The City of San Diego

Traffic Signal Design Guidelines

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The City of SAN DIEGO

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The following guideline outlines standardized procedures for preparing traffic signal plans within the City of San Diego. It is not meant to serve as a comprehensive textbook but rather as a tool to ensure consistency and provide designers with the necessary information to create plans with minimal uncertainty. The designer must possess a strong working knowledge, experience, and judgment in traffic signal design principles. Any deviations from these guidelines must be approved by the City Engineer before traffic signal plans are finalized.

1 Specifications, Standards, and Guidelines

The Engineer-of-Work preparing to design traffic signal plans shall utilize this design guideline and the following:

Standard Specifications:

- (ECP1010122-01) Standard Specifications for Public Works Construction ("The GREENBOOK"), Latest Edition.
- (ECP1010122-02) City of San Diego Standard Specifications for Public Works Construction ("The WHITEBOOK"), Latest Edition.
- (PWPI010119-04) Citywide Computer-Aided Design and Drafting (CADD) Standards, Latest Edition.
- (ECPD032324-07) California Manual on Uniform Traffic Control Devices Revision 8 (CA-MUTCD), Latest Edition.
- (ECPD090223-05) California Department of Transportation (CALTRANS) U.S. Customary Standard Specifications, Latest Edition.

Standard Drawings:

- (ECP1010122-03) City of San Diego Standard Drawings, Latest Edition.
- (ECPD092023-06) California Department of Transportation (CALTRANS) U.S. Customary Standard Plans, Latest Edition.

Guidelines:

- City of San Diego Curb Ramp Design Guidelines, Latest Edition.
- City of San Diego Street Design Manual, Latest Edition.

2 General Requirements

2.1 The engineer-of-work shall be a Civil Engineer with current registration in California and shall sign and seal the final plans.

2.2 Traffic signal improvements will be presented on dedicated plans, while signing and striping, civil, and other improvements will be shown in separate plans unless the improvements are minor and simple enough to be displayed on combined sheets upon approval by DCE.

2.3 Any new or modified traffic signal must be connected to the City's Traffic Management Center (TMC). The method of achieving connectivity to the TMC will be determined through coordination between the City Engineer and the designer.

2.4 Any new or modified traffic signal must be interconnected to adjacent signals within 1600 feet on either project end via Ethernet communications.

2.5 Consider a traffic signal modification that installs or replaces one or more traffic signal poles to be a “major” modification, and that a traffic signal modification that makes changes to fixtures without installing or replacing a pole to be a “minor” modification.

2.5.1 A “major mod” must include upgrade to City standards of all vehicular/pedestrian/bicycle signal heads, Accessible Pedestrian Signals (APS), controller, communications, Battery Backup System (BBS), Emergency Vehicle Preemption (EVP) system, cabling, etc. Although not necessarily other poles beyond the project scope; major modifications must be a civil engineering project, meeting City Engineer’s standard for project design, construction, inspection, and as-builts.

2.5.2 In a “minor mod” the work itself must be to City standards but it does not trigger other upgrades; must be approved by a Deputy City Engineer but does not require formal engineering project process

2.6 Pedestrian ramps must comply with the most recent Curb Ramp Design Guidelines memo from the City Engineer.

3 Utility Research/Field Review

3.1 The engineer shall request as-builts from the City and utility companies at the project's onset. As-builts and utility contacts shall be shared with the City Engineer upon request.

3.2 The engineer shall perform field verification of all project traffic signal locations for existing and proposed equipment to check for compliance with the City’s current standards, conditions, and constructability. The engineer shall notify the City at least one week in advance of field verification to ensure City Traffic Management Section (TSM) staff can be present to provide traffic signal cabinet access if necessary. Field verification of a City traffic signal shall not be performed without the City’s knowledge.

3.3 The engineer shall prepare and submit any necessary service requests to San Diego Gas and Electric (SDG&E) for new service or modification to existing service before submitting the final plans. The engineer shall obtain a meter address from the City.

3.4 The engineer shall submit the plans to the utility companies found to be in the work area for conflict review and utility location verification, and utility relocation design if necessary

3.5 The engineer shall provide Computer Aided Design and Drafting (CADD) record drawings following the completion of construction.

3.6 During design, in areas where traffic signal pole placement will be challenging because of potential conflicts, utility markouts and potholing of nearby utilities shall be completed. Pole locations shall be revised as necessary, and the utility base updated to reflect utility markouts.

3.7 Potholing, if done, shall be in accordance with the City’s Whitebook.

4 Submittals for Third Party Projects

4.1 The engineer shall prepare a concept plan and basis of design for the City Engineer's review before beginning detailed design. The engineer shall submit both to the City's Development Services Department and meet to discuss if requested. The basis of design shall include the following:

- 4.1.1 Purpose of traffic signal modification or new traffic signal.
  - 4.1.1.1 For new traffic signals, provide signal warrant analysis.
- 4.1.2 Count data
  - 4.1.2.1 Peak hour vehicle, ped, and bicycle with classification.
  - 4.1.2.2 Average Daily Traffic (ADT)
- 4.1.3 Existing (if any) and/or proposed phasing.
- 4.1.4 Completed left-turn flow chart from National Cooperative Highway Research Program (NCHRP) Report 812, Signal Timing Manual Second Edition (2015), or latest edition.
- 4.1.5 Fieldwork findings and proposed improvements.
- 4.1.6 Traffic signal interconnect approach.
- 4.1.7 Any studies or analyses developed for the project shall be attached to the basis of design for reference.

4.2 The first plan-check submittal shall be at least 90% complete.

4.3 If any City comments require clarification or discussion, the engineers shall schedule a comment review meeting with the City's Development Services Department before resubmittal.

4.4 To assist designers and reviewers, a comprehensive comment response matrix shall be produced for all submittals and used throughout the review process.

5 CADD Standards

Traffic signal plans shall be prepared following the latest version of the City's Computer Aided Design and Drafting CADD Standards. All design files and standard documents can be found on the City's website on the Engineering Documents and References page: https://www.sandiego.gov/ecp/edocref.

The City of San Diego uses the Autodesk AutoCAD CADD program as its basic CADD graphics engine for engineering design and drawing production. Design consultants may use other programs. However, they must be able to be loaded into the City's file management system and meet the requirements below.

1. Files can be converted to DWG format without any loss of data.
2. Element attributes must be recognized by both systems.
3. The City's CADD standards are adhered to.
4. The files are free of any errors from file translation.
5. The files are free of any corruption.

The City Engineer must approve of any deviations from the design plan requirements before the plans are prepared.

5.1 Title Block

The engineer shall use the latest title block found on the City's website. The Title block shall include the following information:

1. Project title
2. Street names/alley block number
3. Description Block
4. Project manager
5. Project engineer
6. Sheet number and total sheet numbers
7. Drawing Number
8. Date
9. CC27 Coordinate
10. CC83 Coordinate
11. Drawn By Initials
12. Approved Section
13. Filmed Date
14. Inspector Signature line
15. As-built Information
16. Change
17. Change Description
18. Addendum
19. Construction Change

5.2 Cover Sheet

Every plan set shall be provided with a cover sheet. The cover sheet shall follow the format presented in the City's D-Sheet Improvement Plan design guidelines and templates including but not limited to the following elements:

1. Vicinity map
2. Project title
3. Keymap
4. Sheet index
5. Work to be done statement
6. General construction notes
7. General traffic signal notes
8. Legend
9. Abbreviations
10. Declaration of responsible charge statement

11. Traffic data table

5.3 Sheet Setup

Traffic Signal design plans shall meet the basic requirements listed below:

5.3.1 Traffic signal improvements shall be depicted on one plan sheet to the greatest extent possible. With the City Engineer's approval, multiple plan sheets may be acceptable for large intersections, complex operations, and railroad preempted signals. Traffic signal communications design shall be depicted on a separate plan.

5.3.2 The engineer shall use the traffic signal plan CADD template available on the City's website. Key elements of the Traffic Signal Design plans and their ideal placement are as follows:

Item	Location
Conductor Schedule	Upper Left
Pole Schedule	Upper Right
Detector Schedule	Below Pole Schedule on the Right Side
Phase Diagram	Upper Right Near Conductor Schedule
Sign Legend	Available Space
Construction Notes	Bottom Right
Details	Available Space

5.3.3 Prepare plans on standard American National Standards Institute (ANSI) "D" sheet size with the current City of San Diego title block and sheet style.

5.3.4 North shall always be oriented up or to the right on all plans. The major arterial shall be horizontal on the plan.

5.3.5 The traffic signal plan view should be drawn at a scale of 1 inch: 20 feet . Corner blowouts shall be shown at a scale of 1 inch:10 feet when needed to show additional detail.

5.3.6 Traffic Signal Design Plans topographic lines and symbols shall conform to Caltrans Standard Plan A10B, and equipment symbols and abbreviations shall conform to Caltrans Standard Plans ES-1A, ES-1B, ES-1C. Any item that is not found in the standard plans shall be included in the legend or abbreviation list on the cover sheet.

5.3.7 Plan symbols for cabinets, pedestals, pole foundations, pull boxes, and detectors/detection areas shall be drawn to scale accurately, depicting the actual size of individual items.

5.3.8 Computer-aided drafting lettering without embellishments shall be used with a minimum text height of one-eighth inch (0.125 inch).

5.3.9 Squares shall be used to designate construction notes.

5.3.10 For construction changes, triangles and rev-clouding shall be used to indicate plan revisions.

5.4 Typical Traffic Signal Plan Elements

The plans shall accurately depict all traffic signal infrastructure, conduit, and wiring. The following design components shall be provided with each traffic signal improvement at minimum and as applicable.

a. Street names in title block (list alphanumerically)
b. North arrow
c. Scale bar
d. Legend
e. Centerline/stationing
f. Pavement markings
g. Pavement/curb/sidewalk
h. Underground utilities
i. Overhead utilities
j. Signal support/span mounted signs and sign legend
k. Lane assignment/lane use arrows
l. Street names on plan view
m. Posted speed on cover sheet
n. Right-of-way
o. Easements
p. Pedestrian signal head locations/orientation
q. Vehicle/Bicycle signal head locations/orientation
r. Push button locations/orientation
s. Preemption device locations/orientations
t. Blank out sign locations/orientations
u. Signal pole locations
v. Controller cabinet location and door swing
w. Service pedestal location
x. Existing and proposed phase diagrams
y. Pull box locations and sizes
z. Conduit sizes and lengths
aa. Signal wiring identified for each conduit
bb. Signal plan sheet notes
cc. Signal head configuration legend
dd. Detection areas
ee. Pole installation and removal schedule
ff. Detector schedule
gg. Sign Legends
hh. City detector placement detail
ii. SDG&E service point

5.5 Pole Schedule

5.5.1 All plans shall contain a pole schedule and shall conform to CA-MUTCD Table 4D-105 (CA) Pole and Equipment Schedule.

5.5.2 Poles shall be identified by lettering which corresponds to the pole schedule. The pole closest to the controller cabinet is pole "A" and continue lettering the poles clockwise around the intersection.

5.5.3 A note shall be placed at the bottom right corner of the pole schedule indicating the Caltrans Standard Plan version the proposed poles shall be built in compliance with.

5.5.4 The following note shall be placed near the pole schedule in its own box as to stand out from the rest of the plan sheet: "AS THE FIRST ORDER OF WORK, THE CONTRACTOR SHALL POTHOLE POLE LOCATIONS PRIOR TO ORDERING POLES. IF CONFLICTS ARE FOUND DURING POTHOLING, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE CITY ENGINEER. FAILURE TO COMPLY SHALL BE AT THE SOLE RESPONSIBILITY OF THE CONTRACTOR FOR ANY LOSS OF TIME, ADDITIONAL COST, AND DAMAGE."

5.6 Conduit and Conductor Schedule

5.6.1 All plans shall contain a conduit and conductor schedule and shall conform to CA-MUTCD Table 4D-106 (CA) Conductor and Conduit Schedule.

5.6.2 Conduit runs shall be identified by numbering enclosed by an equilateral triangle and shall start at the farthest conduit run from the controller corner and increase toward the conduit run between the controller cabinet and the adjacent pull box. This conduit run should have the highest identification number.

5.7 Detector Schedule

5.7.1 All plans shall contain a detector schedule.

5.7.1.1 For 332L cabinets using a C11 harness; detector number, phase, slot, and field terminal shall be provided in the detector schedule following assignments as shown below:

MODEL 332 W/C11 HARNESS DETECTOR ASSIGNMENT										ISOLATORS				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
IU	I1U PHASE 1 COUNT EXT T2-1/2	I2U PHASE 1 COUNT EXT T2-5/6	I3U PHASE 2 COUNT EXT T2-9/10	I4U PHASE 2 CALL T4-1/2	I5U PHASE 2 COUNT EXT T4-5/6	I6U PHASE 3 COUNT EXT T4-9/10	I7U PHASE 3 COUNT EXT T6-1/2	I8U PHASE 4 CALL T6-5/6	I9U PHASE 4 COUNT EXT T6-9/10	I10U PHASE 4 COUNT EXT T10-1/2	I11U SPARE T8-1	I12U PHASE 2 PED T8-4	I13U PHASE 6 PED T8-7	I14U FLASH SENSE T8-10
IL	I1L PHASE 1 COUNT EXT T2-3/4	I2L PHASE 1 COUNT EXT T2-7/8	I3L PHASE 2 EXT T2-11/12	I4L PHASE 2 CALL T4-3/4	I5L PHASE 2 COUNT EXT T4-7/8	I6L PHASE 3 COUNT EXT T4-11/12	I7L PHASE 3 EXT T6-3/4	I8L PHASE 4 CALL T6-7/8	I9L PHASE 4 COUNT EXT T6-11/12	I10L PHASE 4 COUNT EXT T10-3/4	I11L SPARE C-53 T8-2	I12L PHASE 4 PED T8-5	I13L PHASE 8 PED T8-8	I14L STOP TIME T8-11
JU	J1U PHASE 5 COUNT EXT T3-1/2	J2U PHASE 5 COUNT EXT T3-5/6	J3U PHASE 6 COUNT EXT T3-9/10	J4U PHASE 6 CALL T5-1/2	J5U PHASE 6 COUNT EXT T5-5/6	J6U PHASE 7 COUNT EXT T5-9/10	J7U PHASE 7 COUNT EXT T7-1/2	J8U PHASE 8 CALL T7-5/6	J9U PHASE 8 COUNT EXT T7-9/10	J10U PHASE 8 COUNT EXT T11-1/2	J11U SPARE C-54 T9-1	J12U EVA C-71 T9-4	J13U EVB C-72 T9-7	J14U RR1 C-51 T9-10
JL	J1L PHASE 5 COUNT EXT T3-3/4	J2L PHASE 5 COUNT EXT T3-7/8	J3L PHASE 6 COUNT EXT T3-11/12	J4L PHASE 6 CALL T5-3/4	J5L PHASE 6 COUNT EXT T5-7/8	J6L PHASE 7 COUNT EXT T5-11/12	J7L PHASE 7 COUNT EXT T7-3/4	J8L PHASE 8 CALL T7-7/8	J9L PHASE 8 COUNT EXT T7-11/12	J10L PHASE 8 COUNT EXT T11-3/4	J11L SPARE C-75 T9-2	IJ2L EVC C-73 T9-5	J13L EVD C-74 T9-8	J14L RR2 C-52 T9-11

5.7.1.2 For 336L cabinets; detector number, phase, slot, and field terminal shall be provided in the detector schedule following assignments as shown below:

MODEL 336L DETECTOR ASSIGNMENT										ISOLATORS				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
IU	1U PHASE 1 COUNT EXT	2U PHASE 2 COUNT EXT	3U PHASE 3 COUNT EXT	4U PHASE 4 COUNT EXT	5U PHASE 5 COUNT EXT	6U PHASE 6 COUNT EXT	7U PHASE 7 COUNT EXT	8U PHASE 8 COUNT EXT	RR1	EVA	EVB	2P PHASE 2 PED	6P PHASE 6 PED	FS FLASH SENSE
IL	1L PHASE 2 CALL	2L PHASE 2 COUNT EXT	3L PHASE 4 CALL	4L PHASE 4 COUNT EXT	5L PHASE 6 CALL	6L PHASE 6 COUNT EXT	7L PHASE 8 CALL	8L PHASE 8 COUNT EXT	RR2	EVC	EVD	4P PHASE 4 PED	8P PHASE 8 PED	ST STOP TIME

5.7.1.3 For Advanced Transportation Controller (ATC) cabinets; phase, detector number, input assembly, and field input terminal assembly shall be provided in the detector schedule. The template below shall be followed unless otherwise approved:

ATC DETECTOR SCHEDULE			
PHASE	DETECTOR #	INPUT ASSEMBLY	FITA*
1	PS**	1	FIT1-1,2
1	PS**	1	FIT1-6,7
2	PS**	1	FIT2-1,2
2	PS**	1	FIT2-6,7
2	PS**	1	FIT3-1,2
2	PS**	1	FIT3-6,7
2	PS**	1	FIT4-1,2
2	PS**	1	FIT4-6,7
3	PS**	1	FIT5-1,2

ATC DETECTOR SCHEDULE			
PHASE	DETECTOR #	INPUT ASSEMBLY	FITA*
3	PS**	1	FIT5-6,7
4	PS**	1	FIT6-1,2
4	PS**	1	FIT6-6,7
4	PS**	1	FIT7-1,2
4	PS**	1	FIT7-6,7
4	PS**	1	FIT8-1,2
4	PS**	1	FIT8-6,7
1/3	PS**	1	FIT9-1,2
1/3	PS**	1	FIT9-6,7
SPARE	PS**	1	FIT10-1,2
SPARE	PS**	1	FIT10-6,7
5	PS**	2	FIT1-1,2
5	PS**	2	FIT1-6,7
6	PS**	2	FIT2-1,2
6	PS**	2	FIT2-6,7
6	PS**	2	FIT3-1,2
6	PS**	2	FIT3-6,7
6	PS**	2	FIT4-1,2
6	PS**	2	FIT4-6,7
7	PS**	2	FIT5-1,2
7	PS**	2	FIT5-6,7
8	PS**	2	FIT6-1,2
8	PS**	2	FIT6-6,7
8	PS**	2	FIT7-1,2
8	PS**	2	FIT7-6,7
8	PS**	2	FIT8-1,2
8	PS**	2	FIT8-6,7
5/7	PS**	2	FIT9-1,2
5/7	PS**	2	FIT9-6,7
2 PED	PS**	1	FIT11-1,2
4 PED	PS**	1	FIT11-6,7
6 PED	PS**	1	FIT12-1,2
8 PED	PS**	1	FIT12-6,7
EVA	PS**	2	FIT10-1,2
EVB	PS**	2	FIT10-6,7
EVC	PS**	2	FIT11-1,2
EVD	PS**	2	FIT11-6,7

ATC DETECTOR SCHEDULE			
PHASE	DETECTOR #	INPUT ASSEMBLY	FITA*
RR1	PS**	2	FIT12-1,2
RR2	PS**	2	FIT12-6,7

*Field Input Terminal Assembly

**Plan Specific

5.7.2 Group each set of loops with a maximum of four loops to a set.

5.7.3 Each advance loop should be on its own separate detector channel. Special consideration should be given to approaches with three or more lanes.

5.7.4 For approaches with two through lanes and two front loops in each through lane, group the #1 and #2 lane front loops together. For approaches with three (and four) through lanes, group the #3 (and #4) lane front loops together.

5.7.5 A bicycle loop is not grouped with any other loops.

5.7.5.1 Bike box and two stage turn-box detectors will be on separate channels from vehicle detectors.

5.7.6 Left-turn lane loops are grouped together by lane.

5.7.7 Right-turn lane loops are grouped together by lane.

5.7.8 Sneak-by loops are not grouped together with any other loops.

5.7.9 Each set of loops is assigned to a separate detector channel or field input terminal assembly.

5.7.10 Loop sets are numbered beginning with the advance loops for phase two. Continue numbering towards the intersection, working from the curb toward center of roadway. Continue clockwise around the intersection.

5.7.11 When video detection is used, the designer shall note which slots the video card will occupy in the detector assignment table regardless of how many channels are on the card.

5.8 Declaration of Responsible Charge

The following note shall be placed on the Title Sheet and signed by the engineer-of-work. Include signature and dateline for endorsement by the engineer-of-work. The name, California registration number and expiration date of the engineer-of-work shall be printed below the line.

"I hereby declare that I am the engineer-of-work for this project and that I have exercised responsible charge over the design of this project as defined in Section 6703 of the Business and Professions Code, and the design is consistent with current standards. I understand that the check of project drawings and specifications by the City of San Diego is confined to a review only and does not relieve me as engineer-of-work of my responsibilities or project design."

6 Phasing

The engineer shall present the proposed phasing in the basis of design before preparing detailed design. For left turn phasing, the engineer shall complete Exhibit 4-16 from the NCHRP Report 812 Signal Timing Manual (Second Edition). The completed exhibit along with data and recommended left turn operation shall be included in the basis of design for City Engineer review.

6.1 Standard Intersection Phasing

6.1.1 Except within the Centre City area, phase two (2) should be on the major street (the street with the higher classification or higher volume of traffic) in the northbound or eastbound direction.

6.1.2 Within the Centre City area, phase two (2) is in the eastbound direction (westbound on westbound one-way streets). Use phase four (4) for a one-way northbound or one-way southbound street.

6.2 Left-Turn Phasing

Left turn phasing should be considered on a case-by-case basis. Left turn phasing should be installed along any street classified as Major or above, but not automatically on minor streets. On a minor street, use the criteria listed in Section 6.2.1 to determine if protected left-turn phasing is appropriate.

6.2.1 Protected Left-Turn Phasing (Fully Protected)

Fully protected left turn phasing may be installed where any of the following conditions exist:

6.2.1.1 50 or more left-turning vehicles per hour in one direction, and the product of the peak hour left-turning volume and the opposing-thru-plus-right-turning volume is greater than or equal to 100,000;

6.2.1.2 There is limited sight distance;

6.2.1.3 There have been five (5) or more left-turn accidents for any approach being considered (in one direction), which may have been susceptible to correction by the installation of left-turn phasing during any 12-month period during the last three years;

6.2.1.4 There are special factors, such as a high volume of trucks or buses or high pedestrian volumes, that would conflict with permissive left turns;

6.2.1.5 At closely spaced intersections to coordinate the left turn phase with the through phase of the adjacent signal to minimize queuing on the major street.

6.2.2 Protected-Permissive Left-Turn (PPLT) Phasing

PPLT phasing may be used as an alternative to fully protected left-turn phasing, However, where any of the following conditions exist use fully protected phasing:

6.2.2.1 There is limited sight distance in the direction of the opposing traffic stream;

6.2.2.2 There have been five (5) or more left-turn accidents for any approach being considered (in one direction), which may have been susceptible to correction by the installation of left-turn phasing during any 12-month period during the last three years;

6.2.2.3 The 85th percentile speed or posted speed limit (if not available, use design speed) of the opposing approach is 45 mph or higher;
6.2.2.4 There are two or more left turn lanes;
6.2.2.5 There are three or more opposing through lanes;
6.2.2.6 There are 50 or more school-age (K through 12) pedestrians crossing in the conflicting crosswalk in any one hour.

Notes:

- The City Engineer has final decision authority on the type of left-turn phasing to be implemented. The designer shall provide a comparison to the criteria above for the City Engineer to make a final decision.
- If fully protected left turn phasing or PPLT is used in one direction, the same must also be used on the opposing approach if left turns are allowed.
- Where PPLT is appropriate, 4-section vehicle heads with flashing yellow arrows shall be used.
- In high pedestrian areas, omitting the flashing yellow arrow during conflicting pedestrian phase activation should be considered.

6.3 Split Phasing

Split phasing should be considered where unusual geometric conditions result in opposing left turns overlapping with each other and/or at offset intersections. The engineer shall produce turn templates for all left turn movements to ensure there is no physical overlap of vehicle movements. Since split phasing may lengthen the cycle length, other factors to consider include pedestrian crossings on one or both split phases and the impacts a longer cycle length may have on a coordinated system. Split phasing is discouraged and should be used only when all other options have been exhausted. Otherwise, split phasing should be discouraged. Two conditions justify split phasing:

1. When physical overlap of left-turn movements exists. Lead/lag left-turn phasing should be considered first before split phasing.
2. When the same lane is needed to serve both left turns and through traffic due to high left-turn volumes and/or roadway width constraints.

If split phasing is used, the phases shall be assigned to an even and odd phase (i.e., 1 & 2 or 3 & 4), with the even-numbered phase assigned to the approach with the greater number of loop sets.

6.4 Right-Turn Overlap Phasing

Right-turn overlap phasing may be installed when all the following conditions are met:

6.4.1 Conflicting U-turns can be prohibited without affecting traffic circulation;
6.4.2 There are one or more exclusive right turn lanes;
6.4.3 Peak hour right-turn volume exceeds 200;
6.4.4 There is a similar volume of corresponding left turns.

6.5 Pedestrian Phasing

6.5.1 Accessible Pedestrian Signals (APS) push buttons shall be used for new signals and/or when upgrades are required for major modifications.

6.5.2 Every crosswalk at signalized intersections shall have a pedestrian phase unless otherwise approved by the City Engineer.

6.5.3 Typically, pedestrian phases should be assigned to match the corresponding vehicle phase (i.e. northbound vehicle is phase 2, then the pedestrian crossing to the right of that phase should be 2). More complex phasing may require pedestrians to be on a separate phase.

6.5.4 At T-intersections, pedestrian phases on all legs are preferred.

6.5.5 In cases of split phasing, usually the crosswalk on the right side of the lower traffic volume split approach is closed.

6.6 Leading Pedestrian Interval (LPI)

LPI shall be implemented for pedestrian crossings of major streets at intersections with minor streets when the minor street allows permissive left turns across the crosswalk. LPI may be implemented with adequate justification for other pedestrian crossings based on the operational characteristics of the intersection.

When LPI is required, the plans shall identify which pedestrian phases will receive LPI under the phase diagram. For new traffic signals, near-side and far-side, R3-1 NO RIGHT TURN, blank-out signs are required when LPI is implemented. Blank-out signs shall be activated during the LPI. Blank-out sign locations, wiring and operational description shall be included on the plans when blank-out signs are required.

7 Preemption and Priority

7.1 Railroad Preemption at Grade Crossings

When a grade crossing is located near a signalized intersection, traffic can sometimes back up onto the tracks, leading to a motorist being stopped on the tracks. At these locations, traffic signals may be interconnected with the railroad warning system and preempted. Preempted traffic signals are crucial for enhancing safety at intersections where roadways intersect with railway or light rail transit (LRT) tracks. Preemption is a traffic management strategy that coordinates traffic signals with grade crossing warning devices to ensure safe vehicular and pedestrian movement when trains approach crossings.

The California Public Utilities Commission (CPUC) has authority over rail crossings in California, including grade crossings. When a new grade crossing is constructed or an existing grade crossing is modified, the CPUC requires a Formal Application or GO 88-B to be completed. Construction of a new traffic signal within 200 feet of the tracks or modification to an existing traffic signal that is preempted is expected to go through one of these processes with the CPUC. The engineer should contact the CPUC to set up a diagnostic meeting at the beginning of the design effort anytime a traffic signal project is within 200’ of railroad tracks. Any traffic engineer intending to design such a signal

should be knowledgeable in the process and requirements of a Formal Application and/or GO 88-B. The following elements of work are anticipated to be completed or supported by the traffic engineer at a minimum:

- Diagnostic Team Identification.
- Field Diagnostic Meeting Participation
- Signage and Striping Plan
- Crossing Exhibit
- Preemption Calculation Measurement Exhibit
- Preemption Timing Work Sheet
- Traffic Signal Plan
- Preemption Interconnect Wiring Diagram
- Railroad Preemption Request Form
- Design-Vehicle Turning Template
- Temporary Traffic Control

The California Manual on Uniform Traffic Control Devices (CA-MUTCD), published by Caltrans, discusses minimum requirements for railroad preemption. Refer to Parts 4 and 8 in the latest edition. The design of railroad preemption includes details not covered in the CA-MUTCD. The references below offer additional considerations regarding railroad preemption.

- "Highway-Rail Crossing Handbook, 3rd Edition", FHWA-SA-18-040, Federal Highway Administration (FHWA), 2019.
- "The Preemption of Traffic Signals Near Railroad Grade Crossings, 2nd Edition, an ITE Recommended Practice", RP-025D-E, Institute of Transportation Engineers (ITE), 2021.
- "NCHRP Report 812: Signal Timing Manual, Second Edition", National Cooperative Highway Research Program (NCHRP), 2015.
- "Communications and Signals Manual of Recommended Practices", American Railway Engineering and Maintenance of Way Association (AREMA), 2020

When railroad preemption is proposed at a traffic signal, the designer shall prepare a concept of operations to present the following:

1. Stakeholder identification.
2. Operational needs
3. System requirements
4. System concept
5. Proposed technical solution
6. Proposed operations and considerations
7. Implementation strategy

Traffic signal plans prepared for locations that are preempted shall include the following at a minimum:

- Existing and proposed phase diagrams.

- Steady demand sequence for normal operations, preemption, and limited service.
- Part-time turn restriction (blank-out) signs locations (if used).
- Information on railroad interface panel (if used).
- Preemption interconnect wiring diagram.

The City will determine the delivery requirements as the review/approval process is initiated with the CPUC and the rest of the Diagnostic Team.

7.2 Signal Priority

Priority is an operational strategy to reduce the delay that select vehicles experience at traffic signals. Priority could be used for public transit vehicles or other classes of vehicles. It is facilitated by establishing a way for the vehicle to place a priority call with the traffic signal. It is achieved through the signal receiving the priority call and altering its timing to give priority. Two basic ways priority is enacted include reducing the red time (red truncation) or extending the green time (green extension) to allow the select vehicle to proceed through the signal with minimal delay. Priority is different from preemption because, depending on where the signal is in its cycle, when a priority call is received, the signal may or may not grant priority to the requesting vehicle.

Priority can be facilitated through various means, including, but not limited to, point-to-point wireless, Dedicated Short-Range Communications (DSRC), cellular communications, loop detectors, video/radar detection, etc. Designing new traffic signals or modifying existing traffic signals with priority must be closely coordinated with the City. Technology and operational practices are evolving, and the technical/operational solutions implemented may differ from what is currently deployed.

When signal priority is proposed at a standalone signal or corridor, the designer shall prepare a concept of operations to present the following:

1. Stakeholder identification.
2. Operational needs
3. System requirements
4. System concept
5. Proposed technical solution
6. Proposed operations and considerations
7. Implementation strategy

Traffic signal plans shall show the location and type of all signal priority equipment and summarize the operations strategy from the city-approved concept of operations. If communications media (wireless, cellular, fiber, etc.) is installed between signals to achieve the intended operations, a separate communications plan with network architecture, plan views, and splice diagrams (if applicable) shall be provided.

8 Traffic Signal Controller Cabinet

Traffic signal cabinets shall be the type identified in the Whitebook at the time of design unless otherwise approved by the City Engineer. For major traffic signal modifications, any traffic signal cabinet found to be in poor condition shall be replaced. The final decision on the type of cabinet to be installed will be made by the City Engineer.

8.1 Traffic Signal Cabinet Location

Locate traffic signal controller cabinet on the approach side of the minor street as close as possible to the curb return so all movements are visible from the cabinet (this is the safest location to minimize possible knock-overs). The cabinet should be oriented so that a person facing the signal heads will also face the front panel of the controller. Doors should be opened away from the streets. All new traffic signal cabinets should be tested by Street Division's Traffic Signal Maintenance staff prior to installation.

When replacing an existing cabinet with a new cabinet, the new cabinet may be placed on the existing foundation if the following criteria are met:

1. The existing foundation and anchor bolts are found to be in good condition.
2. The existing conduit runs through the foundation will have an acceptable percentage of fill following the proposed improvements.
3. The location of the existing foundation is acceptable and is not impacted by the proposed improvements.

Conduit entry into the traffic signal controller cabinet via type LB conduit body or other methods will not be acceptable for adding additional conduit capacity. If existing conduits do not have adequate capacity, a new foundation should be provided for the new cabinet.

8.2 Traffic Signal Controller

All new traffic signal controllers should be tested by Street Division's Traffic Signal Maintenance staff prior to installation. All new traffic signal controllers shall be 2070LX with Intelight Q-Free MAXTIME software. Any new or modified traffic signal shall be equipped with a controller that meets the City's current standard in the latest revision of the WHITEBOOK.

8.3 Conflict Monitor

The City's standard conflict monitor for a 332L/336L cabinet is an Eberle Design Inc. (EDI) 2010 ECLip, and for an ATC cabinet is a CMUip-2212 HV. Any new or modified traffic signal shall be equipped with a conflict monitor that meets the City's current standard per the latest revision of the WHITEBOOK.

8.4 Emergency Vehicle Preemption Card

The City's standard emergency vehicle preemption card is the Opticom 764 Phase Selector. Any new or modified traffic signal shall be equipped with an emergency vehicle preemption card that meets the City's current standard in the latest revision of the Whitebook.

9 Battery Backup

Battery backup systems shall be provided for the following critical locations:

1. Signals with railroad preemption
2. Signals with a speed limit greater than 50 mph
3. Signals with high accident rate
4. Intersections difficult to flag or require multiple flaggers (non-Routine roadway configurations/geometry, SPUIs, multi-lane approaches, etc.)
5. Signals with high volumes (freeway type off-ramps, major roadways, etc.)
6. Signals with frequent power outages
7. Signals located at schools

Battery backup systems shall be housed in separate side-mounted cabinets adjacent to the traffic signal cabinet. The battery backup system shall be equipped with an emergency bypass switch.

10 Traffic Signal Poles and Mast Arms

Traffic signal pole placement is the most critical element of traffic signal design. The engineer shall take all necessary precautions to ensure each traffic signal pole is placed to avoid conflicts to the greatest extent possible. It is imperative that the engineer field verify the placement of each pole prior to City submittal and check against all available utility and roadway as-built data. Utility potholing shall be completed during design if a critical utility is believed to be in the vicinity of a proposed pole. In special circumstances, potholing of traffic signal pole foundations during design may be required if pole placement is found to be challenging. Plans shall be submitted to utility companies for conflict check before any traffic signal plans are approved by the City Engineer.

10.1 Signal Poles

10.1.1 Poles shall be placed on opposite sides of the curb return (see ES-4C of the Caltrans Standard Plans for typical locations of signal pole placement).

10.1.2 All poles must meet the wind load specified in the latest revision of the State of California Standard Plans.

10.1.3 No standards shall be placed within the limits of the pedestrian ramps, including the ramp slopes. The standards shall be placed to provide a clear pedestrian path of travel to conform with current Americans with Disabilities Act (ADA) requirements.

10.1.4 All traffic signal plans shall indicate required traffic signal pole locations as referenced from Beginning of Curb Return (BCR), End of Curb Return (ECR), and curb face. When there is no curb return to reference, the centerline station and offset shall be provided for reference.

10.1.5 Foundations and bottom of pole circumference for all existing poles shall be shown on the plans. For proposed poles, the base plate or cover, foundation, and bottom of pole circumference shall be shown on the plans.

10.1.6 When determining the location of signal poles in the field, the engineer shall confirm minimum offsets to existing/proposed utility facilities with each affected utility company. Conflicts with basement shall be identified and minimum offsets established.

10.1.7 Provide signal poles with an "arm loading case +1" that accounts for all signal heads and signs to be mounted on the mast arm. The appropriate number of primary signal heads shall be provided per CA-MUTCD Table 4D-1, latest edition.

10.1.8 Where modifications will leave holes in existing poles, the holes shall be repaired pursuant to State of California Standard Specifications, Section 56-3.01C(1).

10.2 Mast Arms

10.2.1 Mast arms shall be provided for all approaches unless approved by the City Engineer.

10.2.2 If fully protected left-turn phasing is provided:

10.2.1.1 One left-turn lane: the mast arm shall be long enough to align the left-turn signal head as close as possible to the center of the left-turn lane.

10.2.1.2 Two left-turn lanes: the mast arm shall be long enough to align the left-turn head with the lane line between the two left-turn lanes.

10.2.1.3 Three left-turn lanes: the mast arm shall be long enough to align one left-turn head with the center of the number one left-turn lane and a second left-turn head shall be provided to align with the line between the number 2 and number 3 left-turn lanes.

10.2.3 If protected-permissive left turn phasing is provided, the mast arm shall be long enough to align the left-turn signal head as close as possible to the center of the left-turn lane.

10.2.4 Avoid signal poles in center medians (use only on very wide streets where signal mast arms are not long enough to reach left-turn lanes).

10.3 Signal Heads

Signal heads shall be evaluated for any signal modification and deficient heads shall be replaced. Signal heads that do not meet the requirements set forth below or in the current CA-MUTCD shall be replaced. Signal heads that are not located in the correct location or are not visible shall be relocated, and/or obstructions removed.

10.3.1 Vehicle Heads

10.3.1.1 All new vehicle indications shall be 12-inch Light Emitting Diode (L.E.D.) type.

10.3.1.2 A minimum of two vehicular heads that are visible to motorists at the limit line shall be provided for all phases.

10.3.1.3 New signal heads shall be equipped with black housing, visors, and black backplate. Yellow retroreflective borders may be required at City selected locations.

10.3.1.4 Primary Vehicle Head Placement: The minimum number of primary signal faces shall be provided for each approach as shown on Table 4D-1 in the current CA-MUTCD. Primary signal faces shall meet the requirements set forth in Figure 4D-4 in the current CA-MUTCD.

10.3.1.5 Line of Sight: Vehicle head visibility shall meet the requirements set forth in Table 4D-2 in the current CA-MUTCD. When an approach does not meet these requirements, a SIGNAL AHEAD (W3-3) warning shall be installed on the approach and SIGNAL AHEAD pavement legends may be installed for each lane. In some instances, the City may require flashing beacons for the SIGNAL AHEAD sign. Additional signal heads should be considered on the nearside traffic signal pole, mounted at 17 feet, or rear-facing on the nearside mast arm as applicable when line of sight for approaching traffic requires. The addition of nearside heads to not count towards the minimum identified in part 2 above.

10.3.1.6 Mounting Height: Vehicle head mounting height shall conform to the standards set forth in the latest edition of Caltrans Standard Plans. When the mounting height differs from this standard it shall be identified on the plan.

10.3.1.7 Vehicle Head Alignment: The number of overhead mounted signal heads shall conform to the alignment and configuration shown in Figures 4D-1 in the latest CA-MUTCD. Figures 4D-6 through 4D-20 in the latest CA-MUTCD may be reference for signal head placement. Configuration and placement of vehicle heads may be adjusted by the City during review.

10.3.1.8 Split Phase: If split-phase, the mast arm indication should be 4-section, with the circular green and green arrow indicated simultaneously with a MAS-4C mounting. The far left signal head should be 3-section and consist of a red arrow, yellow arrow, and green arrow.

10.3.1.9 Left-Turn Heads: Protected left-turn signal heads shall be 3-sections and consist of all left arrows. Protected-permissive left turn signal heads shall be 4-sections and consist of red arrow, yellow arrow, flashing yellow arrow, and green arrow. Left turn heads shall be located over the left turn lane(s).

10.3.1.10 Right-Turn Overlap: Right-turn overlap signal heads shall be 5-sections and consist of red ball, yellow ball, green ball, yellow arrow, and green arrow mounted on the far-right pole, and a second head on the near right pole. A right red arrow to supplement a “NO RIGHT TURN ON RED” sign should not be installed with right-turn overlap phasing.

10.3.1.11 T-Intersection: The designer shall propose one of the following two options for City approval:

10.3.1.11.1 Option 1: Use circular indications on far left pole, on mast arm, and on the far-right pole; allow pedestrian crossings on both sides of the stem of the T-intersection.

10.3.1.11.2 Option 2: Use all left arrows on the far left pole; at the end of the mast arm use a 4-section head; use all circular indications on the far-right pole; prohibit pedestrian crossing on the left side of the stem of the T-intersection if approved by City. Option 2 should only be used if option 1 is not feasible.

10.3.2 Programmed Visibility Heads

Programmed Visibility (PV) shall be considered for any approach with a nearby signal within 300'. The City Engineer shall approve the use of PV Heads based on their proximity to nearby signals and visibility to nearby conflicting signal displays. Full-head programmable heads and louvered heads may be considered.

10.3.3 Bicycle Heads

Bicycle heads shall be used when separate bicycle phasing is required. Bicycle heads shall be 8-inch L.E.D type with yellow housing, yellow visors, and yellow backplate. Bicycle heads shall be configured as shown in Figure 4D-112 (CA) in the current CA-MUTCD.

10.3.4 Pedestrian Heads

All pedestrian indications shall be L.E.D. countdown type.

10.4 Emergency Vehicle Preemption Detectors

10.4.1 Provide EVP for all approaches (except minor driveways).

10.4.2 Mount single-direction and/or bi-directional dual channel EVP detector near the end of the mast arm, but not on the signal head.

10.5 Safety Lighting

Refer to the current City of San Diego Street Design Manual and the Caltrans Traffic Operations Manual (latest edition), Chapter 205, Part 1 for safety lighting requirements.

10.5.1 Safety light mast arms shall be 15 feet long.

10.5.2 The luminaire make and model shall be provided at the bottom right of the pole schedule.

10.5.3 Signal plans shall show average maintained foot-candles (mfc) in the center of the intersection. The designer shall calculate the center mfc and show it on the plan.

10.5.4 Provide a minimum of 1.0 mfc and a maximum of 2.0 mfc. Try to achieve 1.4 mfc or brighter on 4-lane streets and 1.2 mfc on industrial/commercial collector streets.

10.5.5 Provide a minimum of 0.15 mfc in the crosswalks.

10.6 Street Name Signs

Street name signs shall be installed at all signalized intersections. Street name signs shall be per City standards prior to signal turn on.

11 Push Buttons

11.1 Accessible Pedestrian Systems (APS) push buttons shall be installed for new traffic signals and major traffic signal modifications with pedestrian phasing unless otherwise approved. Pedestrian push buttons should be 2-inch minimum (50 mm) in diameter complying with ADA standards.

11.2 Push buttons shall be installed per the City, Access Board, and the requirements below. When possible, the push buttons should be installed on traffic signal poles. When pole

placement does not meet push button placement requirements, the use of pedestrian push button posts shall be considered. The City Engineer has final approval of all push-button locations.

11.3 Placement: Push button location shall conform with Figure 4E-3 of the latest CA-MUTCD and be placed between 1.5 feet and 6 feet from edge of the curb, no further than 10 feet. With a lateral distance from crosswalk of no more than 5 feet. Push buttons shall be placed adjacent to a level landing area.

11.3.1 For single ramps, one PPB post may be used, but an adapter mounting shall be used. APS push buttons shall not be mounted upside down.

11.3.2 For directional ramps, two Pedestrian Push Button (PPB) post shall be used and placed as shown in Figure 4E-4 of the latest CA-MUTCD.

11.4 Height and Reach: Push button height shall conform with the latest United States (U.S.) Access Board guidance and be no greater than 46 inch as measured from the level landing area. Push button poles shall be placed such that no more than 24 inch reach is necessary to push the button from the level landing area.

11.5 Push Buttons on Signal Poles: Pole and push button placement shall maintain clear ground space for either a parallel or a forward approach to the pedestrian push-button.

11.5.1 For large mast arm poles and decorative poles extension brackets may be required to achieve minimum reach distance requirements.

11.5.2 The signal poles should be placed so as to provide a clear ground space in front of each pedestrian push-button. This clear ground space should conform to current ADA requirements.

11.5.3 Where a forward approach is provided, the push button should abut and be centered on the clear ground space.

12 Detection

Loop detectors shall be used unless special conditions exist and are approved by the City Engineer.

- Consider video/radar detection for approaches with decorative pavements, bridge decks, or other special circumstances. Mount cameras on the mast arm or luminaire arm. When a video/radar detection system is used for advanced detection, the detection zone placement shall meet setback requirements in Section 10.3 and not exceed the manufacturer's maximum recommended distance from the detection device. Note that curves on the road, trees, or other site conditions may affect the video detection system's ability to detect approaching vehicles.
- Two loops maximum can be shown per each sawcut line on the traffic signal plan.
- Pull box shall be installed in line with conduit stub-out to detector handhole. Conduit stub-out shall be placed no further than 10 feet from the first loop. Long saw cuts will not be allowed.

12.1 Limit Line Detection

12.1.1 All vehicle detector loops should be circular Type E (6 feet diameter) EXCEPT at the limit line where Type F loops per ES-5B in the most current Caltrans Standard Plan should be used on all traffic lanes.

12.1.2 If the approach has advance detection, install two loops per lane spaced 10 feet apart from edge to edge starting at the limit line.

12.1.3 Install four loops spaced 10 feet apart from edge to edge at the limit line in left-turn lanes and for approach lanes without advance detection.

12.1.4 Right-turn-only lanes will have a loop configuration the same as the adjacent through lane.

12.1.4.1 Wide thru lanes (>22') shall have a separate loop to detect right-turning vehicles at the right edge of the through lane.

12.1.5 On the minor street, if the distance between the limit line and the major street curb line is 16' or greater, an additional sneak-by loop should be installed that is 4' back from major street curb line. The lateral placement is dependent on the anticipated position of the vehicle attempting to turn right on red. The additional sneak-by loop should not be placed within 6' of any other loop. It may be placed in the crosswalk.

12.1.5.1 If a right turn pocket exists on the minor street, then the additional sneak-by loop should be on a separate channel.

12.1.5.2 If there is a sneak-by loop at the limit line, then the additional sneak-by loop can be on the same channel.

12.2 Bicycle Detection

12.2.1 All bicycle lane detector loops should be Type Q per Caltrans Standard Plan ED-5B, and a detail with dimensions shall be provided on the plan. Width of Type Q loop varies: 6 inch to 12 inch inside bicycle lane line and 6 inch to 12 inch outside gutter or other channelization lines, providing a 3-foot wide to 4-foot-wide loop.

12.2.1.1 If the phase is on recall, install a 6-foot-long Type Q loop, 44 feet in advance of the limit line in the bicycle lane on recall phases.

12.2.1.2 If the phase is not a recall phase, install a 6-foot-long Type Q loop at the limit line.

12.3 Advance Detection

12.3.1 Install advance detection on all approaches with an 85th percentile speed or posted speed limit greater than 30 mph (if not available, use design speed).

12.3.2 Install advance loops at high-speed T-intersections: Continue designing these locations with advance loops, even though the 85th percentile approach speed data is only about 25 mph, since advance loops may be desired for extending the green signal at locations where the heaviest amount of traffic is on the base portion of the tee. The location of these advance loops should be based on existing speed survey data for the road segment in question, unless otherwise directed by the City Engineer.

12.3.3 Distance from limit line to advance detection varies with approach speed as shown in the following table (assuming a deceleration rate of 10 fps and one second perception-reaction time):

Table x: Advance Detection Zone Placement

Approach Speed (MPH)*	Distance from Limit Line (ft)
30	140
35	185
40	230
45	285
50	345
55	405
60	475

*Use higher of 85th percentile speed or *Posted speed when 85th percentile speed is available*.

12.3.4 If the approach speed is unknown (i.e., on a new street), assume 45 mph for 4-lane streets and 55 mph for 6-lane streets.

13 Pull Boxes

13.1 All pullboxes (box, lid, extension) shall be concrete and size No. 6 unless otherwise indicated. Pullbox covers shall be stamped "Traffic Signal".

13.2 Pull box lids shall not be bolted down.

13.3 Pull boxes shall not be placed: in paved shoulder, in traveled way, in driveways, within one foot of a sidewalk access ramp or flares. Pull boxes shall be located beyond the door opening paths of traffic signal controller cabinets and service cabinets.

13.4 Pull boxes should not be placed in medians except for approaches that are 6-lanes or more. Median pull boxes would be used for left-turn lane loop detectors.

13.5 If placing pull boxes within the traveled way is unavoidable, traffic-rated pull boxes shall be used.

13.6 Pull boxes shall be spaced at intervals of 200 feet or less.

13.7 A No. 5 pull box may be used for advance loops.

13.8 Electrical power pull box shall be No. 5 and shall be placed no more than 20 feet from the service pedestal.

14 Conduit

14.1 Conduit shall be no smaller than 2-inch. All legs of the intersection shall have two 3-inch conduits crossings installed (one spare with mule tape) for new signal builds. Street crossing and conduit containing traffic signal cable shall be two 3-inch minimum and shall

contain “Pull Tape” per State of California Standard Specification 86-1.02D(2) and a No. 8 XHHW-2 stranded insulated green trace wire.

14.2 Three 3-inch conduits minimum shall be installed from the controller cabinet base to the adjacent pull box for traffic signal cable and conductor. Communications and service conductors should enter the controller cabinet base in dedicated conduits, separate from the three 3 inch.

14.3 Power and communications cables shall be run in separate conduits throughout the intersection. Safety light conductors may be run in the same conduit as traffic signal cable and other conductors.

14.4 Conduit fill shall not exceed the (National Electric Code) NEC maximum of 40% for existing conduits. For new conduit 26% fill shall not be exceeded.

14.5 Conduit shall be installed to a depth of not less than 18 inches below finished grade.

14.6 Conduit shall be laid out perpendicular to the curb line of the street crossing under the center of the crosswalk where practical.

15 Conductors and Wiring

15.1 All traffic signals shall be wired with traffic signal cable. Any signal being modified with existing phase wire shall be rewired with traffic signal cable.

15.2 Any conduit run on an existing signal where new cable or wire is being pulled shall be field verified to confirm the cable will pull. Any conduit that is frozen shall be replaced to pull the new cable or wire.

16 Traffic Signal Communications

The design of traffic signal communication systems is a vital component of modern transportation infrastructure, particularly in San Diego, where complex traffic management challenges exist. These systems support both current and emerging technologies, including connected vehicles, adaptive signal control, and smart city integration. Developing effective communication systems for traffic signals is essential to address the intricate traffic management needs of the region.

Any newly constructed or modified traffic signal located within 1,600 feet of an adjacent signal must be interconnected using Ethernet communications. Additionally, any adjacent traffic signal within 3,000 feet should be considered for interconnection via Ethernet communications. The City Engineer will have the final say on whether interconnecting adjacent signals is necessary.

Communications between traffic signals can be established through various methods, including fiber optic cables, wireless radios, copper cables, and cellular modems. The City prefers to interconnect traffic signals using fiber optic cables that transmit Ethernet communications. Unless approved otherwise by the City Engineer, traffic signal interconnections should utilize fiber optic cables in dedicated pathways.

16.1 Traffic Signal Interconnect Plans

16.1.1 Traffic signal interconnect design shall be presented on a separate plan at 1 inch = 40 feet scale with 1 inch = 10 feet blowouts provided as needed. The plans will generally include the following a minimum and additional detail may be required at the discretion of the City Engineer:

a. General notes
b. Details
c. Network Architecture
d. Plan Views
e. Splice Diagrams/Connection Details

16.2 Traffic Signal Interconnect Conduit

16.2.1 All interconnect conduits shall be 3-inch minimum. All conduits shall contain "Pull Tape" per State of California Standard Specification 86-1.02D(2) and a No. 8 Cross-Linked Polyethylene High Heat-Resistant Water-Resistant (XHHW-2) stranded insulated green trace wire.

16.2.2 Conduit entry into pull boxes and vaults shall have a minimum bending radius of 36 inches. When fiber optic cable is installed in existing conduit, conduit sweeps into pull boxes shall be replaced if a minimum bending radius of 36 inch is not met.

16.2.3 Conduit shall be installed to a depth of not less than 18 inches below finished grade.

16.2.4 Conduit shall be laid out perpendicular to the curb line of the street crossing under the center of the crosswalk where practical.

16.3 Traffic Signal Interconnect Pull Boxes/Vaults

16.3.1 Traffic signal interconnect vaults and pull box covers shall be marked "TRAFFIC COMMUNICATION."

16.3.2 Boxes/vaults shall be installed between 800 feet (minimum) and 1,000 feet (maximum) apart unless geographical or site conditions necessitate a shorter run.

16.3.3 Signal Interconnect Cable (SIC) conduit shall be installed in pull boxes using 45-degree, UL approved elbows. These elbows shall be placed as far apart in the pull box as possible, oriented toward the cable, and offset to one side to facilitate cable pulling and coiling.

16.3.4 Approximately 200 feet of slack shall be coiled inside each vault box (12 and 144 SMFOC). Approximately 50 feet of slack shall be coiled inside each No. 6 pull box with an extension.

16.4 Closed Circuit Television Cameras (CCTV)

16.4.1 Use of CCTV Cameras shall conform to City of San Diego standards.

17 Pedestrian Crosswalks and Limit Lines

17.1 Every marked crosswalk at a signalized intersection should be a continental crosswalk as per City Standard SDM-116.

17.2 Every crosswalk should have pedestrian phasing or should be closed by pedestrian barricades.

17.3 At T-intersections, crosswalks at all legs are preferred.

17.4 Marked crosswalks should be minimum 10 feet wide unless circumstances warrant a different width (e.g., in the vicinity of the Ballpark area where an extremely large numbers of pedestrians are present).

17.5 Crosswalks should connect straight from pedestrian ramp to opposite pedestrian ramp, without turns, bends, or median noses inside the crosswalk.

17.6 In cases of split phasing, the crosswalk on the right side of the lower traffic volume split approach may be closed.

17.7 At all marked crosswalks, a limit line should be installed 4 feet in advance of the marked crosswalk. Limit lines may be pulled back further than 4 feet from crosswalks to facilitate turning movements, to line up with median endpoints, and other reasons.

17.8 Limit lines shall be perpendicular to the vehicle lanes. At skewed intersections, the limit lines may be staggered to achieve a perpendicular orientation.

18 Signage and Striping

18.1 An R13A (CA), NO RIGHT TURN ON RED (symbolic no right turn) should be used to prohibit a right turn on red. If used, the NO RIGHT TURN ON RED sign should be installed near the appropriate signal head on the near and far side of the intersection.

18.2 When LPI is used, R3-1, NO RIGHT TURN, blank out signs should be posted on the near and far side to be activated with LPI, for new build and major modifications. Unless R13A, NO RIGHT TURN ON RED, is posted.

18.3 Blank-out R3-1, NO RIGHT TURN, signs may not be used in lieu of a traffic signal phase, may not be used at unsignalized locations or HAWKS, and may not be used in conjunction with a green light unless the usage is specified in the MUTCD.

18.4 Intersection Lane Control (R73) signs on signposts should not be used at signalized intersections in lieu of mast arm-mounted lane control signs unless approved by the City Engineer.

18.5 At T-intersections, if used, bicycle lanes should not be placed at the top of the T within the intersection.

18.6 Guide stripes through intersections shall be solid for turning movements and dashed for through movements.

18.7 No striping or pavement markings shall be placed within four feet of a marked crosswalk.

18.8 Sight distance triangles should remain clear to allow for vehicles to turn right on red based on the current AASHTO's "A Policy on Geometric Design of Highway and Streets" case B2 for all approaches. If minimum sight distance cannot be met, an R13A (CA), NO RIGHT TURN ON RED (symbolic no right turn) should be used.

18.9 Install minimum red curb as follows: 30 feet in advance of all limit lines; 20 feet beyond the PCR on the departure side; at the top of a "T" intersection; and in the interior of staggered intersections.

19 Salvaged Equipment

19.1 Salvaged equipment not reused on the Project shall be delivered to the General Services Transportation Department, Street Division, Electrical Section at Chollas Operations Station, 2781 Caminito Chollas, San Diego, CA, and stockpiled. Delivery time and location shall be coordinated with the City forty-eight (48) hours in advance at Telephone No. (619) 527-8031.

19.2 Obtain receipts for all salvaged equipment.

19.3 The CONTRACTOR shall lawfully dispose of all unusable equipment at their expense.

20 Additional Considerations

20.1 Driveways

When driveways are located within a signalized intersection engineering judgement should be used to determine the level of control that is necessary. The following at a minimum should be considered:

1. Signalization of the driveway approach.
2. Installation of flashing beacons pointing toward the driveway approach.
3. Right turn-out and/or in turn restrictions.

The engineer shall provide justification for the selected control in the basis of design by summarizing the driveway characteristics, volumes, and other conditions that lead to their operational recommendation.

20.2 Pedestrian Hybrid Beacon (HAWK)

20.2.1 If a Pedestrian Hybrid Beacon (HAWK) is at an intersection, both poles should be placed on the same side of the intersection as the crosswalk.

20.2.2 Pedestrian Hybrid Beacons shall not be modified to include additional vehicular phases, such as for side streets or left turns.

20.2.3 APS push buttons shall be used for all crosswalks.

20.2.4 Directions provided in previous sections regarding traffic signal communications for traffic signals applies to HAWK signals.

20.3 Bikeway/ Right-Turn Conflicts

20.3.1 Conflicts between bikeways and right-turns may be addressed any of these ways: 1) curbside bikeway replaced by dashed markings on approach to intersection, right turners merge into dashed area; 2) curbside bikeway merges to the left, is placed between right turn lane and through lane; 3) bikeway remains to the right of right turn lane, separate and exclusive traffic signal phases control right turn and bike movements; 4) other approved treatment.