

Memorandum

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To: DISTRICT DIRECTORS
DEPUTY DIRECTORS
DIVISION CHIEFS

Date: November 9, 2018

From: *for* 
PHILIP J. STOLARSKI
Acting Chief
Division of Design

Subject: **DESIGN INFORMATION BULLETIN (DIB) 92**

DIB 92 "Single Point Interchange Guidelines," is now available on the Division of Design website: www.dot.ca.gov/design/stp/dib/dib92.pdf. For projects where the project development process has started, follow the procedures in the Highway Design Manual (HDM) Index 82.5 "Effective Date for Implementing Revisions to Design Standards."

DIB 92 supersedes the guidance issued on June 15, 2001, "Single Point Interchange Planning, Design, and Operations Guidelines." The following is a summary of updated features:

- Consistent with the AASHTO "A Policy on Geometric Design of Highways and Streets".
- Clarification provided regarding design, operations, and maintenance aspects.
- Concepts related to pedestrian and bicycle accommodations.
- Inclusion of various single point interchange photo examples and updated figures.

Project specific applicability and questions should be referred to the Division of Design, Project Delivery Coordinators.

c: David Cordova, Office of Standards and Procedures
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DESIGN INFORMATION BULLETIN NUMBER 92

Department of Transportation
Division of Design
Office of Standards and Procedures

SINGLE POINT INTERCHANGE GUIDELINES

APPROVED BY:



for PHILIP J. STOLARSKI
ACTING DIVISION CHIEF
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1.0 INTRODUCTION

These guidelines have been prepared as a comprehensive document covering design and operations of Single Point Interchanges (SPIs). This guidance is to be used as a supplement to the Project Development Procedures Manual (PDPM), Highway Design Manual (HDM), California Manual of Uniform Traffic Control Devices (CA MUTCD), Traffic Safety Systems Guidance, Ramp Metering Design Manual (RMDM) as well as all other current applicable California Department of Transportation (Caltrans) standards and guidelines. Design Information Bulletin (DIB) 92 provides a guide for the engineer to exercise sound judgment consistent with the project development philosophy discussed in Chapter 80 of the HDM. The HDM design criteria applies to SPIs, except as noted in this DIB.

The SPI is identified as a Type L-13 interchange in HDM Index 502.2(e). See Photo 1 as an example.



Photo 1: SPI Example. SR-99 and Arch Rd.

2.0 PLANNING, APPLICATION, AND APPROVAL OF SINGLE POINT INTERCHANGES

2.1 Approval of SPIs

As with all interchange types, HDM Index 503.2 applies to SPIs. In addition, the PDPM Chapter 27 “Access Control Modification” applies to SPIs.

2.2 Geometric Considerations

The SPI proposal should be analyzed and compared to other conventional interchange types consistent with

the procedures of the PDPM. The SPI alternative should be compared to the L-2 spread diamond, L-9 partial cloverleaf and L-1 tight diamond interchange types. The Diverging Diamond Interchange (DDI) should also be considered according to the guidance in DIB 90. The consideration of the SPI alternative should be based on the discussions in these guidelines in order to select the best overall interchange configuration. See HDM Topic 503 for more information.

SPIs include an intersection that is larger than other intersections at interchanges in order to accommodate a single traffic signal system for left-turn movements as well as the through movements. If appropriate, considering all constraints and need for capacity, the SPI can be designed with a crossing distance of approximately 85 feet (measured from the stop bar to the middle of the far lane for turning vehicles) in order to allow bicyclists to cross within a single signal phase, see Figure 1. However, this crossing distance may not be practical in some cases where higher volumes dictate more lanes and a larger SPI. Most SPI intersections operate with a three-phase signal. Turn lanes are separated from each other at exit ramps. Due to its unique design, certain geometric features are more critical to the SPI's operation than to other types of interchanges. Among those features are crest vertical curves, skew angles, intersection length, and large radius sweeping left-turn movements. See Section 3.0 "Geometric Design" for a detailed discussion of these design items.

The SPI is not a typical interchange design. Geometric design characteristics combined with the traffic signalization design techniques can produce an efficient interchange, as has been experienced around the State and elsewhere.

2.3 Right-of-way Considerations

The available right-of-way (R/W) is an important consideration in selecting the appropriate interchange type. HDM Index 502.2 provides a discussion on interchange types, including the advantages of safety, capacity, and flexibility while still meeting driver expectation. In situations where R/W is restrictive, the most common interchange considered is the tight diamond; however, the SPI may also be an appropriate alternative. The R/W requirements for SPIs and tight diamond interchanges are similar. Other options, such as a roundabout at the ramp termini and a DDI are emerging as alternatives where R/W is constrained. See HDM Index 405.10 and DIB 90 for more information.

2.4 Capacity

When the SPI configuration is unconstrained by the local road system, it has the capability of handling larger volumes of traffic than the tight diamond interchange. However, in urban situations the local road system is often the controlling factor for overall system capacity. The following constraints influence capacity and the selection of an SPI:

2.4.1 Intersection Size

The size of the SPI intersection necessitates a longer traffic signal clearance interval for all movements than a conventional diamond interchange. The all-red clearance interval contributes to the clearance lost time of the signal timing cycle, which reduces capacity and efficiency. The overall travel time through an SPI may be no more than a conventional interchange which typically has two traffic signals, one on each side of the freeway. This needs to be considered when choosing a range of alternative interchange types.

2.4.2 Adjacent Intersections

The single traffic signal of the SPI allows for greater spacing to adjacent nearby intersections. The proximity of adjacent intersections and driveways to ramp termini is a critical factor in the operation of any interchange. Under moderate to heavy traffic demands, SPIs typically require longer signal cycle lengths to maximize operations than a signal at a conventional diamond interchange. When an SPI configuration is used, intersection spacing becomes a more critical feature as all stopped traffic must be stored between the near stop bar and the adjacent intersection. See HDM Index 504.3(3) “Location and Design of Ramp Intersections on the Crossroads,” and 504.8 “Access Control” for more information regarding traffic operations and other considerations with respect to ramp and intersection spacing.

2.4.3 Left-Turn Movements

SPIs are generally more efficient than tight diamond interchanges in handling large volumes of left-turning traffic where it can be accommodated by the receiving roadway. Tight diamond interchanges may perform similar to SPIs when handling large through volumes on the local streets. A comparison of traffic delay between the SPI and the combined two signal system of a tight diamond interchange should be analyzed. SPIs are more efficient for high left-turning truck volumes due to their large left-turn radii. SPIs may not operate efficiently when current left-turn movements are unbalanced. Left-turn pockets from the local road to the SPI entrance ramp will have much more storage capacity than a typical diamond interchange, which may be constrained by the intersections on both sides of the freeway structure.

2.4.4 Storage Capacity on Metered Ramps

An SPI can typically deliver significantly more left-turn traffic volume to entrance ramps. Therefore, adequate storage capacity should be provided on metered ramps. See the Ramp Meter Design Manual for additional information. A double left-turn lane design should be considered for future storage and traffic volume efficiency if it presently is not warranted.

2.4.5 Bicycles

A local agency or Caltrans District planning document that identifies the local street to include a bikeway through the interchange may affect the selection of interchange configuration. Planning efforts should include outreach to local agencies. Due to the speed difference between bicycles and motor vehicles, the capacity and operation of SPI intersections may diminish the advantages of an SPI over another interchange alternative. The required green and all-red clearance intervals necessary for a bicycle to clear most SPI intersections are substantially longer than what is needed for a motor vehicle. The higher volume of bicycles near schools, transit centers and other land uses that typically attract bicycles may render an SPI alternative less desirable. Needs of all users may make signal timing and operations somewhat less efficient. This situation may also be common with other interchange alternatives, especially those with multiple signal systems. Section 3.8 “Pedestrians and Bicyclists” discusses bicycle accommodations through SPI intersections.

2.4.6 Pedestrians

Since the traffic signal at the SPI is timed to move motorists efficiently through the intersection, pedestrians may only cross a portion of the intersection in a single cycle. It may take a pedestrian more than one cycle to traverse the SPI along the local street as opposed to one cycle of a typical diamond interchange; although it must be realized that a typical diamond interchange will have two traffic signals for pedestrians to traverse.

High volumes of the right-turn exit ramp movement and/or high volumes of pedestrians may necessitate an added traffic signal or pedestrian hybrid beacon (if coordination with local road traffic is unnecessary) to better regulate this movement. As with most interchange types, designing for pedestrian crossings at the local road within the SPI should be avoided. This is especially the case with an SPI because of the crossing distance and signal timing operations.

2.4.7 SPIs with Incorporated Frontage Roads

If the SPI is designed adjacent to a frontage road, the frontage road becomes an intricate part of the interchange design. This configuration requires that the frontage roads be one-way and in the direction of ramp traffic. A slip ramp from the mainline to the frontage road provides access to and from the intersection. This ramp should connect to the frontage road at least 650 feet from the crossroad to accommodate merge/diverge movements and the need for storage. An SPI incorporating a frontage road(s) by combining the ramps and frontage road is shown in the 2011 AASHTO “A Policy on the Geometric Design of Highways and Streets” (Green Book), Figure 10-25.

A fourth signal phase is required with this configuration to allow through moves on the frontage road. This layout typically requires at greater distance between stop bars to accommodate the frontage road width. The fourth signal phase and additional intersection size required to accommodate frontage roads reduces the available green time. Typically, bicycles are allowed to use the traffic lanes or shoulders and can legally turn left at an intersection. In order to accommodate a left-turning bicycle in an SPI, longer signal timing is required. This longer signal timing may make the intersection operate less efficiently. At a three-phase SPI intersection, bicyclists will typically not be turning left onto the freeway, but will be proceeding as through traffic along the local road. The frontage road connection to the ramps would be part of the freeway access control.

2.5 Parallel Local Streets

In order to take advantage of the three-phase signal of an SPI intersection, the local street system must be able to accept and deliver the traffic. Short spacing from the ramp intersection to adjacent local streets and driveways will limit the ability for the local street system to handle the large volumes of through traffic that the SPI can deliver. The purported advantages of the SPI will often not materialize where the local street system is not compatible. A traffic capacity analysis should determine the number of lanes of the local road system.

2.6 Operational Expense and Future Planning

SPIs are typically more challenging to maintain than conventional interchange configurations. Their size and shape requires more maintenance effort for structures, electrical, signing, delineation and pavement markings. SPIs constructed with “butterfly” shaped structures lack flexibility for future modifications or expansion (see Section 2.8 “Construction Costs and Staging”). If future expansion or modification is needed, major reconstruction of an overcrossing structure will typically be necessary due to the complexity of the structure design. Due to the size and geometrics of the SPI, widening certain features (e.g., the freeway, local street, or ramp terminals) is normally more expensive than for conventional interchanges. This holds true for either overcrossings or undercrossings. Therefore, the SPI design should take into consideration the future addition of lanes within the proposed structure and footprint.

2.7 Power Failure or Flashing Operation

The battery back-up system (BBS) requirement for traffic signals will ensure the SPI continues to function in the event of a power outage. The BBS will typically function for 4-8 hours, which afterwards will switch to flashing mode.

Intersection operations during conditions of flashing mode, especially during periods of darkness, require particular attention. The size of the intersection and position of the entering vehicles may complicate the required “stop and proceed in order of arrival” rule. Manually directing traffic will be difficult on an SPI intersection without signal control. Plans for timely operation of the SPI intersection during power outages should be developed cooperatively between Caltrans and the appropriate local agency.

2.8 Construction Costs and Staging

SPIs require a substantial initial investment. Significant differences in construction costs exist between the SPI and other conventional interchanges. Additional costs are attributed to the larger overcrossing structure surface area, additional vertical clearance required at undercrossings, retaining walls, and overhead sign structures.

Converting an existing interchange to an SPI involves significant costs and staging issues. The upper roadway will require significant reconstruction to raise the profile necessary to accommodate the longer and deeper structure for the overcrossing or undercrossing.

Staging for SPIs can be more complex than other interchange types and may result in local road closures. It is important that proposed SPIs receive a constructability review in accordance with current project development procedures.

2.9 Alternative Selection

Compared to SPIs, diamond and partial cloverleaf interchanges often result in lower construction costs as well as reduced future maintenance and expansion costs. The choice of interchange type should be based upon the best combination of expense and desired results. The SPI should not be arbitrarily chosen without considering other alternatives. In addition to the "no-build" alternative, an SPI should be compared to a diamond interchange in the project initiation document. Various considerations, such as safety, construction costs, maintenance costs, projected traffic demands, right-of-way impacts, expected bicycle and pedestrian usage, interchange type, and site conditions factor into choosing the best alternative.

3.0 GEOMETRIC DESIGN

3.1 Design Speed

The standards for design speed discussed in the HDM Topic 101 apply to SPIs. The local road design speed should reflect the anticipated 85th percentile speed. However, the selected design speed should not be lower than the posted speed limit. Design speed should not be lowered to accommodate economy of design. Design speed of the ramps must be consistent with HDM Index 504.3 except as discussed in these guidelines. Further guidance for ramp design is provided in Section 3.1.3 “Horizontal Alignment.” The design speed is the basis of many geometric requirements, as specified in the HDM. The following addresses some important features relative to SPIs:

3.1.1 Sight Distance and Visibility

Visibility is a key feature to accommodate efficient operation of SPIs. Drivers need to have clear visibility of all signing, delineation, signals, and curbs within the intersection. It is important that drivers are able to understand and see their destination and path through the intersection.

To verify the driver's ability to see the signing, delineation, signals, and curbs within the intersection, the designer should plot the vertical alignment of each movement through the intersection.

3.1.2 Vertical Alignment

At overcrossing locations, it is preferable for the SPI intersection to be designed with a crest vertical curve that is on the flattest profile reasonable in order to improve visibility. At undercrossings, the vertical alignment of local streets should have a constant grade or sag vertical curve, as appropriate, through the intersection. Vertical clearance for falsework is an important consideration due to the depth of the structure.

Undercrossing vertical alignments should be designed with enough vertical clearance to accommodate signal heads beneath the bridge soffit without reducing visibility to the signal heads. See Section 7.2 "Undercrossings" for related signal guidelines.

3.1.3 Horizontal Alignment

The horizontal alignment of the local street should be constructed on a tangent segment through the intersection, as delineation and signing can be better understood by the driver before entering the intersection. Where compound curves are utilized for a left-turn alignment through the SPI intersection, the smaller curve radius should be at least half that of the larger curve radius. Broken back curves for left-turn movements through the intersection should be avoided.

The exit ramp termini should be designed to avoid aligning headlights into the eyes of drivers on the opposite exit ramp. Exit ramps on ascending grades are particularly prone to directing headlights into the driver's eyes of the opposing exit ramp.

An important consideration for exit ramp left-turn movements is adequate visibility to the stop bar and both signal heads at the ramp terminus, see Figure 1 callout to Section 3.1.3. Note that at least two signal heads are required for exit ramp left-turn movements. Place at least one overhead signal near the center of the intersection, and the second signal head mounted on the divisional island or "pork chop" island. See Section 7.0 "TRAFFIC SIGNALS" and Figures 4A and 4B.

Geometrics for left-turn movements provide for higher speeds at SPIs than at typical ramp intersections, therefore stopping sight distance should be provided along the exit ramp left-turn segment. The geometric design should match or exceed the design speed provided by the ramp's horizontal alignment in accordance with the criteria in HDM Index 203.2 and should be at least 25 mph per HDM Index 504.3(1)(a), see Photo 2. The left-turn angle is typically 45 to 60 degrees with a minimum radius of 150 to 200 feet. HDM superelevation and alignment standards do not apply to SPI turning roadways at the intersection, as is similar with other large intersections.



Photo 2: Left-Turn Exit Ramp Example. SR-99 and Arch Rd.

3.1.4 Corner Sight Distance at Exit Ramps

It is important to provide visibility between exit ramp traffic and cross traffic approaching from the left, see Figure 1 callout to Section 3.1.4. Pedestrian fencing and bridge railing on overcrossings or the bridge abutment on undercrossings should not obstruct visibility. There are both safety and operational benefits associated with adequate corner sight distance. Corner sight distance per HDM Index 405.1 applies to the exit ramp design.

3.2 Intersection Size

Minimizing intersection size can be the most significant factor in successful SPI operation. SPI intersections operate best when they are small and compact. See Section 2.2 “Geometric Considerations” and Section 3.8 “Pedestrians and Bicycles” for more information. Larger intersections require longer paths for vehicles to traverse through the intersection. Smaller intersections typically improve the driver’s ability to identify and understand the intersection layout, thereby reducing the potential for driver confusion and wrong-way movements. Larger intersections will mean longer distances to traverse for bicyclists. Bicycle issues are covered in more detail in Sections 2.4 “Capacity” and 3.8 “Pedestrians and Bicycles.”

Signal operation has a direct relationship to intersection size. The amount of red clearance time increases with intersection size, thus increasing the overall signal timing cycle length, requiring more storage for waiting traffic and reducing the efficiency of the intersection. The following geometric features can reduce the size of an SPI intersection:

1. Increasing the median width of the local street allows the local street stop bars to be placed near the center of the intersection. This aspect can be difficult to visualize but is easily understood if the designer draws and compares the effects of different median widths.
2. Field observations noted that some vehicles on the local road stop beyond the stop bar in the left lane of a double left-turn pocket. A wider median space between the opposing through movement and the left-turn pocket at the stop bar may help align the stop bars closer in-line.
3. At undercrossings, signals should be hung beneath the bridge soffit. The vertical clearance should be sufficient to hang signal heads vertically, thus allowing local street stop bars to be located nearer the center of the intersection. See Section 7.2 “Undercrossings” for additional information on signal placement at undercrossings.

3.3 Right-Turns at Exit Ramps

The discussion and standards in HDM Index HDM 504.3(3) “Location and Design of Ramp Intersections on the Crossroads” apply to SPIs. Constrained locations that make the SPI an appealing interchange choice are usually found in urban areas. As such, the local road should be designed to best accommodate bicyclists and pedestrians. The SPI discussion in Chapter 10 of the 2011 Green Book says “... the right-turn movements from the exit ramps are typically free-flow or yield control and only the left-turns pass through the signalized intersection.” However, the free right-turn movement may not be the best design for the speed and context, see HDM Index 403.6(2) and Section 6.1.4 for right-turn restriction guidance. The signal or stop condition is depicted on Figure 1. Intersection spacing guidance is also discussed in HDM Index 504.3(3). SPIs are particularly sensitive to poor intersection spacing and require a traffic operations analysis.

3.4 Lane Widths

The lane widths for left-turn lanes should be 14 feet through the intersection. Additional width may be required for truck off-tracking, see HDM Table 504.3.

3.5 Merging and Weaving Distance for Entrance Ramps

A typical SPI entrance ramp accepts traffic from double left-turn lanes and a free right-turn lane. The ramp therefore commonly provides three lanes near the intersection. Caltrans generally builds one-lane entrances except under specific circumstances; three lanes must be merged into one prior to entering the freeway. Merges should occur one lane at a time and provide adequate length consistent with ramp design in HDM Index 504.3.

Where a turn lane converts into a high-occupancy vehicle (HOV) preferential lane on the entrance ramps, adequate weaving distance should be provided to allow vehicles entering the ramp room to weave into the HOV preferential lane or the mixed flow lane. To avoid this weave, it may be feasible to begin the HOV preferential lane on the local street leading to the ramp. Where this occurs, advance overhead signing should be installed to prepare drivers for the weave. When an HOV preferential lane does not begin on the local street, an overhead sign should be placed at the ramp entrance stating “HOV ONLY AHEAD.” Where entrance ramps include an HOV preferential lane, adequate distance for merging from the far lane to the HOV preferential lane should be provided. See the Ramp Metering Design Manual for more information. Figure 1 illustrates the above concepts. Also see HDM Index 504.3(2).

3.6 Skew

SPIs are best utilized when the freeway and local street alignments intersect at a 90-degree angle. Intersection skew angles should not be less than 75 degrees from normal. In extreme circumstances intersection skew angles less than 60 degrees from normal may be considered. The underlined standard in HDM Index 403.3 “Angle of Intersection” does not apply to exit ramp left-turn lanes for SPIs.

3.7 Center Island Layout

A raised center island is an essential design element. See Section 4.1 for geometric and other pertinent information.

3.8 Pedestrians and Bicyclists

Geometric width for bikeways is provided in HDM Index 301.2 and DIB 89. The CA MUTCD Part 9 provides the marking guidance at right-turn locations. The option for green colored pavement, especially at turning locations, can be advantageous. The HDM shoulder standards apply through the SPI, which can help with bicycle operations, see Photo 3. Another bicycle accommodation is the limit line detection for bicycles, which is required for new or modified limit line detection. Due to the length of the crossing distance and the overall size of the SPI, it may take more than one cycle for a pedestrian to cross the interchange as shown in Figure 1. Sidewalks should accommodate the pedestrian through the SPI per HDM Index 105.2. See Photos 3 and 7. Also, to accommodate pedestrians, a pedestrian push button should be installed when crossing the ramp locations. Additionally, a nearby pedestrian overcrossing or undercrossing may mitigate the concerns of the pedestrian and bicycle modes. This would be part of an overall network strategy.



Photo 3: Shoulder and Sidewalk Example. I-680 and Monument Blvd.

4.0 ISLAND FEATURES

4.1 Center Island

The minimum dimension of the raised center island should be 6 feet per side, 10 feet preferred, with a minimum surface area of 100 square feet. All lanes should have a 2-foot offset from the raised center island. Consistent with Sections 3.4 “Lane Widths” and 3.7 “Center Islands Layout” of these guidelines and to facilitate orderly left-turn movements, a raised center island as shown in Figure 3 should be provided. The island perimeter should be 4-inch Type D curb. For more information, refer to HDM Index 405.4 “Traffic Islands.” For signage requirements, see Section 6.1.2 of the guidelines.

4.2 Median Islands

Opposing through traffic on the local street approaching and departing an SPI intersection must be separated by a raised concrete median island. Curb type and median width are discussed in HDM Chapter 300. Also see the discussion regarding median width in Section 3.2 “Intersection Size.” See Section 6.1.2 for the median island signs and markers.

4.3 Left-Turn Channelization of Local Street

On the local street, a striped channelization island to separate left-turning vehicles from through vehicles may be provided as shown on Figure 2. If used, the island should consist of 8-inch white thermoplastic striping. The island should be at least 5 feet wide at the widest point. The island should direct the left-turning vehicles towards the freeway entrance ramps. A striped divisional island or “pork chop” island should be provided beyond the left-turn lane stop bar.

4.4 Ramp Islands

The channelizing island separating the left- and right-turn lanes where entrance and exit ramps connect to the local street must be a raised island. The island facilitates pedestrian traffic and must be clear of landscaping or other obstructions that could restrict sight distance. Use curb consistent with HDM Table 303.1 surrounding the island perimeter, with Type K markers at the ramp island nose.

5.0 PAVEMENT DELINEATION AND MARKINGS

5.1 Pavement Color

Striping and delineation are valuable visual tools to facilitate channelization through the intersection. Dark colored pavements perform best for color contrast. However, on bridge decks with portland cement concrete pavement apply black contrasting treatment as described in the CA MUTCD Part 3.

5.2 Pavement Marking Materials

In an effort to reduce lane closures and associated maintenance problems, durable pavement marking material is recommended for all permanent pavement markings and legends. Comply with the CA MUTCD Part 3, the Caltrans standard plans for marking details, and the Pavement Marking and Monitoring Policy Memorandum dated July 11, 2017 issued by the Division of Traffic Operations.

5.3 Lane Line Extensions (Swinglines)

In an effort to help guide drivers through SPI intersections, swinglines (Detail 40 plus reflective markers at approximately 21-feet on center) should be provided for all left-turn movements. This will usually be the lane line between double left-turn movements. In some instances, a second swingline may be appropriate at

the left edge of the left lane. Left edge swinglines consisting of Type H markers spaced no closer than 4-feet on center for motorists in the number 1 lane may be considered for vehicles turning left from the exit ramp to the local road on larger intersections and/or through crest vertical curves.

5.4 Stop Bars

In an effort to increase visibility and driver conformance, all stop bars should be white thermoplastic, 2 feet in width.

5.5 Pavement Markings

Numerous pavement markings can contribute to driver confusion. Pavement markings between the stop bars at an SPI intersection should be kept to a minimum. Directional arrows or legends between stop bars at SPI intersections should be avoided. However, all lanes approaching the intersection should be clearly marked with the appropriate directional arrows. Additionally, directional arrows should be placed adjacent to all stop bars. Consider the placement of high-visibility crosswalks where appropriate. See Figure 2 of these guidelines.

6.0 SIGNS

6.1 Standard Signage

All standard interchange sign packages (e.g., R5-1, R6-1, etc.) are required and must be located where they are clearly visible to reduce the risk of wrong-way movements at exit ramps. In addition to the standard sign packages, the following signs should be installed at SPIs:

6.1.1 Guide Signs

For SPI overcrossings, left-turn movements at entrance ramps should have G85 signs with arrows mounted on sign bridges as shown in Figure 3. Additionally, G85 & G83 signs are required over local streets on all approaches to the SPI intersection as shown. Guide signs should not be located where they could impair traffic signal visibility. It is desirable to place the G83 sign in-line with the G85 signs on the local street; however, in instances where turn pocket length prevents the placement of these signs in-line, the G83 sign should be placed on the local cross streets as appropriate. See Photo 4.

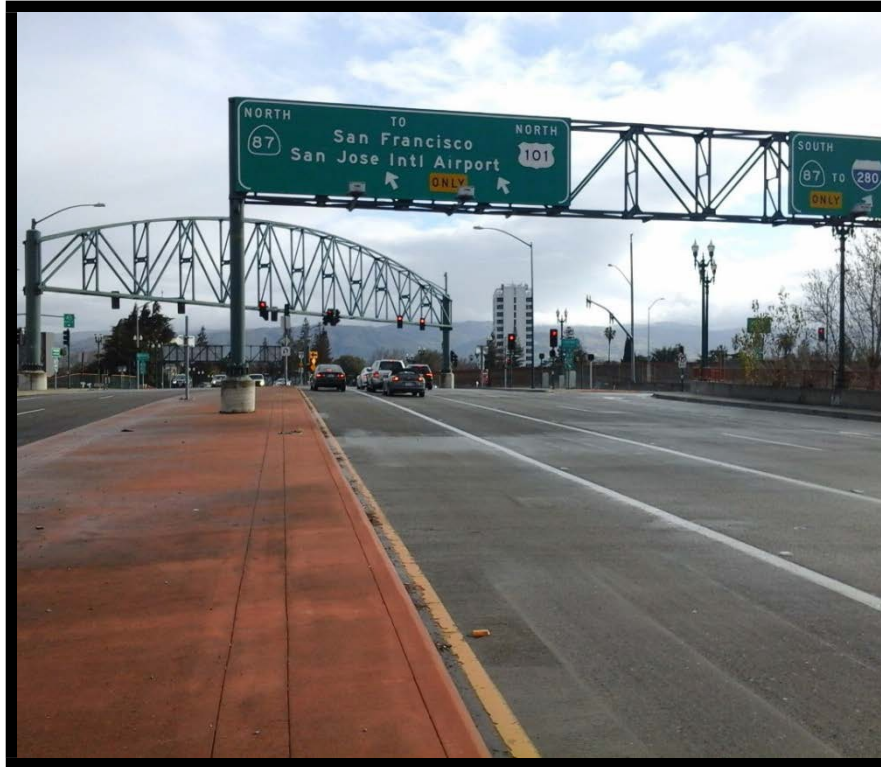


Photo 4: Overhead Structure Example. SR-87 and Taylor St.

6.1.2 Center/Median Island Signs

The center island should be signed with a W1-6 sign and Type N markers placed back-to-back facing each exit ramp, and Type K markers at the noses as shown in Figure 3. Signs should be placed for maximum visibility to approaching traffic and to reduce driver confusion that may be caused by opposing headlights and geometry as discussed in 3.1.3 “Horizontal Alignment.” Signs in the center island should be mounted on breakaway posts.

Median island noses must be signed with R4-7 signs mounted on break away posts and Type K markers.

6.1.3 U-Turns

U-turns are prohibited on the local roads when exit ramp right-turns are signalized due to the overlap of traffic signal phasing. Proper signage must be placed prohibiting this U-turn movement. R3-4 (No U-turn) signs may be placed on the traffic signal bridge or adjacent to the traffic signal heads. U-turns may be allowed at SPIs as long as the U-turn does not conflict with other movements. Pedestrian signals must be timed only with the local street through movement because of conflicts with U-turns from exit ramps.

6.1.4 Right Turn on Red

One of the primary benefits of an SPI is its ability to move large volumes of traffic through the signalized intersection. Therefore, many existing SPIs allow free right-turns at exit ramp termini. However, free right-turns may not be compatible with urban environments where bicyclists and pedestrians are present as discussed in Section 3.3 “Right Turns at Exit Ramps.” At signal controlled right-turn lanes, traffic should be allowed to turn right on red when practical. Where right turn on red is

not allowed, a sign indicating that right turn on red is prohibited, R13A(CA), should be placed. This sign will reduce driver confusion and prevent conflict with vehicles, bicycles, and pedestrians. See Photo 5.

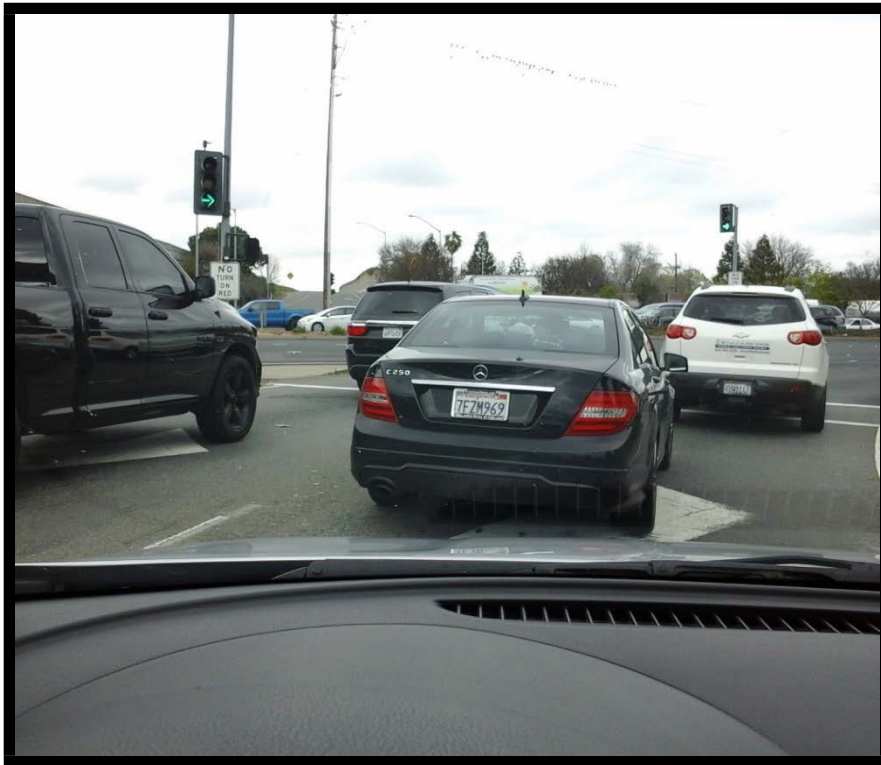


Photo 5: Example of Right-Turn Restriction. I-680 and Monument Blvd.

6.1.5 Signs on Traffic Signal Bridge

No guide signs are allowed on the traffic signal bridge or adjacent to overhead traffic signal heads. In an effort to increase visibility of the traffic signal, signage should be minimized on the traffic signal bridge.

7.0 TRAFFIC SIGNALS

7.1 Overcrossings – Traffic Signal Bridge

On SPI overcrossings, a traffic signal bridge spanning the width of the intersection is required. The traffic signal bridge should be placed over the center of the intersection with traffic signal heads placed perpendicular to the through traffic movement. When there are two or more left-turn lanes, two signal indications should be mounted on the signal bridge for that movement. When there are two or more through lanes, two signal indications should be mounted on the signal bridge for that movement. Signals for right-turn movements should be placed as shown in Figure 4A. Far side signals beyond the signal bridge are not allowed. Additional signal indications may be placed on separate poles as shown in Figure 4A. In an effort to increase signal visibility, overhead guide signs, decorative features, artwork, and extraneous messages are not permitted.

on the signal bridge. Lighting should not be located where direct or scatter light may reduce the visibility of the signal indications.

7.2 Undercrossings

On SPI undercrossings, traffic signals should be mounted under the structure, to minimize intersection width. Backplates are recommended to reduce backlight. If intersection width standards and signal set back requirements can be met, signals may be placed on the face of the SPI structure. See Photo 6.

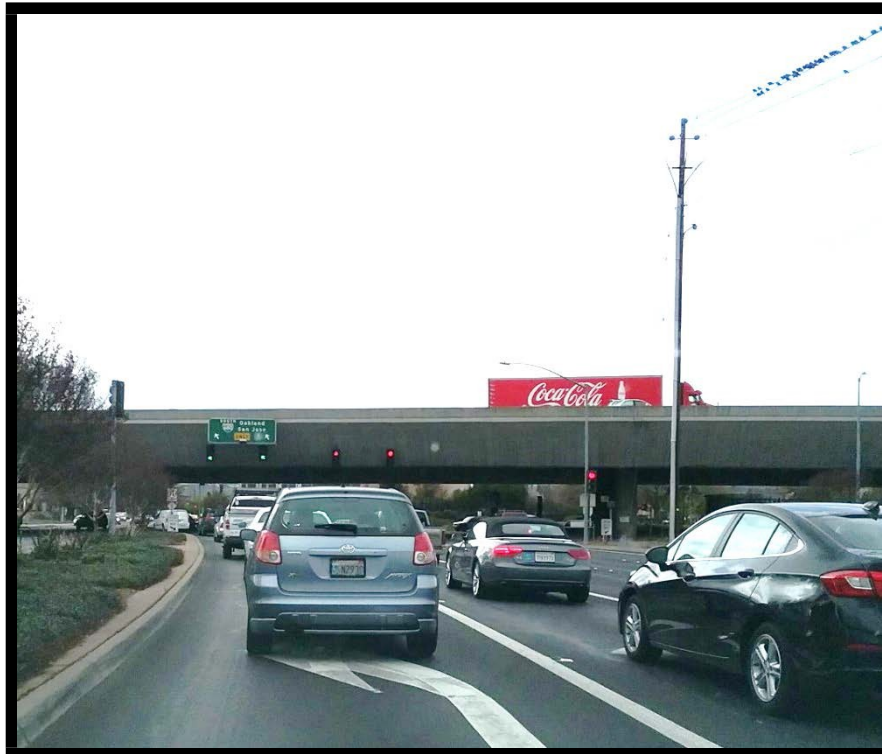


Photo 6: Signal Head Placement Example. I-680 and Monument Blvd.

7.3 Signal Heads

All signal sections shall be 12 inches in diameter per Caltrans standards. Programmable visibility heads should not be used. Signals should utilize vertical signal face positioning. However, if placed under a structure, the signal heads may be placed horizontally. Use appropriate arrow signal lenses for turn movements (45-degree angle is preferred). The indication for through movements must utilize standard circular lenses.

7.4 Signal Placement

Signal poles should not be placed in the center island or on the median island bull nose. Signals may be placed in median islands to control the right-turn movements from the freeway exit ramps, see Figure 4A for an example. There should be no signal heads located at the far side of the intersection facing through traffic on the local street.

7.5 Maintenance Considerations

SPIs can be more complex to maintain than other types of interchanges. For ease of maintenance, access to signal heads and signs located over the center of the intersection should be provided. The maintenance electricians must have access to the signal heads. To avoid multiple lane closures during maintenance operations, overcrossings should include a catwalk that provides access to all signals and signs located on the signal bridge.

A maintenance vehicle pullout (MVP) should be provided on the local road approach to the SPI in order to maintain traffic signal cabinets and for other electrical purposes, see Photo 7. Other MVPs can be located in the interchange area as needed for various maintenance needs, such as, landscape, signs, etc.



Photo 7: Maintenance Vehicle Pullout Example. SR-99 and Arch Rd.

8.0 LIGHTING DESIGN

8.1 Intersection Lighting

Intersection lighting should be maintained at the SPI. See Figures 5A and 5B for the typical lighting plan at an undercrossing and overcrossing, respectively. Caltrans requires 0.6 horizontal footcandle (fc) as the minimum maintained horizontal illuminance at the intersection of centerlines of entering streets. Therefore, for SPIs, this intersecting point would normally be in the vicinity of the center island that separates all the left-turn movements.

Lighting should be provided at the entrance of each entrance ramp. All areas bounded by the crosswalks should have minimum maintained 0.15 horizontal fc.

For an overcrossing intersection, Type 15 or Type 21 structure electroliers should be used. High mast lighting may be used to flood the general area.

Sign lighting should not be placed on the traffic signal bridge.

For an undercrossing intersection, 70 watts or 100 watts high pressure sodium flush mount bridge soffit lighting should be used. The intersecting point of the centerlines should have the minimum maintained 0.6 horizontal fc. All areas bounded by the crosswalks should be lit by either bridge soffit lighting under the structure or by Type 15 electroliers outside the structure area.

The intersection lighting should be maintained by the agency responsible for maintaining the signal, as it is an integral part of the traffic signal system.

Note: Regarding the following Figures 1 through 5B, traffic control devices and design criteria for bicycle and pedestrian accommodations are not shown. As referenced in Section 1.0, see the CA MUTCD and the HDM for further guidance.

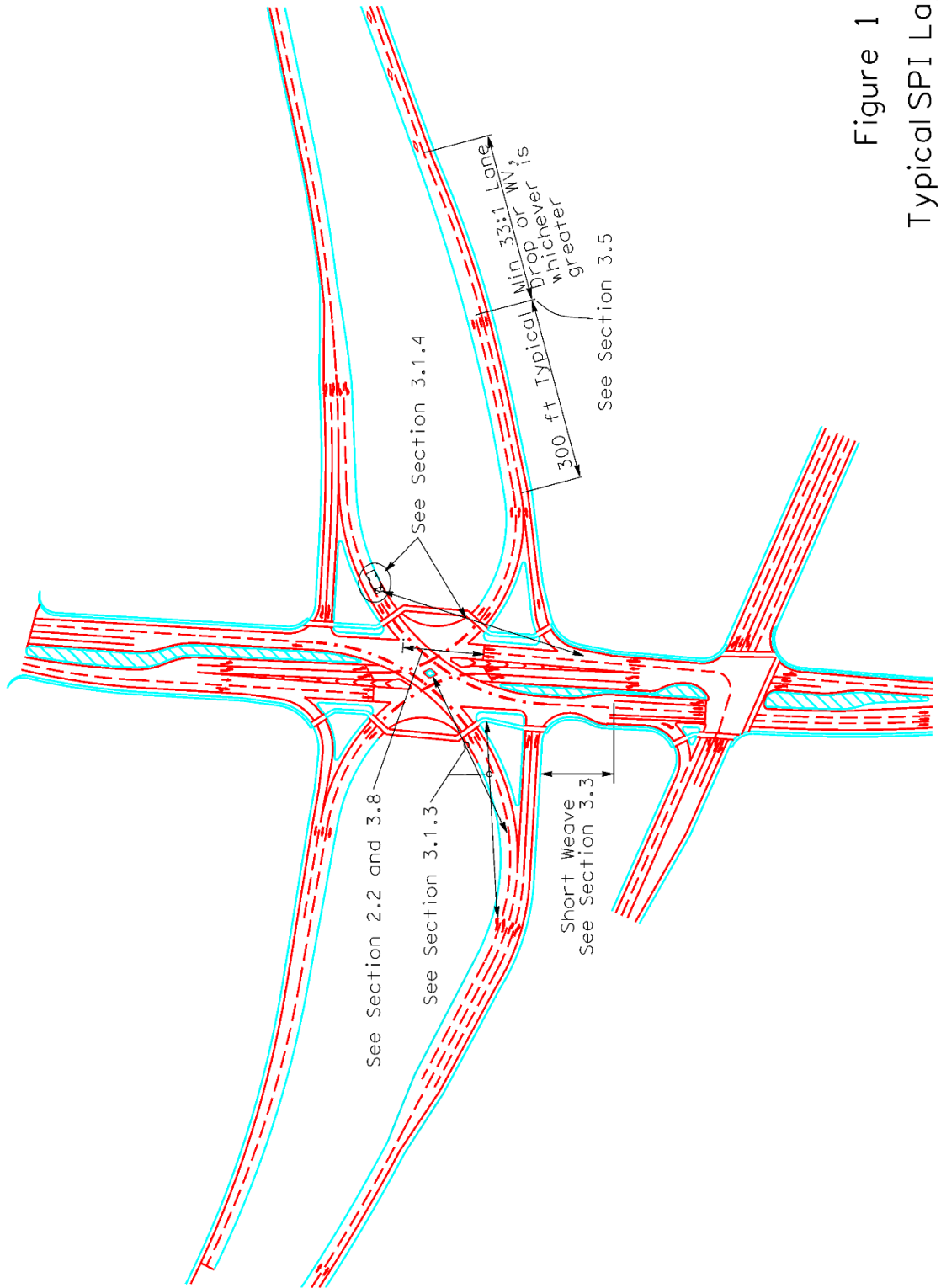


Figure 1
Typical SPI Layout

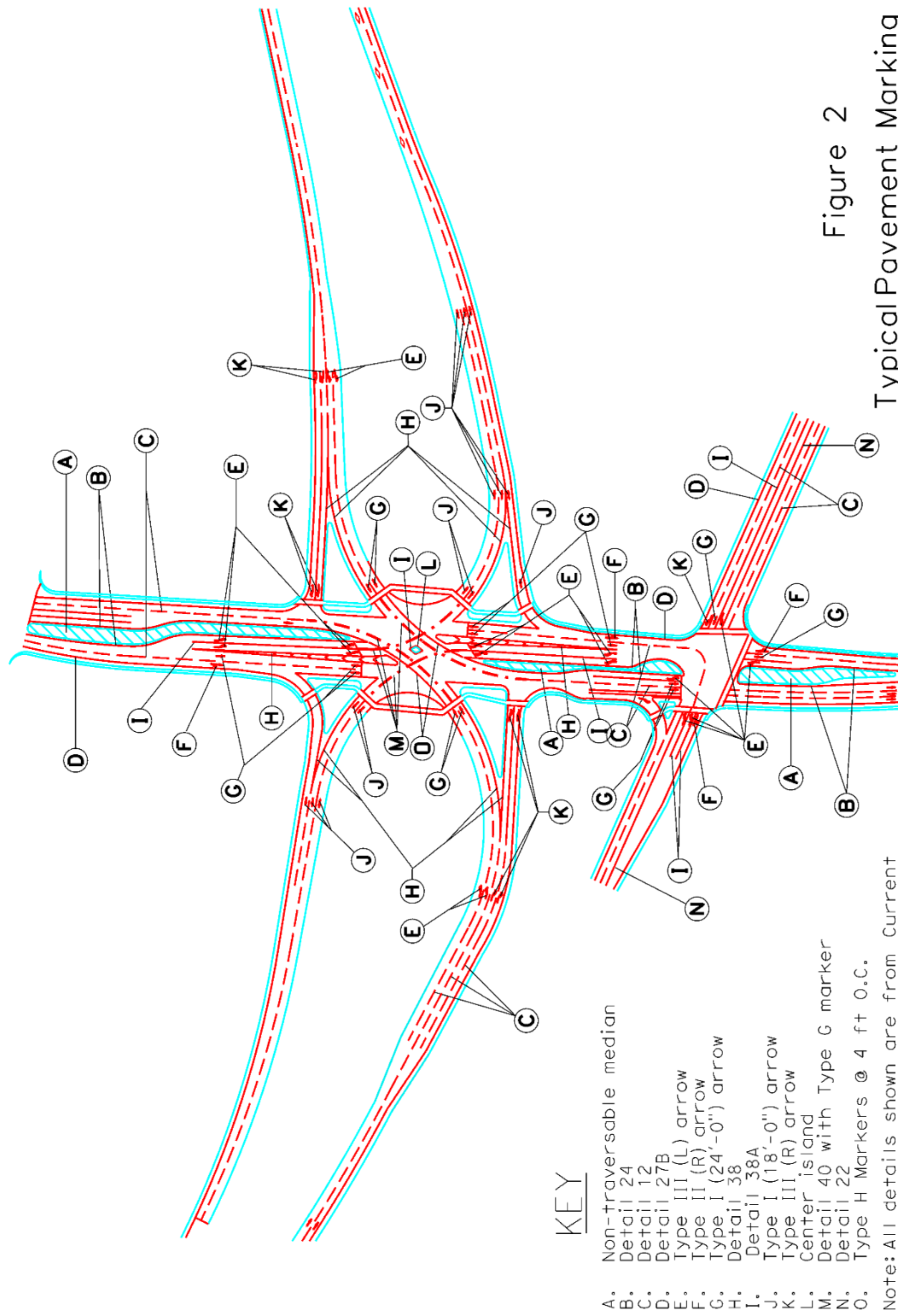


Figure 2
Typical Pavement Marking Plan

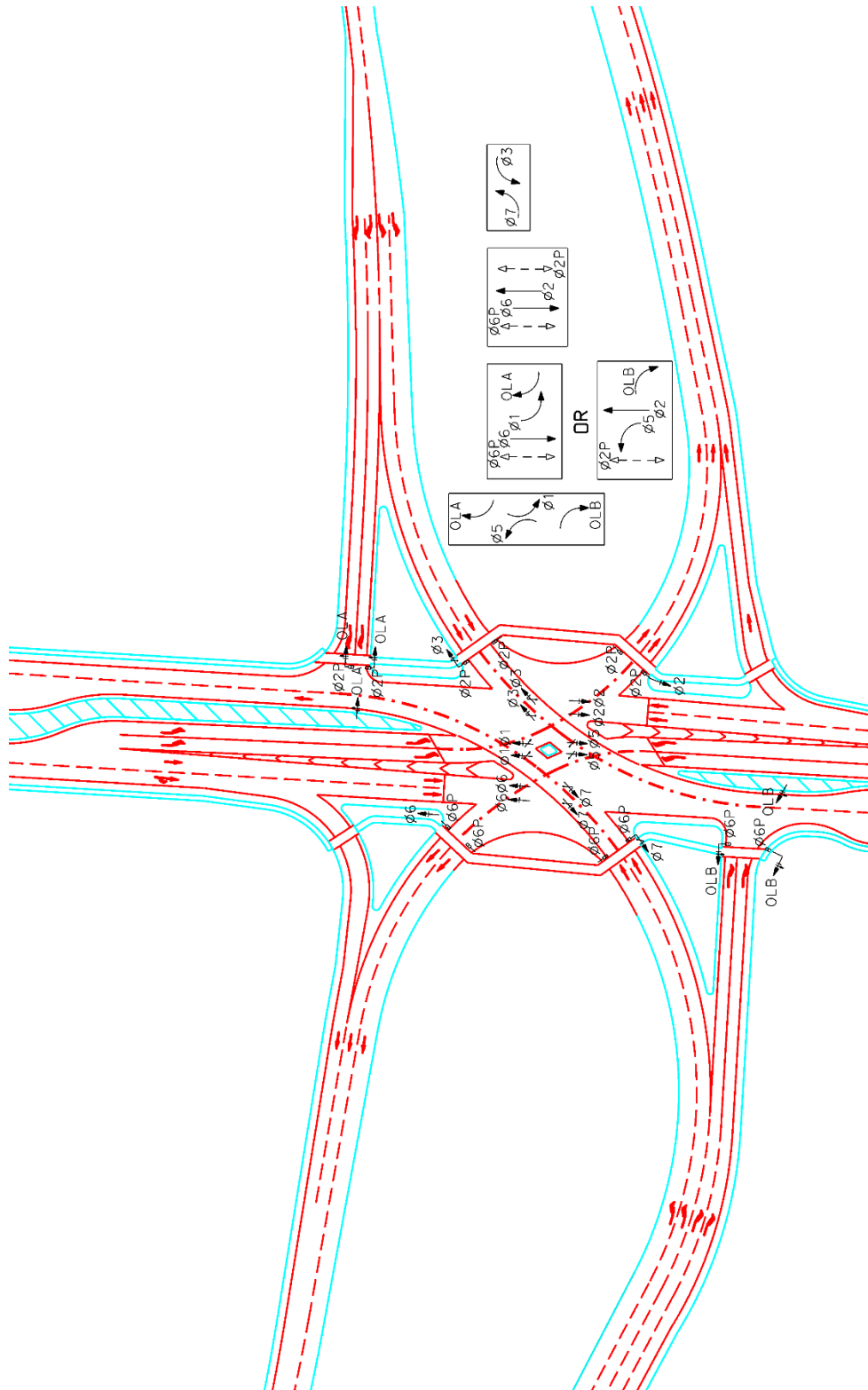


Figure 4B
Typical Signal Layout
(Undercrossing)

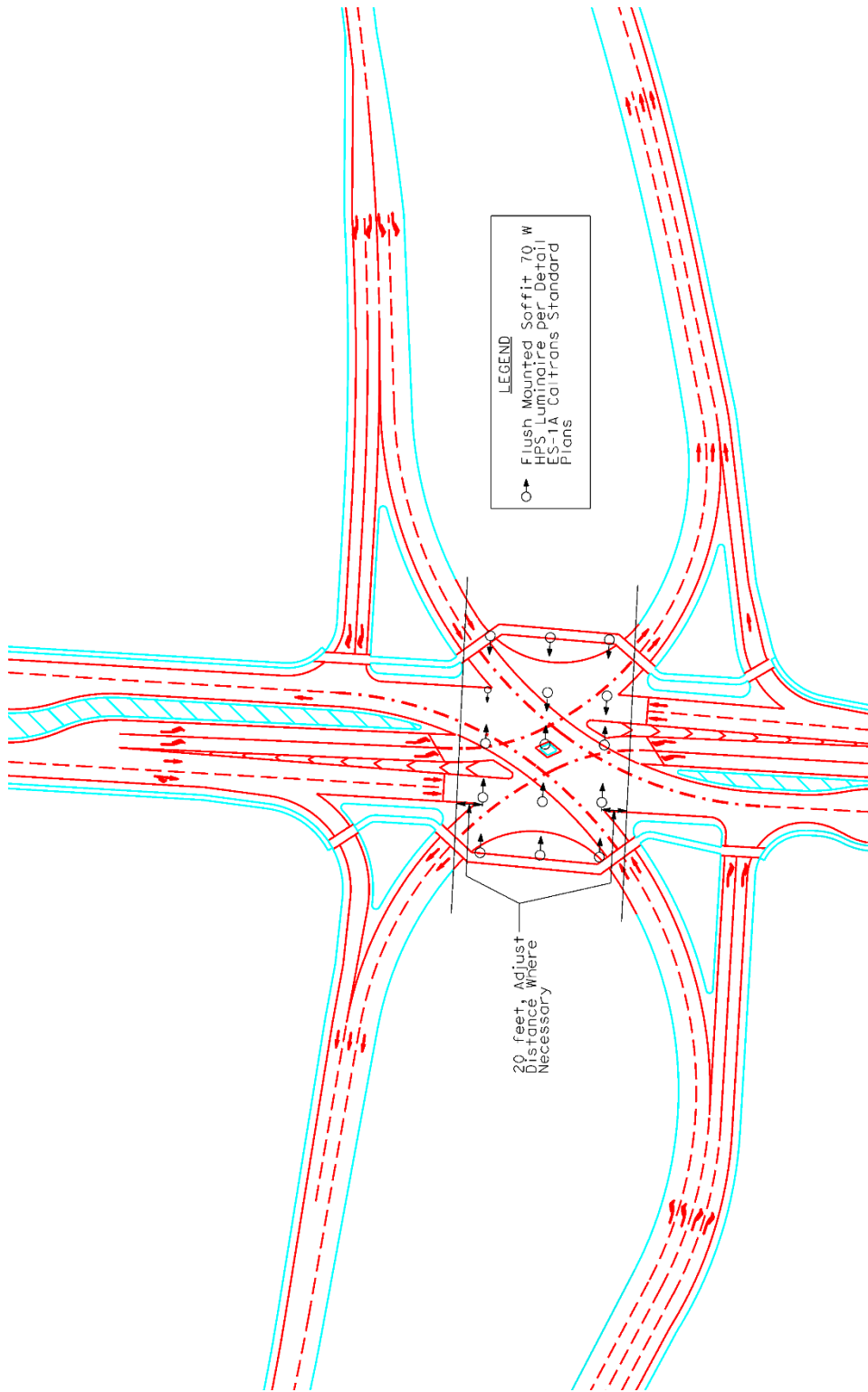


Figure 5A
Typical Lighting Plan
(Undercrossing)

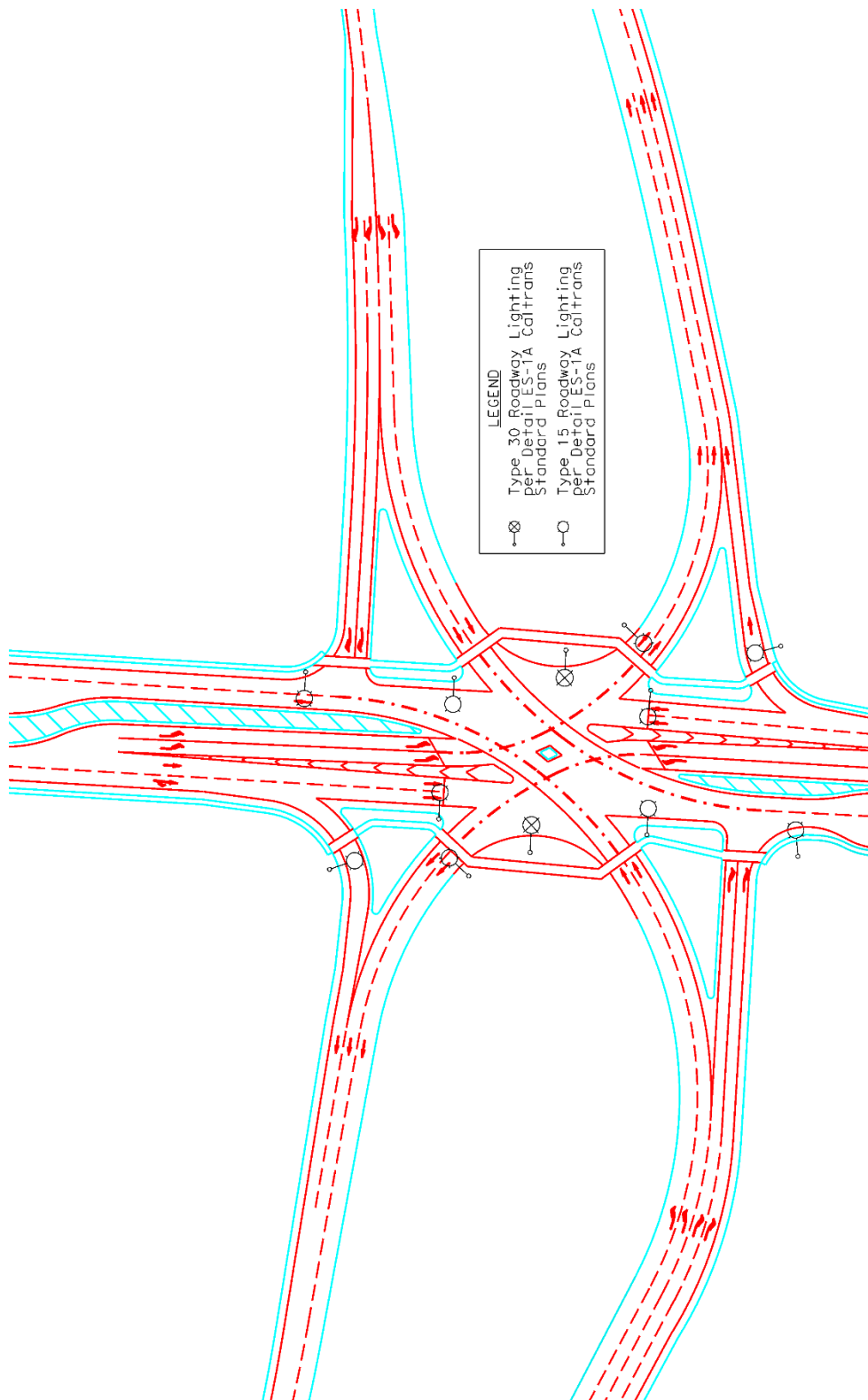


Figure 5B
Typical Lighting Plan
(Overcrossing)