:302>

UDOT ADA Pedestrian Access Program Pedestrian Access Ramp Manual

<http://www.udot.utah.gov/main/f?p=100:pg:0::1:T,V:584>,

UDOT Quality Control / Quality Assurance Documentation

<http://www.udot.utah.gov/main/f?p=100:pg:0::1:T,V:3187>,

UDOT Project Design Criteria (PDC) Form

<http://www.udot.utah.gov/main/f?p=100:pg:0::1:T,V:1560>,

UDOT Design Exception, Design Waiver, and Deviation from UDOT Standards

<http://www.udot.utah.gov/main/f?p=100:pg::::1:T,V:653>

UDOT CADD Downloads

<http://www.udot.utah.gov/main/f?p=100:pg:0::1:T,V:1519,70827>

includes CADD Standards Manual and Latest Plan Sheet Development Standards.

UDOT Roadway Design Manual of Instruction

<http://www.udot.utah.gov/main/f?p=100:pg:0::1:T,V:1498>,

UDOT State Furnished Materials Forms (Signal and ATMS)

<http://www.udot.utah.gov/main/f?p=100:pg:0::1:T,V:%202962>,

UDOT DDI Guideline

<http://www.udot.utah.gov/main/uconowner.gf?n=14769524027177477>

UDOT Project Delivery Network

<http://www.udot.utah.gov/main/f?p=100:pg:0::1:T,V:3140>

FHWA MUTCD

http://mutcd.fhwa.dot.gov/kno_2009r1r2.htm

UDOT Sign Manual

<http://www.udot.utah.gov/main/uconowner.gf?n=3000306255336296>

UDOT Traffic Signal Turn-on Checklist

<http://www.udot.utah.gov/main/f?p=100:pg:0::1:T,V:2960>

Utah Standard Highway Signs Supplement

<http://www.udot.utah.gov/main/uconowner.gf?n=13202015905895727>

UDOT Policy R930-6. Access Management

<http://www.udot.utah.gov/main/uconowner.gf?n=11066229893635233>

FHWA Subsurface Utility Engineering

<http://www.fhwa.dot.gov/programadmin/sueindex.cfm>

UDOT Policies (Street Name Signs – 06C-03, Highway Lighting – 06C-06, Pedestrian Access Program – 06C-16, Signal Pre-Emption – 06C-18, Traffic Signals – 06C-51)

<http://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:2668>,

Other Reference Materials (latest edition):

[AASHTO A Policy on Geometric Design of Highways and Streets](#)

[AASHTO Structural Supports for Highway Signs, Luminaires & Traffic Signals](#)

[AASHTO Roadside Design Guide](#)

[ITE Manual of Traffic Signal Design](#)

[NFPA National Electric Code](#)

[AASHTO An Informational Guide for Roadway Lighting](#)

[IESNA Roadway Lighting, RP-8-00](#)

APPENDIX 4 LEFT-TURN PHASING AT SIGNALIZED INTERSECTIONS

Left-Turn Phases at Signalized Intersections

UDOT

Updated November 13, 2014

Purpose

To define the process for warranting left-turn phasing at existing signalized intersections.

UDOT Recommended Guidelines

Guidelines for Left-Turn Phasing

The following flow-chart has been established as criteria for recommending left-turn phasing at signalized intersections. A left-turn phase may be installed after less restrictive measures to reduce delay, congestion, and crashes have been considered. The overall signalized corridor/network operations should be considered when evaluating the impacts of left-turn phasing. Even if the criteria in the flowchart are met for left-turn phasing, engineering judgment should be used to determine whether left-turn phasing is implemented.

Before completing the flowchart for left-turn phasing, the intersection should be evaluated by the TOC to determine if signal timing adjustments can mitigate the problem. The intersection should also be evaluated for sight distance and geometric issues that may determine whether a protected-only left-turn phase is required. A field review is recommended for all sites before changes to left-turn phasing are implemented. Criteria for left-turn phasing are found on the attached flowchart.

Guidelines for Dual Left-Turn Lanes

UDOT recommends the following guidelines in helping to make decisions when to install dual left-turn lanes.

- I. A capacity sensitivity analysis should be performed. When performing the capacity sensitivity analysis, the default analysis values in Synchro should be:
 - a. Cycle length: 120 seconds
 - b. Ideal saturation flow rate: 1900 vphpl
 - c. Percent heavy vehicles: 2%
 - d. Lane widths: 12 feet
 - e. Analyze with no parking and non CBD
 - f. Optimize splits

Table 1 below shows the recommended left turn volumes and the opposing through volume to capacity (v/c) ratio to use in assisting to make the decision for dual left-turns. The v/c ratio is calculated using HCM 2010 methodologies.

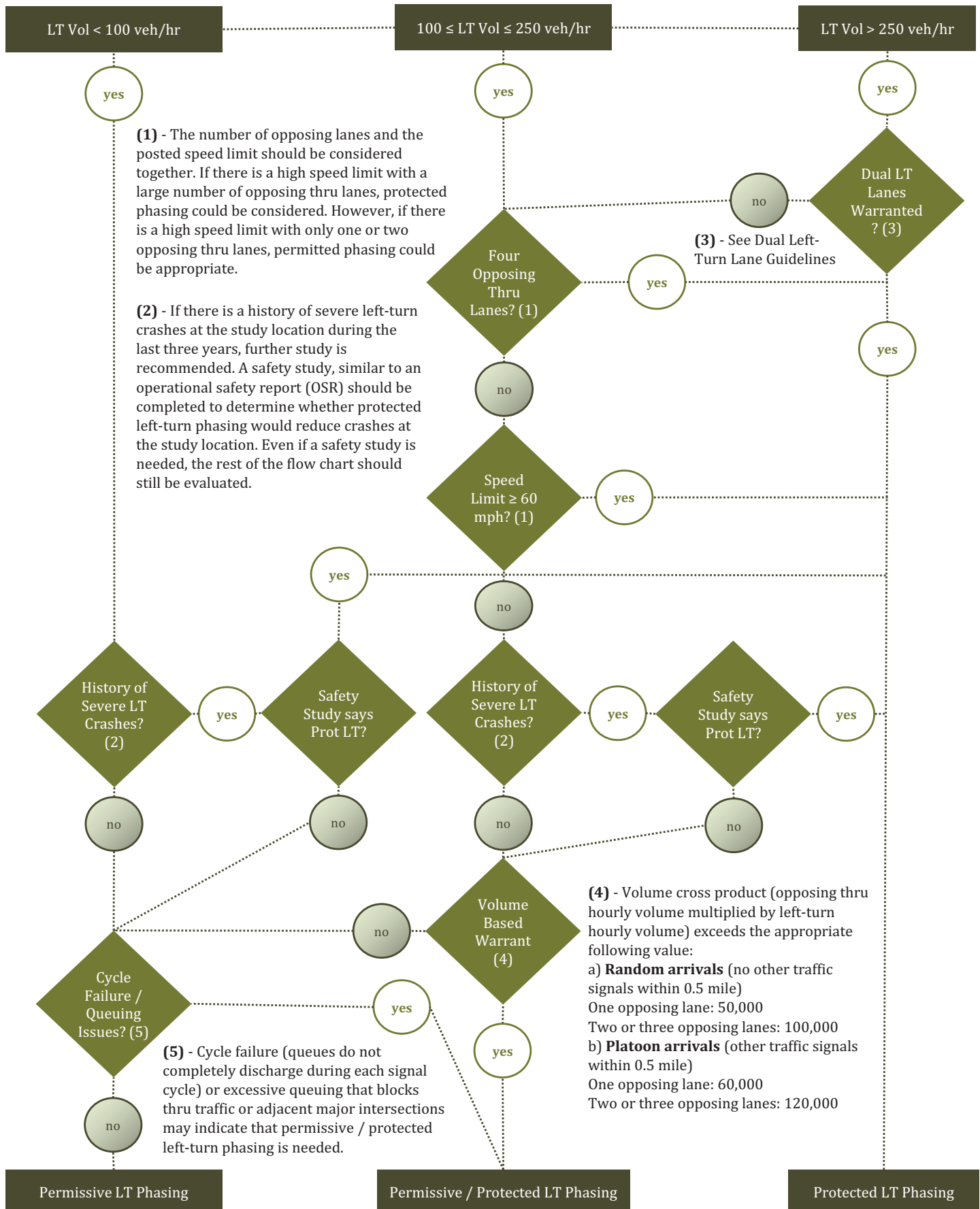
Table 1: Capacity Analysis Guidelines

Left-Turn Volume	Opposing Through V/C $\geq$	Recommend
250 - 269	0.95	Dual Left-Turn Lanes
270 - 279	0.75	Dual Left-Turn Lanes
280 - 319	0.65	Dual Left-Turn Lanes
320 - 359	0.6	Dual Left-Turn Lanes
360 - 389	0.55	Dual Left-Turn Lanes
390 - 420	0.5	Dual Left-Turn Lanes
≥ 420		Dual Left-Turn Lanes

- II. The number of hours where left-turn volume meets the guidelines in the capacity analysis in Table 1 should be considered where the dual left-turn lanes provide a benefit. A comparison with the vehicle delays should be made during the other non-peak hours in the day.
- III. The location of the intersection where the dual left is being considered should also consider the lane distribution that will be obtained. For example, if the intersection is close to a freeway on-ramp, there may not be good lane utilization since vehicles will favor the lane providing the best access to the ramp.
- IV. Consideration should be given for the need to minimize the green time given to left turns on one approach so that added green time is available for the other phases.
- V. Compatibility of the dual left exclusive phasing operations with the signal coordination should be evaluated.
- VI. The Designer and Project Manager shall consult with the Region Traffic Operations Engineer and the Division of Traffic & Safety before adding dual left-turn lanes when the left-turn volume is less than 420 vph.
- VII. If there is no opposing through movement, such as at a three-way "T" intersection, then no additional signal phase is needed. Instead of using the above volume and v/c criteria, consideration should be given to opposing pedestrian phases, available right-of-way needed for the additional lane, and existing left-turn queue lengths at the intersection. If cycle failure (queue doesn't clear during each signal cycle) is occurring often, dual left-turn lanes should be considered.

Left-Turn Phasing Guidelines

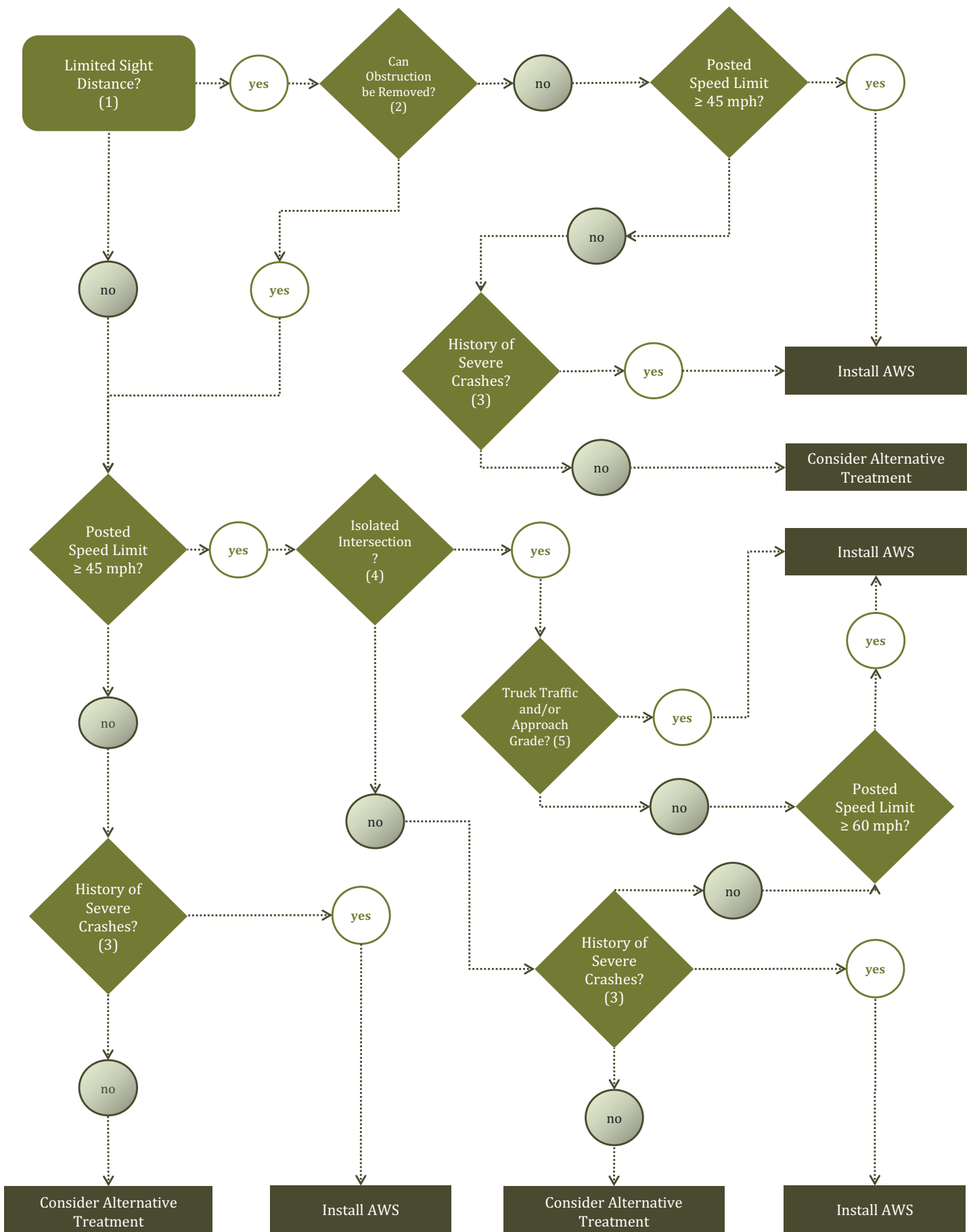
Updated November 13, 2014



APPENDIX 5 AWS GUIDELINES

AWS Guidelines

Adopted July 20, 2015



AWS Guidelines

Adopted July 20, 2015

Notes:

(1)- Limited sight distance (determined by the 85th percentile speed) may be due to vertical & horizontal curves or obstacles such as trees, buildings, overpasses, etc. In evaluating sight distance, consideration should be given to heavy vehicles (see AASHTO Greenbook Section 3.2.2). For downhill grades approaching an intersection, additional sight distance should be provided as follows (see AASHTO Greenbook Table 10-4):

-1.2 times greater for downhill grades between 3 to 4 percent

-1.35 times greater for downhill grades between 5 to 6 percent.

Other considerations should include the location of the stop bar or queued vehicles in relation to signal heads and the driver's ability to stop. The 95th percentile queue lengths should be measured in the field.

(2) – Can the obstructions be removed within reason and cost restraints upon initial inspection? Field visits can confirm the recommendation. If a recommendation cannot be confidently made, complete analysis under the assumption that the obstruction cannot be removed.

(3) - If there is a pattern of severe angle or front-to-rear crashes at the study location during the last five years, further study is recommended. A safety analysis should be completed to determine whether AWS would reduce crashes at the study location.

(4) – An isolated intersection is identified by having no other signalized intersection within 3 miles.

(5) - The combination of truck traffic and approach grade are greater than or equal to one of the following criteria:

a) 10% Trucks and 3% Downhill Grade

b) 20% Trucks and 2% Downhill Grade

c) 30% Trucks

Additional Considerations:

- Use of adequate clearance intervals (yellow & all red time).
- Evidence of dilemma zone issues (skid marks, etc.).
- Use of dilemma zone radar detection (Wavetronics Advanced Radar Detection System).
- Use of other more appropriate advanced warning signs.
- Use of near-side signal heads, etc.

APPENDIX 6 PROCUREMENT SAMPLE SIGNAL PLAN AND DOCUMENTS

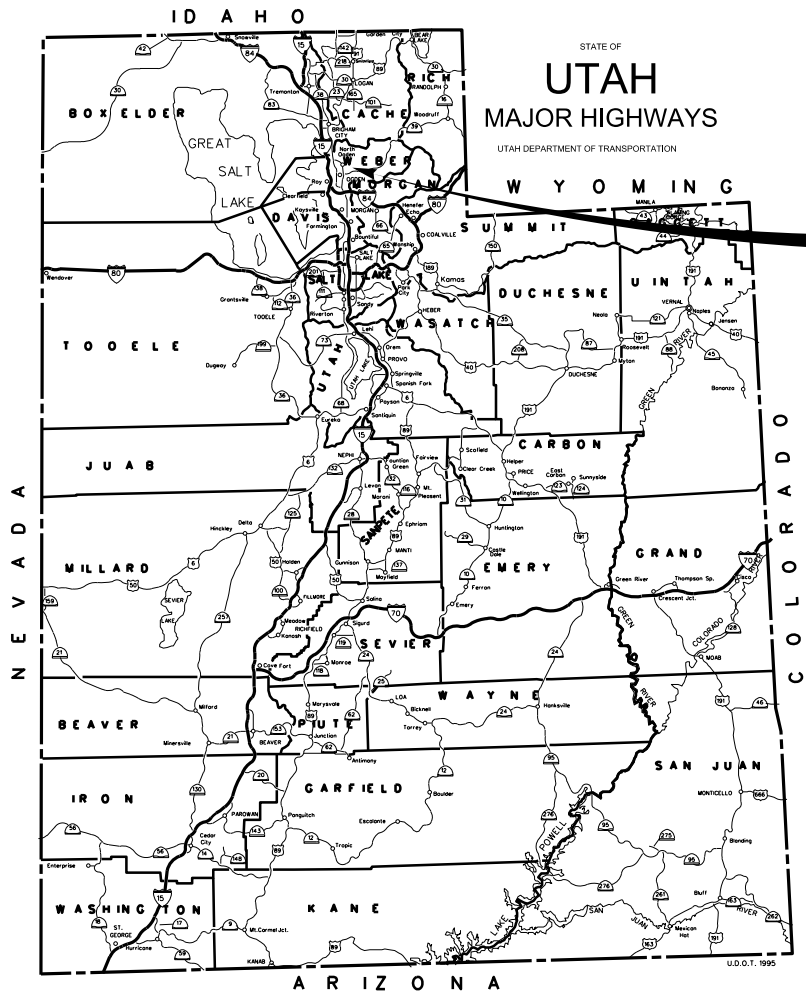
Includes the following:

Plan

1. Title
2. Index to Sheets (1-A)
3. Details (DT-01)
4. Roadway (RD-01)
5. Signal (SG-01)
6. Signal Circuit (SG-02)
7. Signal Schedule (SG-S01, SG-S02, SG-S03)
8. ATMS
9. ATMS Schedule (ATMS-S01)

Documents

10. State Furnished Items Form
11. ATMS State Furnished Items Form
12. Procurement Estimate



UTAH
DEPARTMENT OF TRANSPORTATION

SHEET
NO.
1

U.S. Standard Units
(Inch-Pound Units)
ALL UNITS IN FEET UNLESS
OTHERWISE NOTED

S-0012(34)56

PLANS OF PROPOSED PROJECT
STATE FUNDED PROJECT

S-0012(34)56 PIN: 00000

{ePM SCREEN 710 - PIN TAB - PIN DESCRIPTION}

{ePM SCREEN 710 - PROJECT NUMBER TAB - CONCEPT}

{ePM SCREEN 710 - PROJECT NUMBER TAB - COUNTY} COUNTY
LENGTH 0.10 MILES

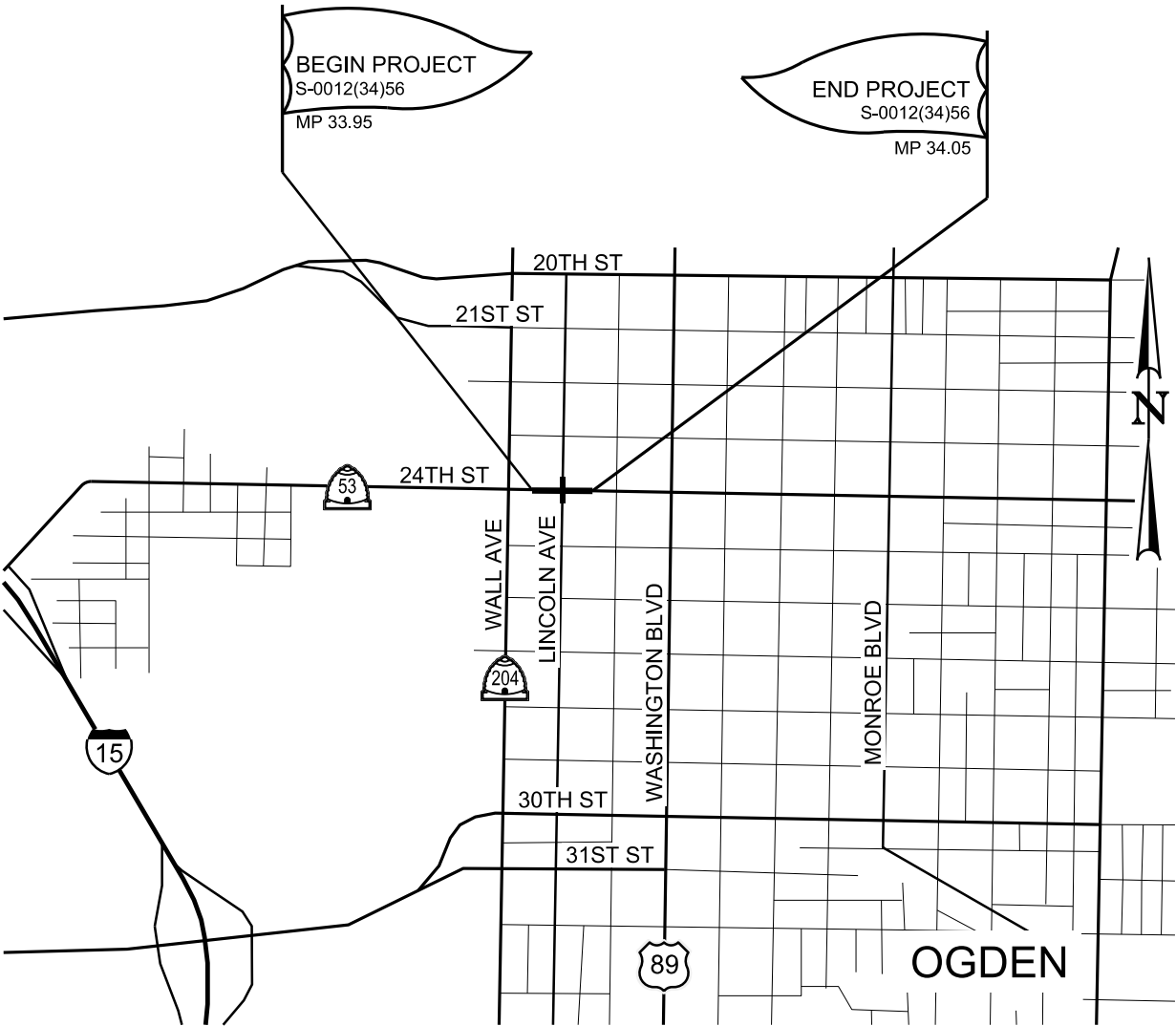
SIGNAL PROCUREMENT
PROJECT
PS&E PLANS
6/1/2015

LIMITATION OF OPERATIONS:

- PERFORM ALL WORK DURING NORMAL WORK HOURS
(7:00 AM TO 5:00 PM)
- NO RESTRICTIONS ON TIME OR DAY FOR SHOULDER CLOSURES.
- LANE SHIFTS AND CLOSURES ALLOWED PER TRAFFIC CONTROL
STD DWGS FROM 9:00 AM TO 3:00 PM.

INDEX TO SHEETS		
SHEET NUMBER	NUMBER OF SHEETS	DESCRIPTION
1	1	TITLE/INDEX TO SHEETS
DT-01	1	DETAILS
RD-01	1	ROADWAY
SG-01	1	SIGNAL
SG-02	1	SIGNAL CIRCUIT
SG-S01 TO SG-S03	3	SIGNAL SCHEDULE
ATMS-01	1	ATMS
ATMS-S01	1	ATMS SCHEDULE
* UDOT SUPPLEMENTAL STANDARD DRAWINGS		
SHEET NUMBER	DESCRIPTION	
DD 18	UTILITY LOCATION REQUIREMENTS	
SL 2, 4, 6	SIGNAL	
SN 13A, 13B, 13C	SIGNING	
TC 1 - 19	TRAFFIC CONTROL	

*SUPPLEMENTAL DRAWING SHEETS ARE NOT INCLUDED IN THIS PLAN SET.
INFORMATION FOUND ON SUPPLEMENTAL DRAWINGS APPLIES TO THIS PROJECT.



THIS SEAL APPLIES TO ALL SHEETS
CONTAINING THIS SIGNATURE

VERIFIED FOR SUBMISSION FOR ADVERTISEMENT

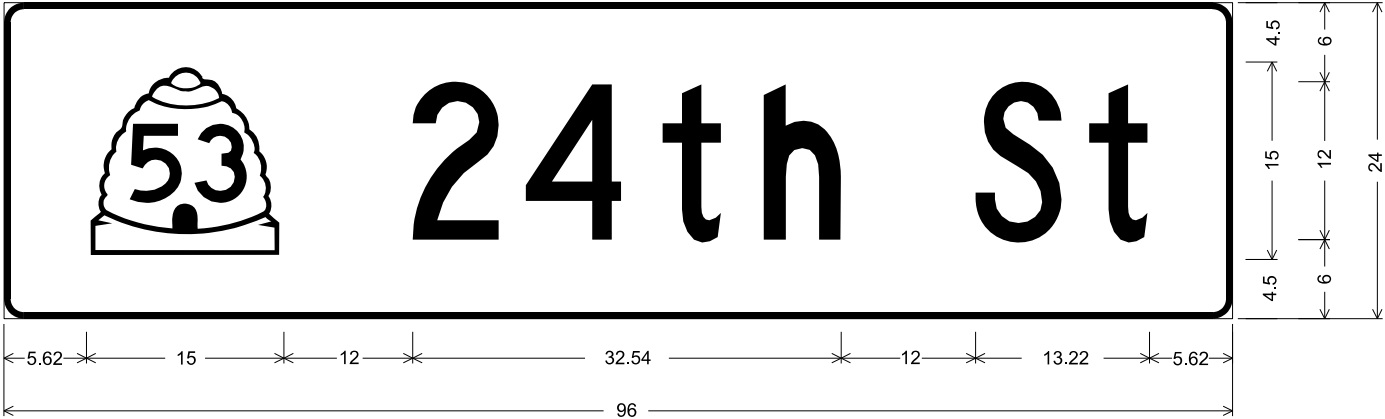
DESIGN ENGINEER

UTAH DEPARTMENT OF TRANSPORTATION
APPROVED FOR ADVERTISEMENT

REGION ONE PRECONSTRUCTION ENGINEER

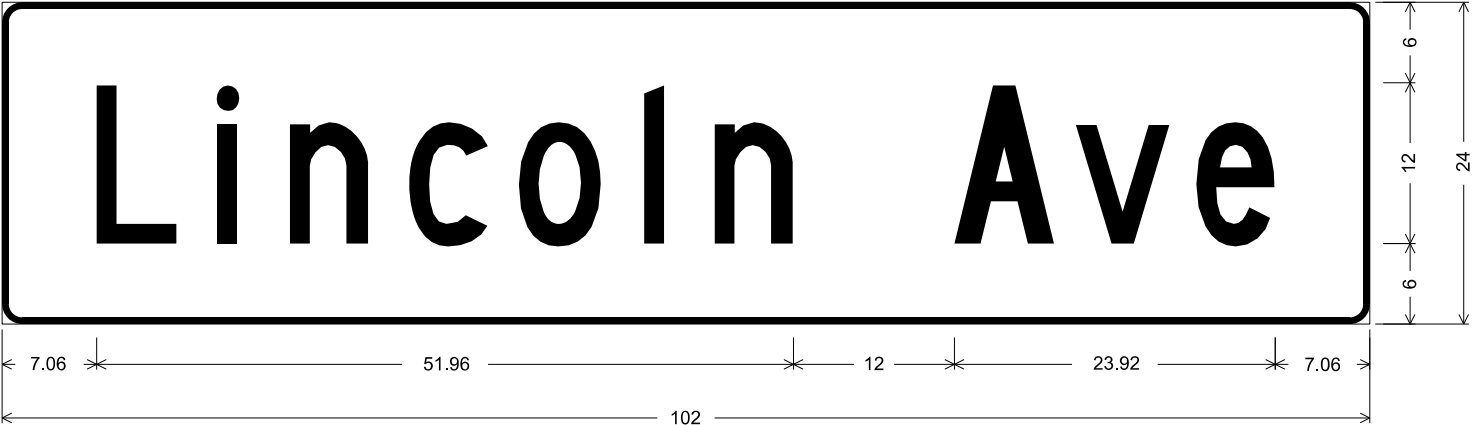
\$\$\$\$to\$\$\$\$

\$\$\$\$to\$\$\$\$



DS3-3 24" STREET ; 1.50" Radius, 0.50" Border, White on Green;
MS1-5-15c Utah Route 3 Digit 5" D; [24th St] C;

MAST ARM MOUNTED SIGN FOR P3 & P5



DS3-4 LINCOLN AVE; 1.50" Radius, 0.50" Border, White on Green;
[Lincoln Ave] C;

MAST ARM MOUNTED SIGN FOR P1 & P4

PROJECT		PROJECT NAME LINE 1		UTAH DEPARTMENT OF TRANSPORTATION CONSULTANT FIRM, INC.				REVISIONS			
PROJECT NUMBER		PROJECT NAME LINE 2									
S-0012(34)56		PIN 00000									
DETAILS		APPROVED		X/XX/20XX		DATE		APPROVED BY		REMARKS	
				PROFESSIONAL ENGINEER				NO.		DATE	
				QC		CHECKED BY		XYZ			
				DRAWN BY		ABC					

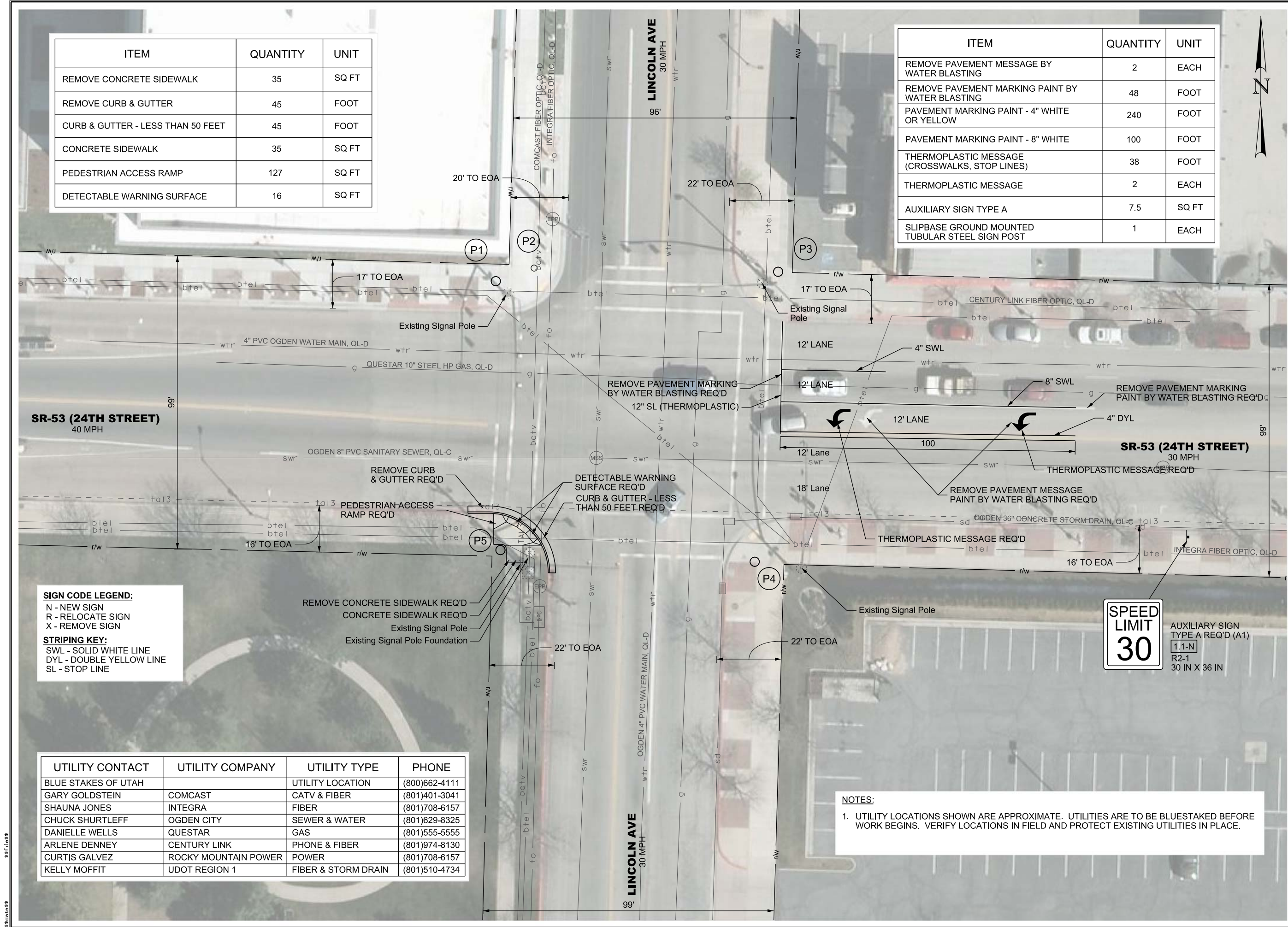
ITEM	QUANTITY	UNIT
REMOVE CONCRETE SIDEWALK	35	SQ FT
REMOVE CURB & GUTTER	45	FOOT
CURB & GUTTER - LESS THAN 50 FEET	45	FOOT
CONCRETE SIDEWALK	35	SQ FT
PEDESTRIAN ACCESS RAMP	127	SQ FT
DETECTABLE WARNING SURFACE	16	SQ FT

ITEM	QUANTITY	UNIT
REMOVE PAVEMENT MESSAGE BY WATER BLASTING	2	EACH
REMOVE PAVEMENT MARKING PAINT BY WATER BLASTING	48	FOOT
PAVEMENT MARKING PAINT - 4" WHITE OR YELLOW	240	FOOT
PAVEMENT MARKING PAINT - 8" WHITE	100	FOOT
THERMOPLASTIC MESSAGE (CROSSWALKS, STOP LINES)	38	FOOT
THERMOPLASTIC MESSAGE	2	EACH
AUXILIARY SIGN TYPE A	7.5	SQ FT
SLIPBASE GROUND MOUNTED TUBULAR STEEL SIGN POST	1	EACH

SIGN CODE LEGEND:
N - NEW SIGN
R - RELOCATE SIGN
X - REMOVE SIGN

STRIPING KEY:
SWL - SOLID WHITE LINE
DYL - DOUBLE YELLOW LINE
SL - STOP LINE

UTILITY CONTACT	UTILITY COMPANY	UTILITY TYPE	PHONE
BLUE STAKES OF UTAH		UTILITY LOCATION	(800)662-4111
GARY GOLDSTEIN	COMCAST	CATV & FIBER	(801)401-3041
SHAUNA JONES	INTEGRA	FIBER	(801)708-6157
CHUCK SHURTLEFF	OGDEN CITY	SEWER & WATER	(801)629-8325
DANIELLE WELLS	QUESTAR	GAS	(801)555-5555
ARLENE DENNEY	CENTURY LINK	PHONE & FIBER	(801)974-8130
CURTIS GALVEZ	ROCKY MOUNTAIN POWER	POWER	(801)708-6157
KELLY MOFFIT	UDOT REGION 1	FIBER & STORM DRAIN	(801)510-4734



NOTES:

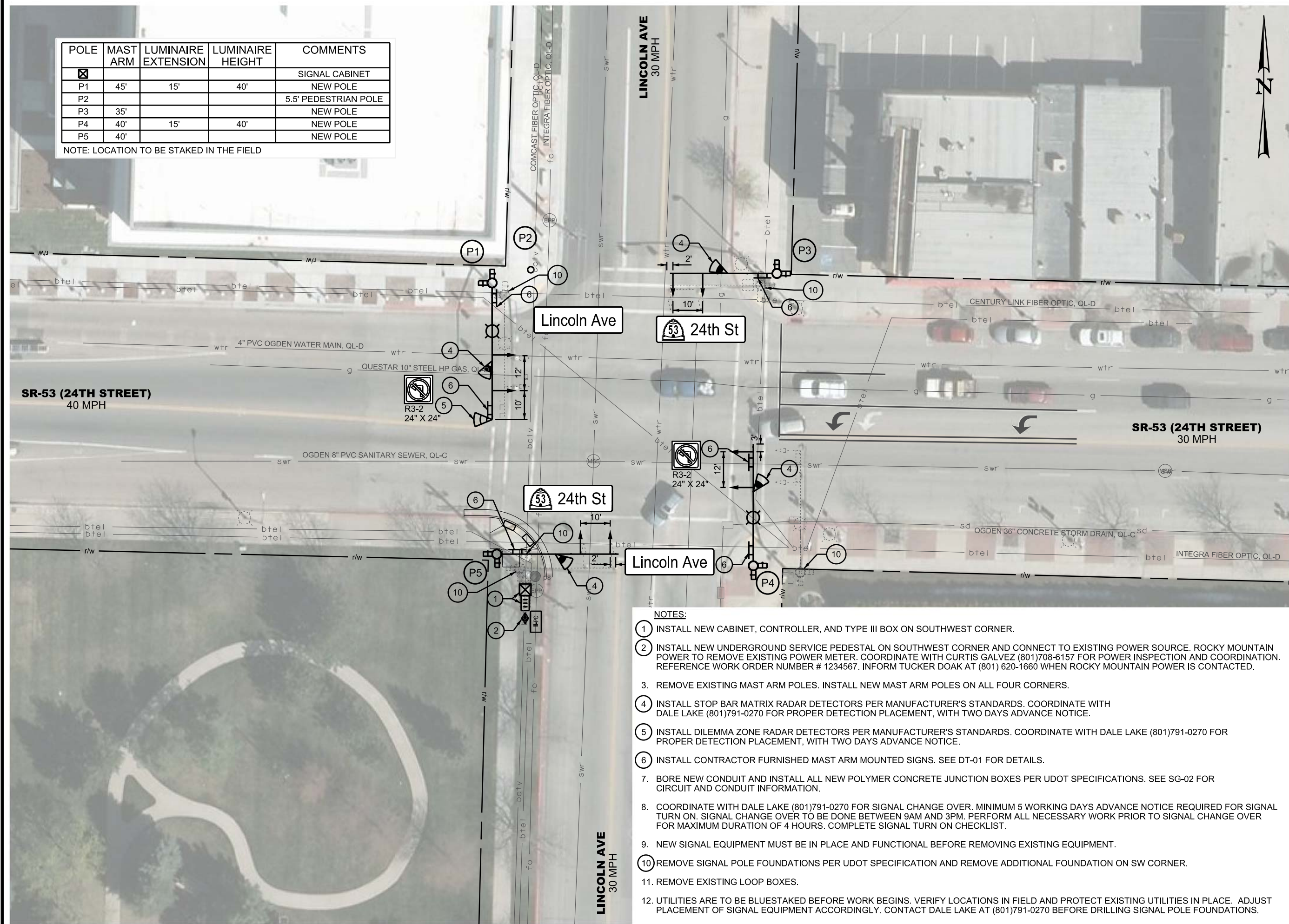
1. UTILITY LOCATIONS SHOWN ARE APPROXIMATE. UTILITIES ARE TO BE BLUESTAKED BEFORE WORK BEGINS. VERIFY LOCATIONS IN FIELD AND PROTECT EXISTING UTILITIES IN PLACE.

PROJECT		PROJECT NAME LINE 1		UTAH DEPARTMENT OF TRANSPORTATION CONSULTANT FIRM, INC.				REVISIONS					
		PROJECT NAME LINE 2											
PROJECT NUMBER	S-0012(34)56		PIN	00000	APPROVED	X/XX/20XX DATE	DRAWN BY ABC	QC CHECKED BY XYZ	PROFESSIONAL ENGINEER	NO.	DATE	APPROVED BY	REMARKS
	ROADWAY												

\$\$\$\$notes\$\$\$\$

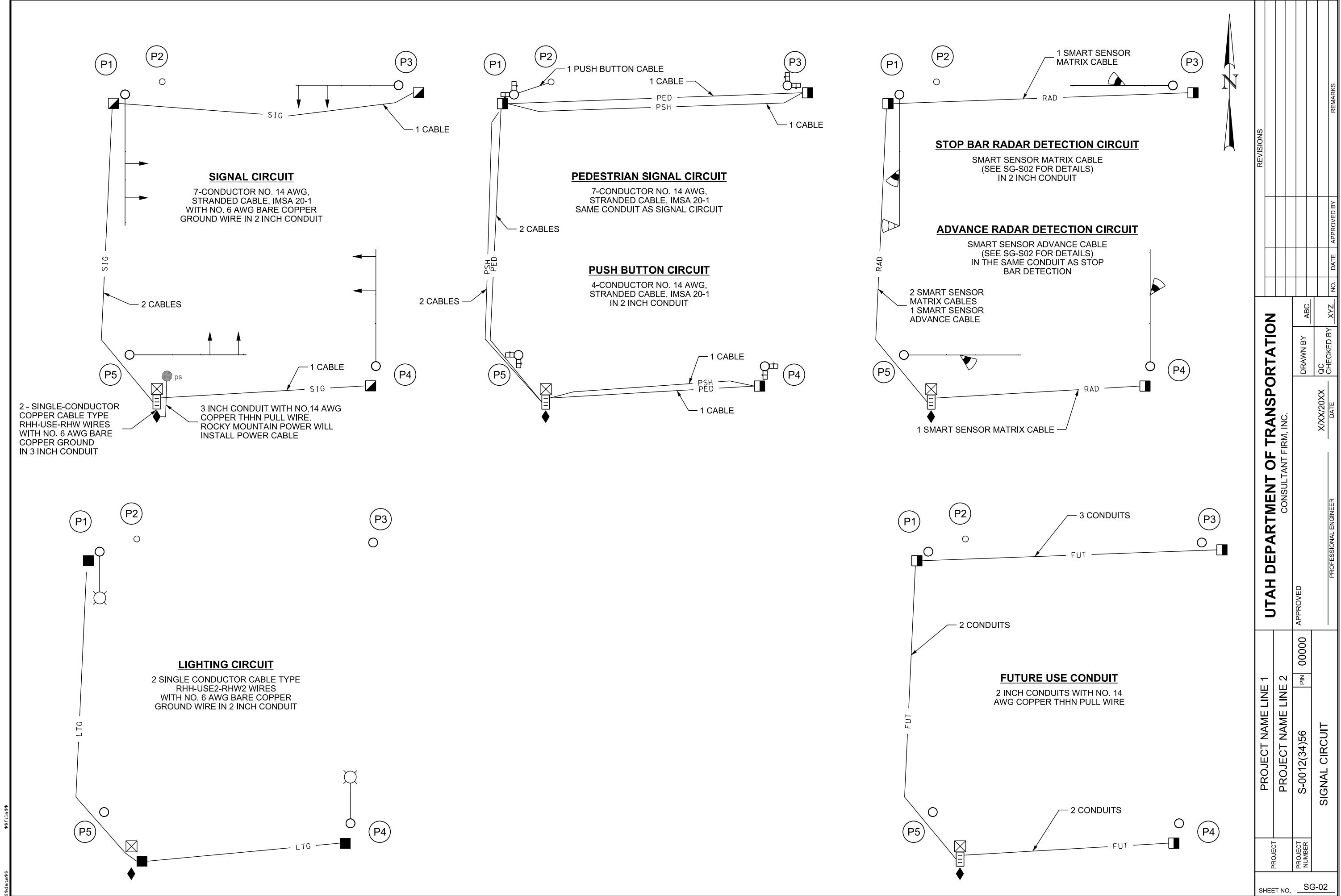
POLE	MAST ARM	LUMINAIRE EXTENSION	LUMINAIRE HEIGHT	COMMENTS
☒				SIGNAL CABINET
P1	45'	15'	40'	NEW POLE
P2				5.5' PEDESTRIAN POLE
P3	35'			NEW POLE
P4	40'	15'	40'	NEW POLE
P5	40'			NEW POLE

NOTE: LOCATION TO BE STAKED IN THE FIELD



- NOTES:**
1. INSTALL NEW CABINET, CONTROLLER, AND TYPE III BOX ON SOUTHWEST CORNER.
 2. INSTALL NEW UNDERGROUND SERVICE PEDESTAL ON SOUTHWEST CORNER AND CONNECT TO EXISTING POWER SOURCE. ROCKY MOUNTAIN POWER TO REMOVE EXISTING POWER METER. COORDINATE WITH CURTIS GALVEZ (801)708-6157 FOR POWER INSPECTION AND COORDINATION. REFERENCE WORK ORDER NUMBER # 1234567. INFORM TUCKER DOAK AT (801) 620-1660 WHEN ROCKY MOUNTAIN POWER IS CONTACTED.
 3. REMOVE EXISTING MAST ARM POLES. INSTALL NEW MAST ARM POLES ON ALL FOUR CORNERS.
 4. INSTALL STOP BAR MATRIX RADAR DETECTORS PER MANUFACTURER'S STANDARDS. COORDINATE WITH DALE LAKE (801)791-0270 FOR PROPER DETECTION PLACEMENT, WITH TWO DAYS ADVANCE NOTICE.
 5. INSTALL DILEMMA ZONE RADAR DETECTORS PER MANUFACTURER'S STANDARDS. COORDINATE WITH DALE LAKE (801)791-0270 FOR PROPER DETECTION PLACEMENT, WITH TWO DAYS ADVANCE NOTICE.
 6. INSTALL CONTRACTOR FURNISHED MAST ARM MOUNTED SIGNS. SEE DT-01 FOR DETAILS.
 7. BORE NEW CONDUIT AND INSTALL ALL NEW POLYMER CONCRETE JUNCTION BOXES PER UDOT SPECIFICATIONS. SEE SG-02 FOR CIRCUIT AND CONDUIT INFORMATION.
 8. COORDINATE WITH DALE LAKE (801)791-0270 FOR SIGNAL CHANGE OVER. MINIMUM 5 WORKING DAYS ADVANCE NOTICE REQUIRED FOR SIGNAL TURN ON. SIGNAL CHANGE OVER TO BE DONE BETWEEN 9AM AND 3PM. PERFORM ALL NECESSARY WORK PRIOR TO SIGNAL CHANGE OVER FOR MAXIMUM DURATION OF 4 HOURS. COMPLETE SIGNAL TURN ON CHECKLIST.
 9. NEW SIGNAL EQUIPMENT MUST BE IN PLACE AND FUNCTIONAL BEFORE REMOVING EXISTING EQUIPMENT.
 10. REMOVE SIGNAL POLE FOUNDATIONS PER UDOT SPECIFICATION AND REMOVE ADDITIONAL FOUNDATION ON SW CORNER.
 11. REMOVE EXISTING LOOP BOXES.
 12. UTILITIES ARE TO BE BLUESTAKED BEFORE WORK BEGINS. VERIFY LOCATIONS IN FIELD AND PROTECT EXISTING UTILITIES IN PLACE. ADJUST PLACEMENT OF SIGNAL EQUIPMENT ACCORDINGLY. CONTACT DALE LAKE AT (801)791-0270 BEFORE DRILLING SIGNAL POLE FOUNDATIONS.

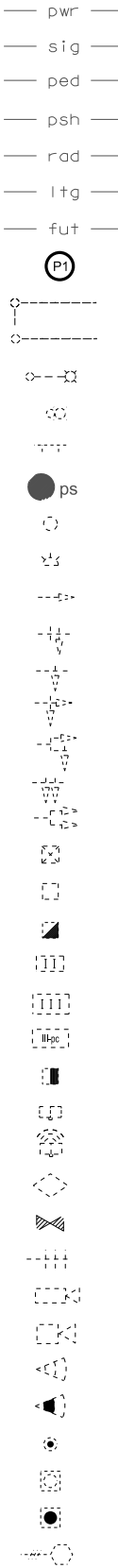
UTAH DEPARTMENT OF TRANSPORTATION				CONSULTANT FIRM, INC.			
PROJECT NAME LINE 1		PROJECT NAME LINE 2		APPROVED		DRAWN BY	
PROJECT NUMBER		S-0012(34)56		PIN		QC	
						CHECKED BY	
						DATE	
						NO.	
						DATE	
						APPROVED BY	
						REMARKS	



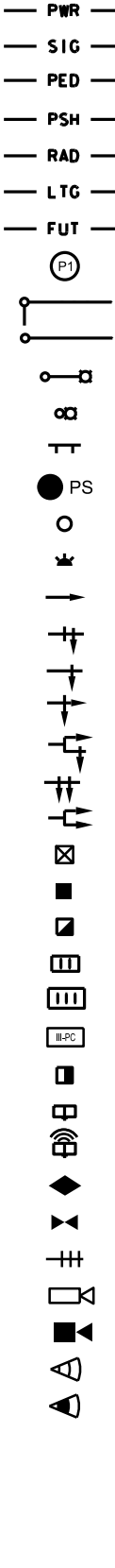
SHEET NO.		SG-02		UTAH DEPARTMENT OF TRANSPORTATION										CONSULTANT FIRM, INC.										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LEGEND

Existing

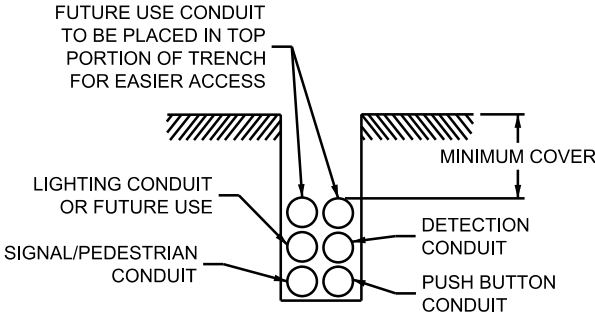


PROPOSED



- POWER SOURCE CIRCUIT CONDUIT
- SIGNAL CIRCUIT CONDUIT
- PEDESTRIAN SIGNAL CIRCUIT CONDUIT
- PEDESTRIAN PUSH BUTTON CIRCUIT CONDUIT
- RADAR DETECTION CIRCUIT CONDUIT
- LIGHTING CIRCUIT CONDUIT
- FUTURE USE CONDUIT
- SIGNAL POLE IDENTIFICATION
- DUAL MAST ARM SIGNAL POLE
- MAST ARM SIGNAL POLE
- SIGNAL POLE LUMINAIRE EXTENSION WITH ARM
- SIGNAL POLE LUMINAIRE EXTENSION WITH VERTICAL ATTACHMENT
- MAST ARM MOUNTED SIGN
- POWER SOURCE
- TRAFFIC SIGNAL POLE
- TYPE 0, 12"-1 SECTION SIGNAL HEAD ASSEMBLY
- TYPE I, 12"-3 SECTION SIGNAL HEAD ASSEMBLY
- TYPE II, 12"-3 SECTION SIGNAL HEAD ASSEMBLY
- TYPE III, 12"-3 SECTION WITH ALL ARROWS
- TYPE IV, 12"-4 SECTION SIGNAL HEAD ASSEMBLY
- TYPE V, 12"-5 SECTION SIGNAL HEAD ASSEMBLY
- TYPE VI, 12"-4 SECTION WITH ALL ARROWS
- PEDESTRIAN HYBRID BEACON, 12"-3 SECTION SIGNAL HEAD ASSEMBLY
- TRAFFIC SIGNAL CONTROLLER CABINET
- TYPE I-PC JUNCTION BOX
- TYPE II-PC JUNCTION BOX
- TYPE II DIVIDED JUNCTION BOX (FOR SIGNAL & LIGHTING)
- TYPE III-PC JUNCTION BOX
- TYPE III-PC JUNCTION BOX (ATMS)
- SAME JUNCTION BOX USED FOR SIGNAL CIRCUIT
- PEDESTRIAN SIGNAL HEAD WITH PUSH BUTTON
- AUDIBLE PEDESTRIAN SIGNAL HEAD
- UNDERGROUND SERVICE PEDESTAL (USP)
- PREEMPTION CONTROL SYSTEM DETECTOR
- DIRECTIONAL ANTENNA
- VIDEO DETECTION CAMERA
- CCTV CAMERA
- RADAR DETECTION, DILEMMA ZONE
- RADAR DETECTION, STOP BAR
- WIRELESS DETECTION PUCK
- WIRELESS DETECTION, ACCESS POINT
- WIRELESS DETECTION, REPEATER
- SENSOR LOOP

SALVAGING, REMOVAL, AND RELOCATION OF EXISTING EQUIPMENT																																				
LOCATION	SALVAGE										REMOVE														RELOCATE											
	TRAFFIC SIGNAL CONTROLLER	TRAFFIC SIGNAL CABINET	UNDERGROUND SERVICE PEDESTAL	SIGNAL HEAD	COUNTDOWN PEDESTRIAN SIGNAL HEAD	VIDEO DETECTION CONTROLLER	VIDEO DETECTION CAMERA	RADAR DETECTION SENSOR	SENSYS ACCESS POINT		TRAFFIC SIGNAL CABINET FOUNDATION	UNDERGROUND SERVICE PEDESTAL FOUNDATION	MAST ARM SIGNAL POLE FOUNDATION	TRAFFIC SIGNAL POLE FOUNDATION	LUMINAIRE POLE FOUNDATION	MAST ARM SIGNAL POLE	MAST ARM	HIGHWAY LUMINAIRE POLE	LUMINAIRE EXTENSION	LUMINAIRE ARM	TRAFFIC SIGNAL POLE	SIGNAL HEAD	PEDESTRIAN SIGNAL HEAD	PEDESTRIAN PUSH BUTTON	MAST ARM MOUNTED SIGN	JUNCTION BOX		TRAFFIC SIGNAL CONTROLLER CABINET	SIGNAL HEAD	COUNTDOWN PEDESTRIAN SIGNAL HEAD	VIDEO DETECTION CAMERA	LUMINAIRE EXTENSION & ARM	PRIORITY SYSTEM CONTROL	MAST ARM MOUNTED SIGN	RADAR DETECTION SENSOR	
	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA
24TH ST & LINCOLN AVE	1	1									1		5			4	4		2	2		8		8	8	4	8									
TOTAL	1	1									1		5			4	4		2	2		8		8	8	4	8									



- PROVIDE MINIMUM COVER FOR ALL ROADWAY CROSSINGS: 24" FOR CONDUIT PLACED IN TRENCH; 36" FOR DIRECTIONAL BORE CONDUIT.
- PROVIDE 18" MINIMUM COVER FOR CONDUIT PLACED OFF ROADWAY WITHOUT CONCRETE ENCASEMENT OR CAPPING.
- PROVIDE 12" MINIMUM COVER FOR CONDUIT PLACED OFF ROADWAY WITH CONCRETE ENCASEMENT OR MINIMUM 2" THICK CONCRETE CAPPING.
- MINIMUM OF 6 CONDUITS ARE REQUIRED FOR EACH ROAD CROSSING LOCATION.

TRENCHING AND BORING DETAIL

NOTES:

- RETURN SALVAGED ITEMS COMPLETE WITH ALL PARTS AND ASSOCIATED HARDWARE TO APPROPRIATE REGION. CONTACT REGION SIGNAL LAB TO SCHEDULE DELIVERY DATE.
- CONTRACTOR RESPONSIBLE TO DISPOSE OF REMOVED ITEMS AND ASSUME RESPONSIBILITY THEREAFTER. REUSE MATERIALS ONLY AS SPECIFIED OR AS APPROVED BY THE ENGINEER.
- REFER TO UDOT STD DWG SL SERIES FOR DETAILS.

REGION	CONTACT	PHONE
1	DALE LAKE	801-791-0270
2	DAVE MOUNT	801-330-4446
3	GRANT JACKSON	801-227-8040
4 (PRICE / MOAB)	GRAIG OGDEN	435-896-1327
4 (CEDAR/RICHFIELD/ ST. GEORGE)	LEE THOMPSON	435-590-9976

UTAH DEPARTMENT OF TRANSPORTATION
CONSULTANT FIRM, INC.

APPROVED
PROJECT NAME LINE 1
PROJECT NAME LINE 2
S-0012(34)56
PIN
00000

PROFESSIONAL ENGINEER
X/XX/20XX
DATE

DRAWN BY
ABC
QC
CHECKED BY
XYZ

REVISIONS

REMARKS

PROJECT

PROJECT NUMBER

SHEET NO. SG-S01

	SIGNAL STRUCTURAL SUPPORT SYSTEM						SIGNAL HEAD													POWER SOURCE SYSTEMS (SEE NOTE 5 THIS SHEET)						
	MAST ARM SIGNAL POLE FOUNDATION - 3' x 12' (30' TO 65')	MAST ARM SIGNAL POLE FOUNDATION - 3' x 14' (70' TO 75')	TRAFFIC SIGNAL/PEDESTAL POLE FOUNDATION - 2' X 3'	HIGHWAY LUMINAIRE POLE FOUNDATION - 2.5' x 8'	CABINET FOUNDATION	UNDERGROUND SERVICE PEDESTAL FOUNDATION	TYPE 0 SIGNAL HEAD WITH LED MODULE	TYPE I SIGNAL HEAD WITH LED MODULES	TYPE II SIGNAL HEAD WITH LED MODULES	TYPE III SIGNAL HEAD WITH LED MODULES	TYPE IV SIGNAL HEAD WITH LED MODULES	TYPE V SIGNAL HEAD WITH LED MODULES	TYPE VI SIGNAL HEAD WITH LED MODULES	BACK PLATE FOR TYPE 0	BACK PLATE FOR TYPE I, II, III	BACK PLATE FOR TYPE IV, VI	46" SIGNAL HEAD BRACKET	58" SIGNAL HEAD BRACKET	MAST ARM MOUNTED SIGN WITH MOUNTING BRACKETS	SIGNAL & LIGHTING					UNDERGROUND SERVICE PEDESTAL	POWER SOURCE (3 WIRE 240 VOLT)
																				SINGLE CONDUCTOR NO. 4 CABLE	SINGLE CONDUCTOR NO. 6 CABLE	2" CONDUIT	3" CONDUIT	3" GALVANIZED RIGID STEEL CONDUIT		
LOCATION	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	LIN FT	LIN FT	LIN FT	LIN FT	LIN FT	EA	EA
24TH ST & LINCOLN AVE	4		1		1	1		8							8		8		6		30		15		1	1
TOTAL	4		1		1	1		8							8		8		6	\$	\$	\$	\$	\$	1	1
USE	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:

1. SEE UDOT STD DWG SL SERIES.
2. USE CONTROLLER CABINET FOUNDATION CONDUITS AS FOLLOWS:

A. SIGNAL CIRCUIT CABLES.
B. PEDESTRIAN CIRCUIT CABLES.
C. VIDEO POWER AND DETECTION CIRCUIT CABLES.
D. PEDESTRIAN PUSH BUTTON CIRCUIT CABLES.
E. FUTURE USE (2 CONDUITS.)
F. 120/240 VOLT POWER CIRCUIT TO THE CONTROLLER CIRCUIT BREAKER OR UNDERGROUND SERVICE PEDESTAL.
3. PROVIDE 3-FEET EXTRA CABLE LENGTH COILED INSIDE EACH JUNCTION BOX FOR EACH CIRCUIT (POWER, SIGNAL, DETECTOR, LIGHTING, ETC.).
4. INSTALL 3/4" x 10" COPPER COATED STEEL GROUND ROD IN EACH JUNCTION BOX WITH 50 LINE VOLTAGE AND ABOVE.
5. USE RHH/USE-2/RHW-2 ELECTRICAL CABLE, COPPER, RATED FOR 600 VOLTS.
6. CONTACT THE SERVING POWER COMPANY A MINIMUM OF THIRTY (30) DAYS BEFORE POWER SERVICE IS REQUIRED. SEE UDOT STD DWG SL 3 FOR UNDERGROUND SERVICE PEDESTAL DETAIL. CONTACT REGION SIGNAL LAB (SEE SG-S01 FOR CONTACT INFORMATION) THREE (3) DAYS IN ADVANCE OF UNDERGROUND SERVICE PEDESTAL INSPECTION. MAKE ALL ARRANGEMENTS WITH LOCAL POWER COMPANY FOR INSTALLATION.
7. PLACE ALL CONDUIT IN SAME TRENCH WHERE POSSIBLE.
8. CONSTRUCT SIGNAL IN A MANNER TO AVOID DAMAGE TO EXISTING UTILITIES. ASSUME RESPONSIBILITY FOR ANY UTILITY DAMAGED BY CONSTRUCTION OPERATIONS. THE PLANS SHOW BURIED UTILITY LOCATIONS IN THEIR APPROXIMATE LOCATION ONLY.
9. PROVIDE A 17.5' MINIMUM AND 19.5' MAXIMUM CLEARANCE FROM BOTTOM OF SIGNAL HEADS (INCLUDING BACK PLATES AND BRACKETS) TO TOP OF PAVEMENT.
10. SMART SENSOR CABLE: COLOR-CODED, TWISTED PAIR, 6 - CONDUCTOR WIRE WITH 20 AWG FOR POWER AND 22 AWG FOR COMMUNICATION. WAVETRONIX PART # WX-SS-705 OR APPROVED EQUIVALENT.

	SIGNAL AND PEDESTRIAN SIGNAL HEAD					STREET LIGHTING CIRCUIT				GROUND SYSTEM				DETECTION DEVICE									JUNCTION BOX			FUTURE USE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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\$ THESE ITEMS ARE CALCULATED BY THE CONTRACTOR

* CONTRACTOR FURNISHED AND INSTALLED

UTAH DEPARTMENT OF TRANSPORTATION
CONSULTANT FIRM, INC.

PROJECT NAME LINE 1
PROJECT NAME LINE 2
S-0012(34)56
SIGNAL SCHEDULE

PROJECT
PROJECT NUMBER

APPROVED
X/XX/20XX
DATE
PROFESSIONAL ENGINEER

DRAWN BY
QC
CHECKED BY
XYZ.

REVISIONS

NO.
DATE
APPROVED BY
REMARKS

STATE FURNISHED MATERIALS

SIGNAL SCHEDULE																								HIGHWAY LIGHTING SCHEDULE																						
	TRAFFIC SIGNAL		POLE								MAST ARM								ANCHOR BOLT		POLE				EXTENSION				ARM		LED MV LUMINAIRE W/ PC			LED 480 V LUMINAIRE W/O PC												
	CONTROLLER	CABINET	POLE BASE PLATE ADAPTER	56" TRAFFIC/PED SIGNAL POLE (SLIP BASE)	11" TRAFFIC/PED SIGNAL POLE (SLIP BASE)	15" TRAFFIC/PED SIGNAL POLE (SLIP BASE)	TYPE A MAST ARM SIGNAL POLE (30' TO 55')	TYPE B MAST ARM SIGNAL POLE (60' TO 75')	TYPE DC DUAL MAST ARM SIGNAL POLE (30' TO 45')	TYPE A POLE CAP	TYPE B POLE CAP				30' MAST ARM	35' MAST ARM	40' MAST ARM	45' MAST ARM	50' MAST ARM	55' MAST ARM	60' MAST ARM	65' MAST ARM	70' MAST ARM	75' MAST ARM				2" DIA x 66" ANCHOR BOLT W/ HARDWARE	1" DIA x 36" ANCHOR BOLT W/ HARDWARE	40' HIGHWAY LUMINAIRE POLE (SLIP BASE)	30' HIGHWAY LUMINAIRE POLE (SLIP BASE)	40' HIGHWAY LUMINAIRE POLE (FIXED BASE)	40' HIGHWAY LUMINAIRE POLE (BARRIER MOUNT)	25' LUMINAIRE EXTENSION * (FOR TYPE A MAST ARM POLE)	30' LUMINAIRE EXTENSION * (FOR TYPE A MAST ARM POLE)	40' LUMINAIRE EXTENSION (FOR TYPE A MAST ARM POLE)	40' LUMINAIRE EXTENSION (FOR TYPE B MAST ARM POLE)	VERTICAL LUMINAIRE EXTENSION ATTACHMENT	10' LUMINAIRE ARM	15' LUMINAIRE ARM	TYPE A	TYPE B	VERTICAL TENON ADAPTER	TYPE A	TYPE B	
LOCATION	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA				EA	EA	EA	EA	EA	EA	EA	EA	EA	EA				EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	
24TH ST & LINCOLN AVE	1	1		1			4			2						1	2	1										16	4								2		2							
TOTAL	1	1		1			4			2						1	2	1										16	4							2		2								

STATE FURNISHED MATERIALS

DETECTION SCHEDULE																		
	**PREEMPTION CONTROL						RADAR DETECTION SYSTEMS								AUDIBLE PED PUSH BUTTON			
	ONE CHANNEL, ONE DIRECTION DETECTOR	ONE CHANNEL, TWO DIRECTION DETECTOR	TWO CHANNEL, TWO DIRECTION DETECTOR	DETECTOR MOUNT	TWO CHANNEL PHASE SELECTOR	FOUR CHANNEL PHASE SELECTOR	ADVANCE SENSOR EXTENDED RANGE (DILEMMA ZONE)	MATRIX SENSOR (STOP BAR)	SENSOR MOUNT (6" 3-AXIS ALUMINUM BRACKET)	100' CABLE WITH CONNECTOR	SPICE BOX	CABINET INTERFACE DEVICE (CLICK 650)			2-WIRE AUDIBLE PED BUTTON ASSEMBLY (FULL INTERSECTION)	2-WIRE CENTRAL CONTROL UNIT	4-WIRE AUDIBLE PED BUTTON ASSEMBLY (1 OR 2 CROSSINGS)	
LOCATION	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA			EA	EA	EA	
24TH ST & LINCOLN AVE							1	4	5	5	4	2						
TOTAL							1	4	5	5	4	2						

NOTES:

1. NOTIFY RESIDENT ENGINEER 4-6 WEEKS PRIOR TO DATE MATERIALS ARE NEEDED.
2. PICK UP STATE FURNISHED CONTROLLER CABINET AND CONTROLLER EQUIPMENT AT THE REGION SIGNAL LAB. CONTACT REGION ELECTRONICS SUPERVISOR, 10 DAYS PRIOR TO DESIRED PICK UP DATE.

REGION	CONTACT	PHONE
1	DALE LAKE	801-791-0270
2	MIKE XIRAS	801-887-3763
3	GRANT JACKSON	801-227-8040
4 (PRICE/MOAB)	GRAIG OGDEN	435-896-1327
4 (CEDAR/RICHFIELD/ ST. GEORGE)	LEE THOMPSON	435-590-9976

3. PICK UP STATE FURNISHED ANCHOR BOLTS, SIGNAL POLE STEEL, AND OTHER ELECTRONICS HARDWARE AT STATE WAREHOUSE. FURNISH LOADING EQUIPMENT AND PERSONNEL TO LOAD STATE FURNISHED MATERIALS. CONTACT GREG PALMER, (801) 965-4258, TO SCHEDULE PICK UP. MINIMUM 48 HOURS ADVANCE NOTICE REQUIRED.
4. CONTACT REGION SIGNAL LAB TO REQUEST IN-PROGRESS SIGNAL INSPECTION 8 DAYS PRIOR TO TURN-ON. COMPLETE UDOT TRAFFIC SIGNAL TURN-ON CHECKLIST PRIOR TO CONTACTING REGION SIGNAL LAB. MINIMUM 5 WORKING DAYS ADVANCE NOTICE REQUIRED FOR SIGNAL TURN ON.

REGION	CONTACT	PHONE
1	DALE LAKE	801-791-0270
2	DAVE MOUNT	801-330-4446
3	GRANT JACKSON	801-227-8040
4 (PRICE/MOAB)	GRAIG OGDEN	435-896-1327
4 (CEDAR/RICHFIELD/ ST. GEORGE)	LEE THOMPSON	435-590-9976

- * LUMINAIRE EXTENSION CAN BE USED ON TYPE B POLES, BUT THE HEIGHT WILL INCREASE BY 5'.

SHEET NO.	PROJECT	PROJECT NAME LINE 1		UTAH DEPARTMENT OF TRANSPORTATION				REVISIONS			
		PROJECT NAME LINE 2		CONSULTANT FIRM, INC.							
SG-S03	PROJECT NUMBER	S-0012(34)56	PIN	00000	APPROVED	DRAWN BY	ABC				
	SIGNAL SCHEDULE					QC CHECKED BY	X/XX/20XX				
					PROFESSIONAL ENGINEER		DATE	NO.	DATE	APPROVED BY	REMARKS

\$\$\$notes\$\$\$

ATMS WIRE SCHEDULE SUMMARY	
1	6 STRAND PRE-TERMINATED DROP CABLE
2	Existing 48 SMF Fiber

SR-53 (24TH STREET)
40 MPH

SR-53 (24TH STREET)
30 MPH

LINCOLN AVE
30 MPH

LINCOLN AVE
30 MPH

ATMS CONSTRUCTION NOTES:

- 1
- POLYMER CONCRETE JUNCTION BOX. TIER 22. TYPE III REQ'D (LID MARKED WITH "COMMUNICATION" LABEL).

2

3

4

5

NOTES:

1. UTILITIES ARE TO BE BLUE STAKED BEFORE WORK BEGINS. VERIFY LOCATIONS IN FIELD AND PROTECT EXISTING UTILITIES IN PLACE. ADJUST PLACEMENT OF EQUIPMENT ACCORDINGLY.
2. CONDUIT PATHS SHOWN ON PLANS MAY NOT REPRESENT ACTUAL FIELD LOCATION AND CONDITIONS. FIELD LOCATE ALL NEW CONDUIT, EXISTING CONDUIT, JUNCTION BOXES, AND UTILITIES BEFORE CONSTRUCTION.
3. MAINTAIN A MINIMUM OF 1-FT CLEARANCE BETWEEN ATMS CONDUIT AND ALL UTILITIES.
4. FIELD VERIFY CONDUIT AND CABLING QUANTITIES BEFORE ORDERING.
5. ALL ATMS CONDUITS TO BE INSTALLED A MINIMUM OF 3 FT BELOW FINISHED ROADWAY GRADE. IF MINIMUM INSTALLATION DEPTH IS UNOBTAINABLE, COORDINATE ACCEPTABLE INSTALLATION DEPTH WITH ENGINEER.
6. CONTACT LEON HADLEY AT (801) 887-3765 AFTER ATMS WORK IS COMPLETED FOR ATMS INSPECTION.



SHEET NO. ATMS-01

PROJECT

PROJECT NUMBER

PROJECT NAME LINE 1

PROJECT NAME LINE 2

S-0012(34)56

PIN

00000

ATMS

APPROVED

UTAH DEPARTMENT OF TRANSPORTATION

CONSULTANT FIRM, INC.

APPROVED

PROFESSIONAL ENGINEER

X/XX/20XX

QC

CHECKED BY

ABC

DRAWN BY

REVISIONS

NO.

DATE

APPROVED BY

REMARKS

A T M S SCHEDULE SHEET																			
	COMMUNICATIONS						CCTV							POLYMER CONCRETE BOX			ATMS CONDUIT		
	FIBER JUMPER, SMF, ST-ST, DUPLEX, 3 FT	CAT 5 PATCH CABLE, RJ45-RJ45, 4FT	FIELD ETHERNET SWITCH, 7UTP PORT, 2SMF PORTS, DIN RAIL MOUNT	6 STRAND PRE-TERMINATED DROP CABLE UNIT	TYPE A SPLICE ENCLOSURE	FUSION SPLICE	POSITIONER CCTV PRESSURIZED CAMERA	CAMERA ASSEMBLY (RDPE)	MPEG2/MPEG4/MJPEG ENCODER	DOME CCTV CABLE WITH CONNECTOR, 100 FT	DOME CCTV CABLE WITH CONNECTOR, 250 FT	DOME CCTV CABLE WITH CONNECTOR, CUSTOM LENGTH	CCTV MOUNTING ARM	POLYMER CONCRETE JUNCTION BOX, TIER 122, TYPE III	GROUND ROD 3/4" X 10'		3-INCH CONDUIT		
LOCATION	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	LIN FT	EA	EA	EA		LIN FT		
24TH ST & LINCOLN AVE			1	1	1	4								1	1		44		
TOTAL			1	1	1	4								1	1		44		
USE	*	*	*	**	**	**	***	*	*	***	***	***	***	**	**		**		

* STATE FURNISHED AND INSTALLED
** CONTRACTOR FURNISHED AND INSTALLED
*** STATE FURNISHED AND CONTRACTOR INSTALLED

- NOTES:
1. NOTIFY RESIDENT ENGINEER 4-6 WEEKS PRIOR TO DATE MATERIALS ARE NEEDED.
 2. CONTACT REGION TRAFFIC MANAGEMENT PROJECT MANAGER REGARDING STATE FURNISHED ATMS MATERIALS REQUISITION AFTER PRECONSTRUCTION MEETING TO ENSURE MATERIALS HAVE BEEN ORDERED.

REGION

CONTACT

PHONE

1

MATTHEW SMITH

801-887-3716

2

CHRIS SIAVRAKAS

801-718-0019

3

BRAD CAMERON

801-887-3719

4

MATTHEW SMITH

801-887-3716
 3. CONTACT REGION TRAFFIC MANAGEMENT PROJECT MANAGER TEN DAYS PRIOR TO DESIRED PICKUP DATE OF ATMS MATERIALS. PICKUP STATE FURNISHED ATMS HARDWARE AT STATE WAREHOUSE. CONTACT GREG PALMER, (801) 965-4258, TO SCHEDULE PICK UP. MINIMUM 48 HOURS ADVANCE NOTICE REQUIRED.
 4. SALVAGE EXISTING EQUIPMENT AND RETURN TO APPROPRIATE REGION TRAFFIC MANAGEMENT PROJECT MANAGER. CONTACT REGION TRAFFIC MANAGEMENT PROJECT MANAGER TO SCHEDULE DELIVERY DATE.
 5. MATTHEW SMITH WILL ORDER NECESSARY ATMS EQUIPMENT. ENGINEER TO VERIFY DROP CABLE AND CCTV CABLE LENGTH BEFORE REQUESTING/ ORDERING EQUIPMENT.

PROJECT		PROJECT NAME LINE 1		PROJECT NAME LINE 2		S-0012(34)56		PIN		00000		ATMS SCHEDULE		SHEET NO.		ATMS-S01													
		PROJECT NUMBER																											
UTAH DEPARTMENT OF TRANSPORTATION CONSULTANT FIRM, INC.														REVISIONS															
APPROVED																													
PROFESSIONAL ENGINEER																													
DATE																													
X/XX/20XX																													
QC																													
DRAWN BY																													
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DATE																													
REMARKS																													