3 ROADWAY DESIGN ELEMENTS

New developments and redevelopment projects offer an opportunity to provide safe and convenient bicycle facilities at very little marginal cost. This includes the overall right-of-way width, provision of bike lanes and details such as gutter and drainage design. All new and reconstructed roadways in Santa Clara County should conform to the following guidelines and should be connected to the existing and proposed bicycle network.

Non-motorized connections should be provided to link residential areas with commercial, employment, schools and shopping areas. Non-motorized connections across rivers, railroad tracks and freeways and between developments are strongly encouraged [1] and can increase bicycling (and pedestrian) mode splits significantly. Bike paths should be provided along places of scenic beauty, particularly along the bay, creeks, flood control channels, on ridgelines, and in parks.

IN THIS CHAPTER:

3.1 Roadway and Lane Width

3.2 Drainage Inlets and Gutter Pans

3.3 Pavement Marking Materials

3.4 Roadway Surface Obstacles

3.5 Signage Usage and Design

3.6 Bulbout Design

[1] *See PTG Section 4.4 "creating non-roadway connections"*

This pedestrian walkway between Autumn Street and the San Fernando Light Rail station reduces walk time and is well-lit and attractive.

3.1 ROADWAY AND LANE WIDTH

3.1.1 Arterials Cross-section and Lane Widths

All new arterials should be designed with bike lanes. [2] The gutter pan width should not be considered as usable width for bicycle travel. The optimum minimum bike lane width varies with travel speed (see Table 3-1 and Chapter 7.1).

On multilane roads, travel lane widths of 11 feet maximum should be provided to discourage speeding especially where there is bike and pedestrian activity [3].

Note: If bike lanes are not provided, see Section 7.2 *Wide Curb Lanes* on narrowing inner lanes to provide a wider outside curb lane.

Table 3 – 1
Optimum Bike Lane Widths

Posted Speed (mph)	Width (feet)
0 - 30	4
35 - 40	6
45 or more	8

[2] *See PTG Section 2.2 for guidance on widths of pedestrian zones*

[3] *More discussion on lane widths can be found in: CDT pp. 4-10, AASHTO pp. 315, PTG Section 2.2c, Figure 2.31 and Table 2.5*

3.1.2 Collector Roadways

Collectors should be designed with a maximum design speed of 30 mph. If projected traffic volumes on any roadways are more than 4,000 vpd, bike lanes should be included. Curb radii should be 25 feet maximum to discourage fast right turns.

3.1.3 Rural Roadways

Rural roadways typically have low traffic volumes with varying speeds depending on the terrain and topography. Extremely low volume roads (less than 1000 vpd) may have existing pavements widths of 20 feet or less and typically do not need shoulders. On roads with higher volumes, paved shoulders are typically adequate to accommodate bicyclists.

See Section 7.4 *Rural Roads and State Highways* for guidance on accommodating bicycles on rural roads and on making shoulders more bike-friendly.

At University Avenue in Palo Alto, the wide sidewalks are higher than the roadway thereby reducing the grade change for both pedestrians and bicyclists.

3.1.4 Roadway Bridges and Underpasses

A new roadway overpass or underpass should maintain at a minimum the same cross section as the approaching roadway, including bike lanes or shoulders and sidewalks. If the approaching roadway does not have bike lanes and/or sidewalks or they are less than the minimums presented here, then the bridge shall be provided with minimum shoulder width of five feet; the minimum width increases with posted speed as presented in Table 7-2. The bridge or underpass shall also have minimum six foot sidewalks (optimally 8 feet) on both sides of the roadway. When designing or retrofitting a roadway overpass, standpipes and similar obstructions should be recessed into the wall or otherwise relocated out of the travel way/shoulder or sidewalk. On an existing substandard width bridge or overpass, consider a cantilevered structure to provide access for bicycles and pedestrians.

For a new roadway underpass construction, consider reducing the elevation change for bicyclists and pedestrians by providing wide shared pathway with a minimum of 8 feet of vertical clearance in addition to standard roadway with shoulder with the higher vehicular vertical clearance. A local example is the University Avenue Caltrain undercrossing in Palo Alto. Also at undercrossings, lighting should be provided during the daytime to illuminate any debris that may have accumulated where bicyclists ride.

See also: TDMG Policies UD-2.6; UD-3.3; UD-4.1.1; UD-4.1.2; UD-4.3.1.4; and Figure T-16.

NOTE

HDM §208.10(6) states that "Bicycles are not considered to operate on a sidewalk, except in special cases where signs specifically direct cyclists to use a bike path or the sidewalk." Therefore pedestrian rail heights standards are invoked on roadway bridges with sidewalks.

3.1.5 Bicycle Railings on Roadway Bridges

Caltrans Standard §208.10 Bridge Barriers and Railings

(1) General – There are four classes of railings, each intended to perform a different function.

(a) Vehicular Barrier Railings – The primary function of these railings is to retain and redirect errant vehicles.

(b) Combination Vehicular Barrier and Pedestrian Railings – These railings perform the dual function of retaining both vehicles and pedestrians on the bridge. They consist of two parts – A concrete parapet barrier, generally with a sidewalk, and metal handrailing or fence-type railing.

(c) Pedestrian Railings – These railings prevent pedestrians from accidentally falling from the structure and, in the case of fence-type railing, reduce the risk of objects being dropped on the roadway below. See DIB 82 for additional requirements.

(d) Bicycle Railings – These railings retain bicycles and riders on the structure. They may be specifically designed for bicycles, or may be a combination type consisting of a vehicular barrier surmounted by a fence or metal handrail.

The S.R. 152 flyover of S.R. 156 adds a bicycle railing as it gains elevation. Since bicyclists will only be on the right hand shoulder, it is only needed on the right side of the flyover.

Discussion Minimum Railing Height

The minimum railing height on a roadway bridge depends on whether pedestrians or bicyclists are immediately adjacent to the outside edge of

Table 3-2: Railings on Roadway Bridges

Example 1 Bike lane next to sidewalk, sidewalk adjacent to railing, one combination railing with fence for pedestrians.	Example 2 Bike lane next to vehicular railing, and bike path in between two railings. Outside railing is a ombination railing with fence for pedestrians.	Example 3 Bike lane next to vehicular railing with height for bicyclists, and sidewalk in between two railings. Outside railing is a pedestrian railing.	Example 4 Shoulder only, no sidewalk, one combination railing with height for bicyclists.
			
Gilroy 6th Street overcrossing of US 101 south side.	Gilroy 6th Street overcrossing of US 101 north side.	Oakland 12th Street bridge over Lake Merritt Channel	S.R. 156 at S.R. 152

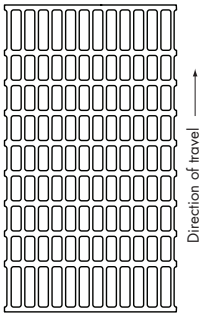
the overcrossing. Table 3-2 on the previous page presents several common situations.

When bicyclists are the adjacent to the edge as shown in Options C and D, the height of the railing depends on the factors discussed in Chapter 9.3.4 such as the degree of severity faced should a cyclist fall over the rail and the angle and speed of the approaching bicyclist. Typical height is 48 inches. The design of the railing would be the Combination Vehicle Barrier/Bicycle Railing; it must be sufficient to retain both vehicles and bicyclists.

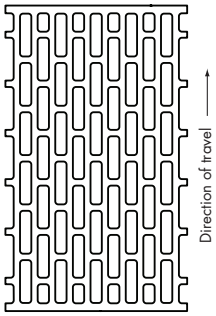
See Appendix C for a discussion of the pros and cons of various rail/barrier designs.

3.2 DRAINAGE INLETS AND GUTTER PANS

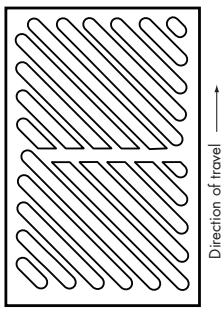
This section describes ways to reconcile storm water drainage design, typically a curb and gutter and drainage grates, with bicycling safety, both which occur on the right edge of the road. First, alternatives to curb and gutter design are presented that would provide the same function as standard gutters and grates while not posing an impediment to bicyclists. Where grates are used, the following practices will reduce their impact on bicycling safety.



TYPE 18-10 or 24-13 GRATE (METRIC: TYPE 450-10 or 600-13)



TYPE 18-8C or 24-106 GRATE (METRIC: TYPE 450-8C or 600-10C)



OTHER BICYCLE PROOF GRATE

Design Considerations

The function of drainage grates is to drain storm water quickly from the roadway and also to provide access to the maintenance worker to clean out the inlet. Gutters are sloped to direct water flow into the inlet. This keeps water from ponding at the longitudinal joint and undermining the pavement. Gutters also protect the curb from being damaged by the contractor during maintenance and resurfacing. However, grates become clogged in areas with many deciduous trees and can be rendered essentially useless. (For example design manuals recommend that a clogging factor of at least fifty percent be assumed for city streets, in the absence of local data.) While the gutter and inlet design must be effective hydraulically, other designs are just as effective in removing water from the roadway, especially in Santa Clara County where the average rainfall is less than the Bay Area average.

3.2.1 Grateless Roadway Designs

Optimally, roadways would be free of drainage grates within the traveled way by the use of curb opening inlets Type OS and OL (Standard Plans D78), particularly on grades of less than three percent. The depression in the vicinity of the curb-face inlet (approximately one inch or 30 mm) that is needed for hydraulic efficiency should take place gradually so that it does not pose an obstacle to bicyclists. Curb-face opening inlet designs can be just as effective as grates. Access for maintenance workers is placed in back (sidewalk-side) of the curb. Alternatively, slotted linear drain inlets (Standard Plans D98A and D98B) can be used in the shoulder area in lieu of grate inlets.

3.2.2 Design of Drainage Grates

Caltrans Standard

Only drainage grates depicted in Caltrans Standard Plans D77B-Bicycle-Proof Grate Details or otherwise known to be bicycle-safe may be used on all roadways per HDM 837.2. Regardless of type of roadway or placement on the roadway, all grates on the roadway or roadway shoulder (except freeways where bicycles are prohibited) must be bicycle-proof.

VTA Best Practice

While attempts have been made to retrofit bicycle-unsafe grates by welding crossbars onto the parallel bars, this is an unsatisfactory solution. Funds are better spent installing correct design grates; Office of Traffic Safety funds can be used to replace improper grates.

NOTE

The Oregon Department of Transportation's (ODOT) Bicycle Design Guidelines state that the most effective way to avoid drainage grate problems is to eliminate them entirely with the use of inlets in the curb face. (average annual rainfall in Oregon = 37 inches)

Grate wider than gutter pan reduces usable bike lane width to less than the 36 in. min. specified in HDM §301.2.

3.2.3 Placement of Drainage Grates

Optimally the roadway should be designed so that the bicyclist does not have to traverse the grate per HDM Section 837.2.

On roadways with curb and gutter, the grate should not be wider than the gutter pan. If the gutter pan needs to be widened to accommodate a large drainage grate, the taper should be on the outside edge.

On roads with bike lanes, the roadway shall be designed such that the minimum asphalt concrete pavement width of 48 inches is maintained between the bike lane stripe and the edge of the gutter lip. If 48 inches of asphalt cannot be maintained, then a curb face inlet design for the drainage grate should be considered (see Section 3.2.1).

On roadways with shoulders, the grate should be placed outside the travel path of the bicyclist, i.e. 48 inches of clear pavement should be maintained between the shoulder stripe and the left edge of the drainage grate. If 48 inches cannot be provided within the existing shoulder width, the shoulder can be widened to accommodate the grate, with the taper on the outside edge, or a narrower grate should be selected. See also Section 7.4.and Figure 7-19.

Slotted linear drain inlet, Castro Street, Mountain View.

3.2.4 Gutter Pan Width

Optimally a twelve-inch maximum gutter pan should be used on new construction projects.

Design Considerations

Some cities, including Santa Clara, have ten-inch gutter pans, while others are typically 24 inches (e.g. cities of Palo Alto and Sunnyvale), and occasionally even 36" (some of Palo Alto's local streets). Optimally, this extra twelve to twenty-four inches should be provided in the curb lane or bike lane instead of in the gutter pan in order to increase the smooth obstacle-free area where bicyclists ride.

Curb-face inlet on newly built street section in Alameda with access to catch basin provided in the landscape strip.

TECH TIP

Caltrans' list of Prequalified and Tested Signing and Delineation Materials that conform to Caltrans Standard Specifications can be found at: *www.dot.ca.gov/hq/esc/approved_products_list/.*

TECH TIP

Recommended Thermoplastic Composition

Crushed glass shall be incorporated into the thermoplastic material at a rate of 9–10 percent by weight of the combined material. The crushed glass will be used as a substitute for an equal amount by weight of the filler material. Glass beads meeting standard requirements shall be incorporated into the thermoplastic composition at a rate of between 28-30% by weight of the combined material.

Pigment	25%
Glass Beads	30 %
Filler	35%
Crushed Glass	*10%

*The crushed glass shall be produced from cullet of clear glass, with a maximum size of 850 micrometers (100% passing by weight) and a minimum size of 425 micrometers (0-2% passing by weight).

Source: Vermont Agency of Transporta*tion*

3.3 PAVEMENT MARKING MATERIALS

Paint is the least recommended marking material due to its low reflectivity and low skid resistance, plus it needs to be reapplied every 12 to 24 months, increasing maintenance costs. Durable pavement markings are preferred. They should be reflectorized and be capable of maintaining an appropriate skid resistance under rainy or wet conditions to maximize safety for bicyclists. The minimum coefficient of friction should be 0.30 as measured with California Test 342 to test surface skid resistance. Pavement marking tape or thermoplastic is recommended.

3.3.1 Pavement Marking Tape

Type I Tape such as 3M Stamark TM tape Series 380I and Series 420 is the least slippery (and most long-lasting) pavement marking. Type I tape is cost-effective when placed after resurfacing, since it lasts as long as (or longer than) the pavement itself. The skid resistance of 3M Stamark TM Series 420 tape is 55 BPN with a retained value of 45 BPN; the equivalent coefficient of friction is not available.

3.3.2 Thermoplastic

Thermoplastic is optimized when the composition has been modified with crushed glass to increase the coefficient of friction (as described in the sidebar) and the maximum thickness is 100 mils (2.5 mm).

3.3.3 Pavement Markers

Pavement markers, whether raised reflective markers (Type C, D, G or H) or non-reflective ceramic pavement markers (Type A or AY, otherwise known as Bott's dots) present a vertical obstruction to bicyclists, and shall not be used as bike lane stripes. Where raised markers cross the travel path of a bicyclist, for example through intersections, a gap of 4 feet should be provided as a clear zone for bicyclists. At gore areas (e.g. Standard Plan A20C) and other locations with channelizing lines, (e.g. Standard Plan A20D) if raised reflective markers are used to supplement the striping, extra lane width shall be provided in the areas where bicycles travel to provide bicyclists with more latitude to avoid the markers. (See also Section 7.2).

3.4 ROADWAY SURFACE OBSTACLES

3.4.1 Utility Covers and Construction Plates

Manhole covers and utility plates present obstacles to bicyclists due to their slipperiness and change in surface elevation with the surrounding pavement. While covers and plates can be replaced with less slippery designs, as discussed below, to minimize their adverse impacts on bicyclists, it is best to design the roadway so that they are not located within the typical path of bicyclists riding on the roadway. Therefore, new construction should not place manhole and other utility plates and covers where bicyclists typically ride i.e. within the six feet adjacent to the curb (or between 8 and 13 feet from curb if parking is permitted).

Wet utility covers and construction plate materials can be very slippery. Plain steel plates have a coefficient of friction of 0.012, which is unacceptably slippery and should never be used on the roadway. The coefficient of friction on all utility covers and steel plates placed on a roadway or highway or shoulder should be a minimum of 0.35. An example of an effective method for covers and plates (both steel or concrete) to have acceptable skid resistance is for the manufacturer to imprint waffle shaped patterns or right-angle undulations on the surface. The maximum vertical deviation within the pattern should be 0.25 inch (6 mm).

The maximum deviation of the surface of the cover or plate itself from the surface of the roadway shall be limited to 0.5 inch (12 mm) per HDM Table 1003.6.

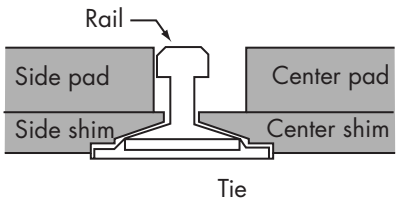
Table 3-3 Bikeway Surface Tolerances

Direction of Travel	Step	Groove
Parallel	No more than 1/2″ wide	No more than 3/8″ high
Perpendicular	-	No more than 3/4″ high

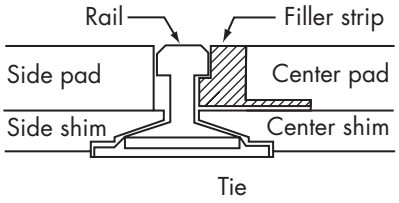
Source: Caltrans HDM 2006, Table 1003.6

NOTE:

As of the printing date, the 2012 update of the HDM removed Table 1003.6 Bikeway Surface Tolerances and did not replace it. The BTG still recommends the use of these tolerances reprinted below in Table 3-3.



Cross section of rubberized railroad crossing for rough perpendicular crossings



Cross section of rubberized railroad crossing with flangeway filler strip for low-speed skewed crossings

Figure 3-2:
Rail Flangeway Filler Options

3.4.2 Railroad Tracks

All railroad crossings should be made as bicycle-safe as possible. Railroad tracks, particularly in intersections, should be removed from rights-of-way that have been abandoned. Priority for these actions should be given to streets with higher bicycle volumes.

Optimizing bicycle-safety involves three issues:

(1) The Angle of the Crossing

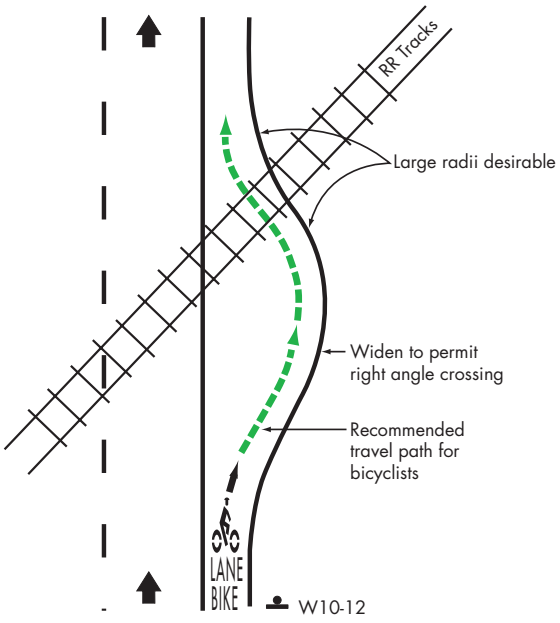
Where the angle of the tracks is not 90 degrees, additional pavement shall be provided so that bicyclists can approach the crossing at 90 degrees as depicted in Figure 3-1 below and in Figure 403.3B of the *Highway Design Manual*. Warning signs should be installed at skewed railroad crossings.

(2) The Smoothness of the Crossing

The surface of the crossing shall be designed such that the rails are as flush as possible with the surrounding pavement with minimal gaps between the roadway and the flangeway. Rubber or concrete crossing materials last longer than wood or asphalt and accordingly require less maintenance. See Figure 3-2 (upper).

(3) The Gap Between the Flangeway and Roadway

On low-speed lightly traveled railroad tracks, commercially available flangeway fillers can eliminate the gap next to the rail. (This solution is not acceptable on commuter rail lines.) See Figure 3-2 (lower).



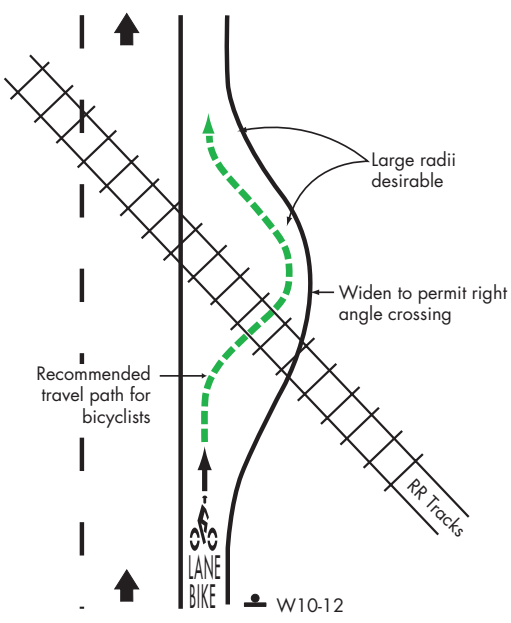


Figure 3-1:
Bikeway Crossing Skewed Railroad Tracks

Not to scale

New concrete railroad crossing at Cox Avenue in Saratoga, funded by Measure B.

Rubberized railroad crossing on route to school in Palo Alto.

3.4.3 Rumble Strips on the Traveled Way

The MUTCD-CA Section 3B.106 states that rumble strips are b*ands of raised material or indentations* in the pavement surface whose purpose is to *call the motorist's attention to standard warning or regulatory devices or otherwise alert drivers by transmitting sound and/or vibration through the vehicle.* They should only be installed where they are considered the optimal solution to the identified problem and where other measures have proved ineffective. Since the abrupt rise can present problems to bicyclists and motorcyclists, the MUTCD-CA states there should be provisions for bicyclists to travel around or through, as described below. Rumble strips shall not be installed in the bike lanes on streets with bike lanes.

See Section 7.4.5 for guidance on *Shoulder Rumble Strips.*

TECH TIP

Typical locations where rumble strips on the traveled way have been used include:

- End of a freeway.
- In advance of toll booths.
- Within a construction zone in advance of the workers.
- In advance of a "T" Intersection where the motorist is not expecting to stop.

Source: MUTCD Section 3B.106(CA)
Refer to MUTCD Section 3B.106(CA) for more guidance on rumble strips

Caltrans Standard for Traveled Way Rumble Strips

Rumble strips on the traveled way generally extend across the travel lanes and are:

- 19 mm (0.75 in) or less in height, if raised;
- 25 mm (1 in) or less in depth, if rolled-in indentations;
- 8.5 mm (0.33 in) +/- 1.5 mm (0.06 in), if ground-in indentations; (A ground-in rumble strip with these dimensions has been field reviewed to confirm rideability for bicyclists & motorcyclists).

VTA Best Practice

When rumble strips are installed in a travel lane including Type A and AY raised ceramic markers, or the latter two listed above, a clear space of 18 to 24 inches through which bikes can travel should be provided at the right-hand edge and in the center of the travel lane.

LOCAL PRACTICE

Some cities are hesitant to use signs that are not contained in the California MUTCD. However, other cities feel that the existing guidance in the California MUTCD gives them the leeway to create signs for a specific situation. Many cities in Santa Clara County have developed and are using such signs. For example, Sunnyvale, Santa Clara and Cupertino use "Share the Road" signs; these are warning (yellow) signs and/or information (green) signs. The City of San Jose is pursuing the approval of the use of a "Yield to Bikes" sign. To be "official" traffic control devices, these signs would need to be submitted to the California Traffic Control Devices Committee (CTCDC). It is possible, and encouraged, that any of the fifteen jurisdictions may opt to pursue the formality of applying to the CTCDC to adopt one or more of the signs in these guidelines that are not currently in the California MUTCD as a State standard.

TECH TIP

The MUTCD and the MUTCD - CA have discontinued many signs that have been used in California. Some are to be removed immediately and some may be retained until the end of their useful life.

3.5 SIGNAGE USAGE AND DESIGN

The MUTCD-CA contains traffic signs that are used on public roadways in California. MUTCD-CA cautions that excessive signage is confusing and distracting to both motorists and bicyclists, and may lessen the effectiveness of signs in general. The placement of signs should be limited to those necessary to:

- Inform highway users of traffic laws or regulations (a regulatory sign);
- Convey a warning that would not be reasonably apparent to a vehicle operator in the interest of his/her safety or that of other vehicle operators, bicyclists or pedestrians (a warning sign);
- Inform or direct motorists, bicyclists or pedestrians (a guide sign);
- Notify drivers and bicyclists of hazards or detours relative to a construction or maintenance project (a construction warning sign).

Traffic signs fall into three categories, and the MUTCD presents the standards as to their shape and color depending on the functional category: regulatory, warning, and guide. Temporary Traffic Control (TTC) signs (formerly called construction signs) are composed of regulatory, warning and guide signs. TTC warning signs are black letters on an orange background. MUTCD-CA contains many of the signs used; additional signs are presented in Caltrans California Sign Specifications and FHWA's Standard Highway Signs. In addition, MUTCD-CA Section 2A.06 provides that: *In situations where word messages are required other than those herein provided, the signs shall be in the same shape and color as standard signs of the same functional type.* Consistent with this statement and the four criteria above, the sign guidelines in this document:

- Expand and refine existing signs within the parameters of the California Manual of Uniform Traffic Control Devices, including suggested practices for placement and frequency.
- Provide guidelines for new signs for situations for which there is no State or Federal standard, but there has been a demonstrated interest in providing signage with a particular message. Including such signs in this document will ensure consistency throughout the County for these situations and circumvent each city developing their own unique sign. Some of these signs, or variations, are currently used by jurisdictions both within and outside Santa Clara County.

Signs specific to Bikeways are presented in Chapters 7 and 8. The signs presented below are the more common signs that might be used along roadways with bicycles.

3.5.1 Regulatory Signs (Black on White)

Regulatory signs give notice of traffic laws or regulations.

Regulatory signs used in conjunction with bike lanes are presented in Chapter 7.

NOTE

Support: CVC 21202(a)(3)) defines a "substandard width lane" as a "lane that is too narrow for a bicycle and a vehicle to travel safely side by side within the same lane.

***Caltrans Standard* – Bicycles May Use Full Lane Sign (R4-11)**

Option:

The Bicycles May Use Full Lane (R4-11) sign may be used on roadways where no bicycle lanes or adjacent shoulders usable by bicyclists are present and where travel lanes are too narrow for bicyclists and motor vehicles to operate side by side.

The Bicycles May Use Full Lane sign may be used in locations where it is important to inform road users that bicyclists might occupy the travel lane.

R4-11

***VTA Best Practice* – Bicycles May Use Full Lane Sign (R4-11)**

Consider using the R4-11 in urban areas where the following conditions exist and the roadway is not a designated bike route. If it is a designated bike route (i.e. signed with the D11-1 sign), consider the shared lane pavement marking instead to reduce sign clutter; see Section 7.3. For rural areas, see the Share the Road sign discussed on Page 7-27:

- Outside lane width < 14 feet with no on-street parking or Outside lane width < 22 feet with on-street parking.
- Collector or arterial street with ADT >2000 vehicles per lane per day (vplpd)

D11-1
(formerly known as Caltrans G93)

***Caltrans Standard* – Other Regulatory Signs**

Bicycles Must Exit R44C (CA) This sign is placed at the beginning of an off-ramp on a freeway segment where bicycles are permitted but now are required to exit.

R44C (CA)

Bicycle Signal Actuation R10-22 This sign may be installed at signalized intersections where pavement markings are used to indicate the location where a bicyclist is to be positioned to actuate the signal (per MUTCD Section 9C.05 and 9B.13). If used, it should be placed at the roadside adjacent to the marking to emphasize the connection between the marking and the sign.

R10-22

Push Button for Green Light R62C (CA) This sign is placed where it is not intended for bicyclists to be controlled by the pedestrian indication, but rather the vehicle indication. Typically, a loop detector is installed to detect bicycles but a push button maybe more expedient in certain circumstances. If used, the push button should be installed near the edge of the sidewalk in the vicinity of where bicyclists will be waiting to cross the street.

R62C (CA)


W11-1


W16-7p


W10-12

AT TWO-WAY STOP SIGN CONTROLLED INTERSECTION
W4-4p


W7-5

W11-15 and W11-15p

W16-1p

VTA SW-1a

VTA SW-1b

ADVANCE OF ON-RAMP
VTA SW-2

ADVANCE OF LEFT-TURN LANES
VTA SW-3

3.5.2 Warning Signs (Black on Yellow)

Warning Signs give notice of a situation that might not be readily apparent.

Caltrans Standard

Bike Crossing (W11-1 and W16-7p) – Where bicycles cross a road at an unexpected location, (i.e. not at a typical intersection), these signs may be posted to alert motorists of the presence of bicycles. To alert motorists of the presence of bicycles on the roadway travelling in the same direction, see, as appropriate, (CA) Bike Route, R81 (CA)Bike Lane, or R4-11 and W16-1p.

Skewed Railroad Crossing (W10-12) – Skewed Railroad Crossing should be used to warn bicyclists and motorcyclists in advance of a grade crossing that is skewed 30 degrees or less from the roadway centerline.

Cross-Traffic Does Not Stop (W4-4p) – These signs may be used to supplement standard markings at intersections which have been converted from 4-way stop to 2-way stop, or when two-way stop signs have been rotated as in the implementation of a bicycle boulevard. Generally, they are used for a limited time until the traffic is used to the change.

Steep Grade (W7-5) – Steep grade sign should be used in advance of a downgrade where the percent grade, length or horizontal curvature may not be readily apparent to cyclists or where accident experience and field observations indicate a need.

Trail crossing (W11-15) – These signs should be posted where motorists two-way bicycle traffic (such as a bike path) crosses through an intersection. See also: TDMG Policies UD-1.1.5; UD-1.1.6; UD-4.16; UD-4.17; and Figures T-12A; T-12B; T-13A; T-13B.

VTA Best Practice

Share the Road (W11-1/W16-1p) – Consider the Share the Road sign assembly on rural roadways; see Discussion in Chapter 7.4

Watch for Bikes on Left (VTA SW-1a) – This sign may be used to warn motorists of the unusual condition where bicyclists are merging from their left; this occurs after a free right-turn onto an arterial as described in Section 5.1.3.

Yield to Bikes (VTA SW-2 & VTA SW-3) – Signs to warn right-turning motorists to yield to bicyclists should be used as appropriate. Two versions are presented: in advance of freeway on-ramps, and in advance of a heavy bicycle left-turn movement /lane.

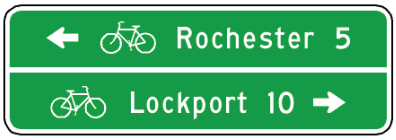
3.5.3 Guide Signs

Guide signs show route designations, destinations, directions, distances, services, points of interest and other geographical, recreational, or cultural information.

Informational signs are essential in informing cyclists of the location of facilities that may not be readily apparent, these should be placed on roads regardless of whether the road is a designated bikeway to point the way to things like bike bridges and tunnels, bike path access points and bike parking. Bike guide signing is presented in Chapter 8, Section 8.1.3.

D1-1b

D1-2b



D1-2C

3.5.4 Construction Zone and Detour Signs (Black on Orange)

Signs used in construction zones and to mark detours for bicyclists are presented in Chapter 4, Section 4.6.5.

3.5.5 Other Signs

Trailhead signage and/or distinctive placemaking signage have been used by Member Agencies to give certain facilities, particularly trails, a distinctive symbol and/or to display a logo or the city seal. Attractive signs and markers can add an element of public art to the facility.

VTA SG-2

The City of Cupertino announces its Bicycle-Friendly City designation at the main entrance points to the city.

Customized Bike Route sign in Oakland with directional placards.

NOTE

For more guidance on bulbouts see also:

- Pedestrian Technical Guidelines Section_3.2;
- The CDT Manual Best Practice 4.26 "Minimize Crossing Distance."
- "Designing Walkable Urban Thoroughfares: A Context Sensitive Approach: An ITE Recommended Practice" *(http://www.ite.org/css/*
- FHWA's PedSafe Guide at : *http://www.walkinginfo.org/pedsafe/downloads/pedsafe_ch5.pdf.*

3.6 BULBOUT DESIGN

Bulbouts, also known as "curb extensions", are an effective design feature either at an intersection or a midblock crosswalk to reduce the distance a pedestrian must walk within the roadway and to increase the visibility of pedestrians to motorists. Bus bulbouts also serve as enhanced passenger loading areas. If a bulbout is provided, certain design elements should be incorporated so that bicyclists are not adversely impacted. These elements address:

1) the width of the curb extension; and

2) the width of the gutter pan adjacent to the bulb-out.

If the street has bike lanes, see Section 7.1.3 and Figure 7-5.

3.6.1 Width of Curb Extension:

Caltrans Standard

For Bulbout standards on state highways, see HDM § 303.4

VTA Best Practice

The bulbout should retain a minimum lane width of 15 feet, to allow for bicyclists and motor vehicles cars to traverse side by side, as measured from the curb face of the bulbout to the lane line. In addition, see next section for maximum gutter pan width.

3.6.2 Width of Gutter Pan:

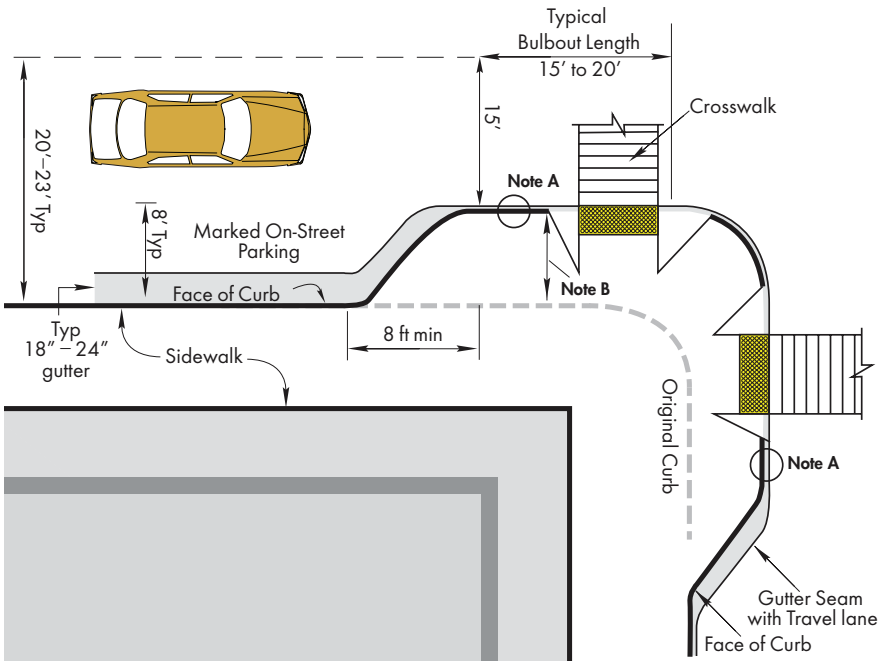
Discussion

As shown in Figure 3-3, the gutter pan width on a street with on-street parking does not adversely affect bicyclists, since the bicyclists are riding ten feet or more way from the curb. However, at the bulbout, the gutter pan width is critical, since the curb is being extended to be immediately adjacent to the cyclist's travel path. The gutter pan reduces the effective lane width and the gutter seam of a typical 24-inch gutter pan is located where a cyclist would normally choose to ride, i.e. about two feet offset from the curb face. Moreover, depending on the location of the catch basin and cross slope of the street, a wide gutter pan on the bulbout may not be needed to effectively drain the storm flow.

See Section 3.2 for more guidance on gutter pan widths.

VTA Best Practice

Optimally, the gutter pan on the bulbout is narrowed to 6 inches or eliminated entirely to maximize the roadway width for cyclists at the bulbout. To be in conformance with ADA practice, the landing at the bottom of the ramp must be level for 24 inches. If the crown of the roadway exceeds 2% slope, then the roadway may need to be repaved to achieve the required level landing. However, the repaving should not leave a seam that could pose a problem to cyclists. This is illustrated in Figure 3-4.



Notes

A. Gutter pan width adjacent to the bulb-out is 6 in. maximum, or eliminate the gutter pan entirely. See also Section 3.6.

B. 6 ft optimum; see Section 3.6

C. Retain lane width of 15 ft. min. from curb face to lane line, so bicyclists and motor vehicles can pass the bulbout side by side.

Figure 3-3:
Bulbout on Street Without Bike Lane

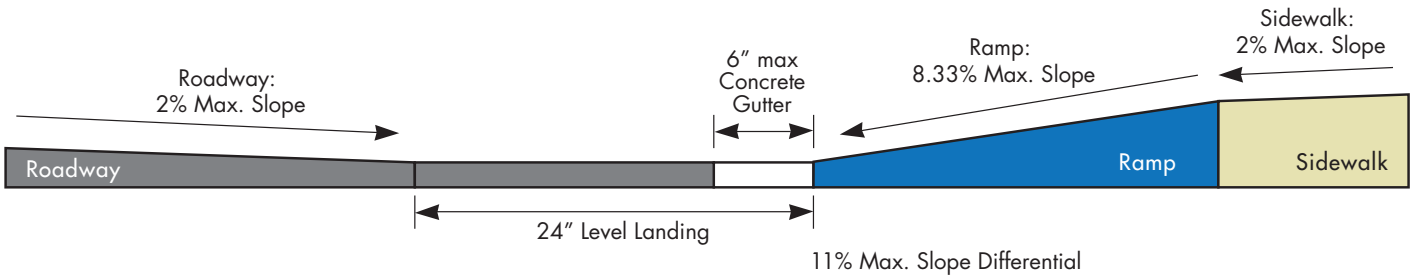


Figure 3-4:
Gutter Pan Dimensions at Bulbout without Bike Lane

The wide gutter pan at this bulbout reduces the available smooth obstacle-free roadway width for a cyclist.

4 MAINTENANCE AND CONSTRUCTION ZONES

4.1 ROADWAY RESURFACING

IN THIS CHAPTER:

4.1 Roadway Resurfacing

4.2 Roadway Patching and Utility Trenching

4.3 Ponding

4.4 Sweeping

4.5 Landscape Maintenance

4.6 Construction Zones and Detours

4.1.1 Gutter Seams

During resurfacing, ensure smooth longitudinal gutter seams by grinding and/or wedge cutting prior to applying the overlay. This will maintain a smooth transition between the asphalt surface of the roadway and gutter pan thereby providing a safe riding surface for bicyclists. (Note: This is standard practice in Palo Alto, Sunnyvale and Los Altos.) See Figure 4-1.

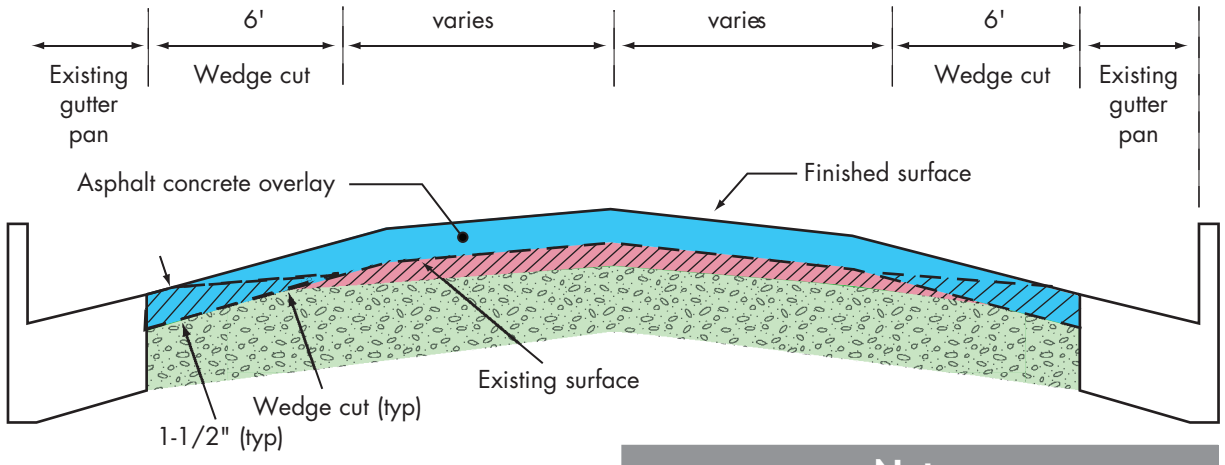
4.1.2 Check Lane Widths

Lane width allocation should be reevaluated during every resurfacing project to determine if bike lanes or wide curb lanes can be provided when the roadway markings are reapplied. See guidelines set forth in Chapter 7.1 Bike Lanes, Chapter 7.2 Wide Curb Lanes or Chapter 7.4 Rural Roads and State Highways.

4.1.3 Pavement Surface

The project should include the following construction practices:

The maximum tolerances for variations in the vertical surface for grooves (indentations) and steps (ridges) are set forth in the HDM Table 1003.6 (see also Chapter 3.4.1). These tolerances should be maintained



Notes

- Depth of wedge cut should equal depth of A Coverlay, typically 2" on arterial streets, 1-1/2"on local streets.
- Finished surface should match level of gutter to within 1/4".

Figure 4-1:
Wedge Cut for Roadway Resurfacing

Not to scale

LOCAL PRACTICE

The City of Palo Alto also requires that contractors guarantee adherence to these standards for one year after project completion.

on all roadways at locations such as driveway lips, where two pavements intersect, and other such seams in the areas where bicyclists can be expected to ride.

4.2 ROADWAY PATCHING AND UTILITY TRENCHING REPAIR

The repair of potholes and trenches should adhere to compaction standards of Caltrans Standard Specification 39-6.03 to ensure that the pavement surface remains intact and smooth. (See Figure 4-2).

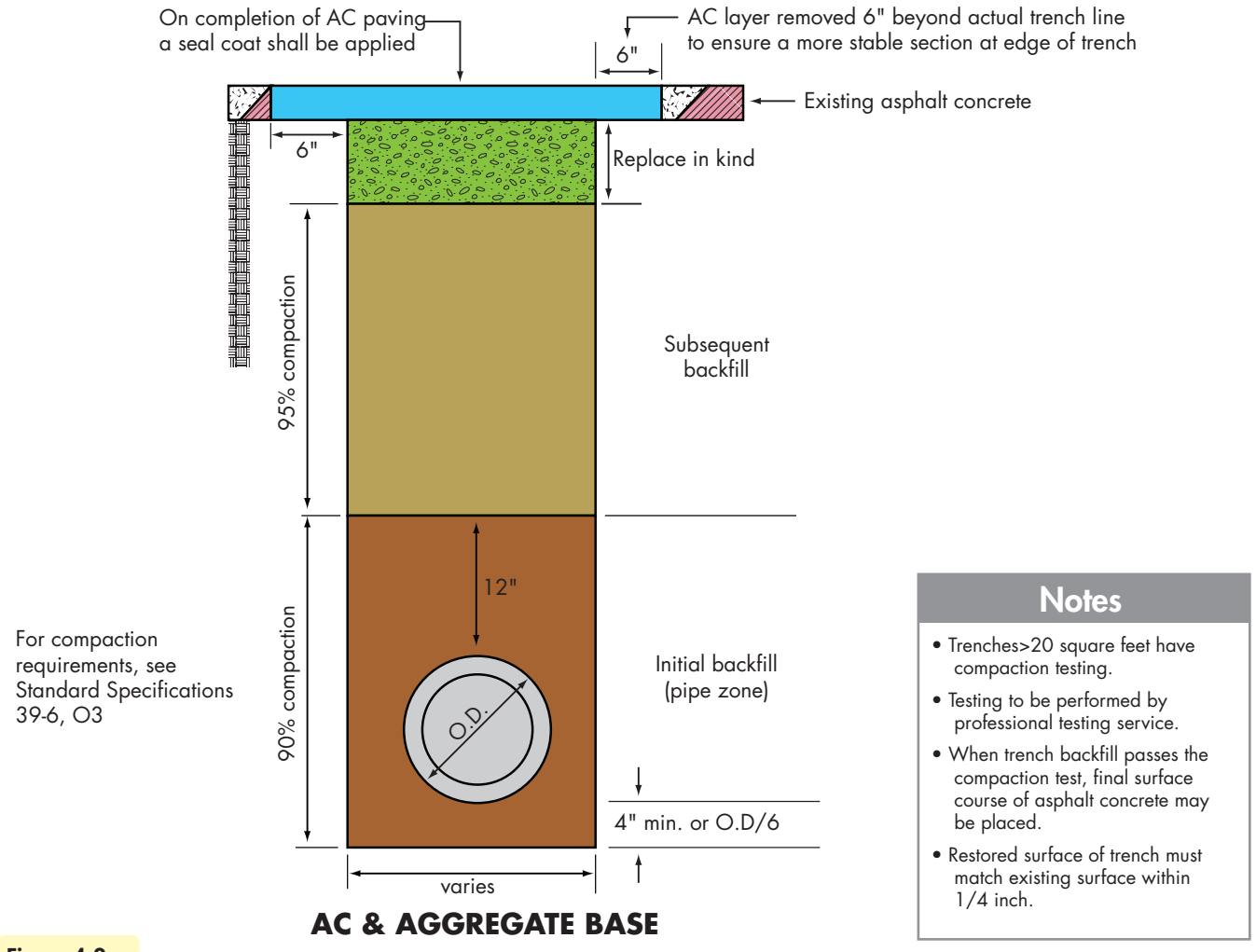


Figure 4-2:
Trenching and Compacting Procedures

4.3 PONDING

Ponding at the edge of the road and in bike lanes occurs when there are dips and bumps in the roadway surface and when drains become clogged. This is potentially a problem for bicyclists because riding through the pond may cause the bicyclist to fall or the pool of water may cover an obstacle, for example a drainage grate with parallel bars. A regular inspection of curb and gutter should be undertaken to identify areas that are raised, sunken or have some vertical differential that would cause ponding; these should be repaired.

4.4 SWEEPING

All roadways should be swept regularly to remove debris such as gravel, glass and leaves which may cause a bicyclist to slip and fall. Roadway sweeping schedules will vary depending on the season, the number and types of street trees and other characteristics of the roadway. Responsible agencies should also remove broken glass from the roadway, including the gutter and shoulder after all accidents. During construction or maintenance activities sweeping is generally required on a daily basis to remove excess gravel and debris.

4.5 LANDSCAPING MAINTENANCE

Shrubs and other landscaping adjacent to the roadway or shoulders, including expressway shoulders, should be regularly inspected to ensure that they do not encroach upon the roadway or shoulder area where bicyclists ride. This includes low encroaching shrubs that occupy the physical space where the bicyclists ride as well as eye level shrubs or tree branches that could hit bicyclists in the face. Table 4-1 lists typical maintenance activities and their recommended frequencies.

Table 4-1
Optimal Maintenance Frequencies For Roads and Trails

Maintenance Activity	Recommended Frequency
Respond to hazardous pavement failure reports	Respond to 100% of reports within 8 hours of report
Maintain clean walkways/roadside areas	80% of areas maintained to a "satisfactory" level as defined by a photographic standard
Sweep roadways or trails	100% of roadways every two weeks, with 90% maintained to a "satisfactory" level as defined by a photographic standard
Maintain arterial street traffic markings	100% of markings annually
Maintain non-arterial street and trail traffic markings	75% of markings every two years
Repair deteriorated non-traffic control signs	100% within 30 days of report/ complaint
Maintain landscaping encroachment onto roadway or trail that obscures sight distance	100% within 24 hours of report.
Sweep during construction	Daily

TECH TIP

There are several considerations in planning for bicyclists in Temporary Traffic Control zones on highways and streets:

- A travel route that replicates the most desirable characteristics of a wide paved shoulder or bikeway through or around the traffic control zone is desirable for bicyclists.
- If the traffic control zone interrupts the continuity of an existing bikeway system, signs directing bicyclists through or around the zone and back to the bikeway is desirable.
- Unless a separate bike path through or around the traffic control zone is provided, adequate roadway lane width to allow bicyclists and motor vehicles to travel side by side through or around the zone is desirable.
- Bicyclists should not be led into direct conflicts with mainline traffic, work site vehicles, or equipment moving through or around the traffic control zone.

Source: Chapter 6D.04 MUTCD(CA)

4.6 CONSTRUCTION ZONES AND DETOURS

Detailed guidance on temporary traffic controls is presented in Chapter 6 "Manual of Temporary Traffic Controls" MUTCD-CA, (formerly Traffic Manual Chapter 5 "Traffic Controls for Construction and Maintenance Work Zones").

4.6.1 Construction Plates

Construction plates used on the roadway should be installed flush with the surrounding pavement or marked as an obstacle. When they cannot be provided flush, then asphalt ramps should be provided to reduce the difficulty for bicyclists. Construction plates should meet the skid resistance criteria discussed in Section 3.4.1. Leading and trailing edges of the plates should be beveled or diked with asphalt to provide a smooth transition for cyclists.

4.6.2 Roadway Construction Zones – Bicycle Considerations

When there is construction on arterial or highway but the road remains open, the MUTCD-CA suggests the bicycle considerations presented in the sidebar. In addition:

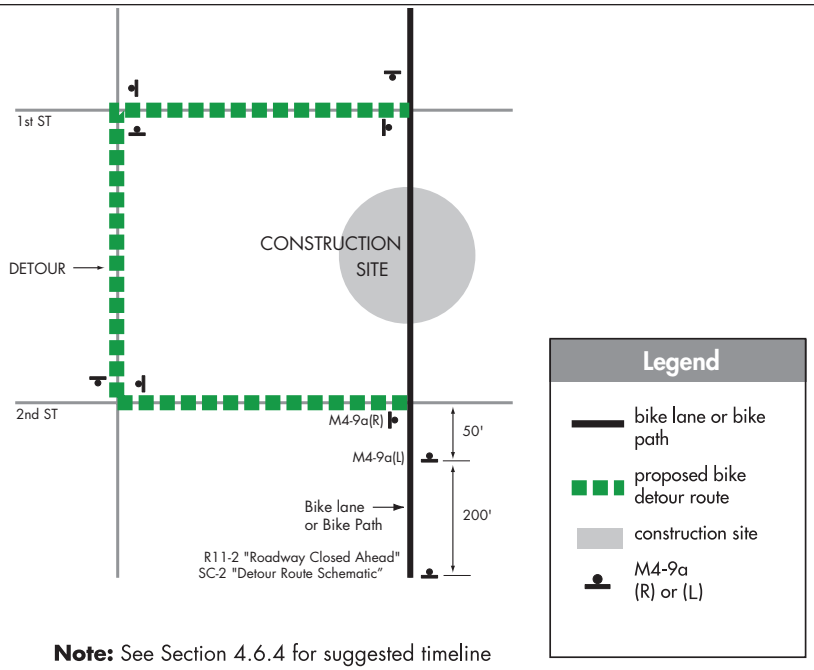
- When there is an existing bike lane or shoulder, every effort should be taken to maintain a bike lane or shoulder through the construction area. For example, where K-rails are used to delineate the zone, place them 4 feet to the right of the lane line, where possible, so bicyclists can safely traverse the construction zone; or provide 15 foot wide temporary lane for side by side use.
- Where a bike lane or wide travel lane cannot be provided, options for accommodating bicycles through roadway construction zones include posting construction zone speed limit at 15 mph to allow for safe lane sharing.
- Where one-way operation is required, flaggers should be trained to allow for bicycles to traverse the zone before allowing opposite direction traffic through.
- Where work on shoulders is required, see MUTCD-CA Chapter 6G.06, 6G.07 and 6G.08.

4.6.3 Road and Path Closures

If an entire roadway is closed and a detour is being provided, first consider whether it is possible to still permit access to bicyclists and pedestrians, since their space needs are much less than those of automobiles. If a detour is necessary, see Section 4.6.4 below.

4.6.4 Construction Detours for Bicyclists

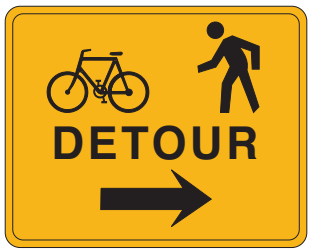
Adequately signing a bike detour is essential to maintain bicycle mobility during maintenance, repair and construction activity. Construction detours should consider and accommodate bicycles through the entire detour. For a bike path closure or if a different detour is provided for bicycles (e.g. use of a bike path or sidewalk), then bike-specific construction warning and detour signing should be used throughout the entire site. (See Section 4.6.5 and Figure 4-3.)



Note: See Section 4.6.4 for suggested timeline

Figure 4-3:
Bike Detour Plan for Closed Street or Path

Not to scale

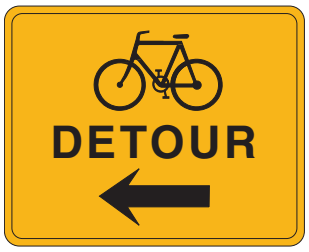


M4-9A

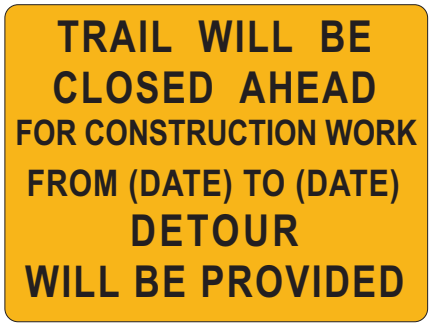
When a bike path or road must be temporarily closed, the detour route should be planned at least three months in advance. For VTA projects, the detour route plans as described below should be submitted to the VTA Bicycle Program Manager; also submit the answers to the questions in Table 4-2. For non-VTA construction projects, the detour route(s) should be developed in conjunction with the agency's Bicycle Coordinator or other appropriate staff person using the process described below or the agency's process, if any.

Table 4-2
Bikeway Closure Evaluation Questions

a)	Explain why facility cannot remain open during the work.
b)	Can a temporary bypass be provided around the work site (on public or private right-of-way) in lieu of or in addition to the detour?
c)	Can the construction/repair work be phased to reduce the length of trail closed at any one period in time?



M4-9C



ADVANCE NOTICE SIGN VTA SC-1

60 days prior to closing the facility

Prior to developing the detour signage plan, submit drawings at scale no smaller than 1"=100 ft (1:1200) that describes the work area, the reason for the closure and the proposed timeframe.

30 days prior

Develop detour signage plan in conjunction with the city traffic engineer and the bicycle coordinator. Details should be included as depicted in Figure 4-3.

14 days prior

A sign giving advance notice that a road/path will be closed and the timeframe should be posted.

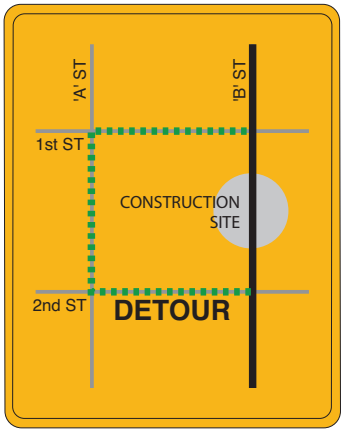
2 days prior

Install detour signing

During road/path work

Inspect detour route throughout duration of project.

4.6.5 Construction Detour Signing (Black on Orange)



VTA SC-2

Caltrans Standard

Bicycle Detour (M4-9c) sign should be used where a pedestrian/ bicycle detour route has been established because of the closing of a bicycle facility to through traffic. It is used with an arrow pointing in the appropriate direction either on the sign face or on a supplemental plaque.

If the detour route for the Pedestrian Detour is the same as for the Bicycle Detour, then the combination pedestrian/bicycle detour sign (M4-9a) may be used.

VTA Best Practice

Advance Notice Sign (SC-1)-Post a sign giving bicyclists advance notice of all bike path closures and of all other detours of more than 0.5 miles. Two weeks notice of path and roadway closures is recommended.

Schematic Detour Route (SC-2)-A schematic of the detour route should be posted at the beginning of the detour if the detour route is complex or there are a lot of non-local users of the facility, e.g. a regional trail.

Detour Evaluation Examples

Below are two examples of trail repair projects and the respective answers to the questions in Table 4-2.

Example 1

a) Explain why facility cannot remain open during the work.

A sanitary sewer pipe has burst and is directly beneath the trail between Station 100.3 and 100.4

b) Can a temporary bypass be provided around the work site (on public or private right-of-way) in lieu of or in addition to the detour?

Yes, the work area affects only 50 linear feet of the trail, and it will be possible for bicyclists and pedestrians to walk around the work site using the adjacent vacant ROW, for distance of 100 feet. They will also have the option of using the signed detour.

c) Can the construction/repair work be phased to reduce the length of trail closed at any one period in time?

No, phasing is not possible since the work site is at a single point along the trail (as shown in detour plan).

Example 2

a) Explain why facility cannot remain open during the work.

Trail is being resurfaced due to severe pavement deterioration and must be closed in order to conduct work.

b) Can a temporary bypass be provided around the work site (on public or private right-of-way) in lieu of or in addition to the detour?

No, the trail is between the Green Canal and a fenced residential area and there is no opportunity to provide an area for trail users to walk around the work area.

c) Can the construction/repair work be phased to reduce the length of trail closed at any one period in time?

Yes, work will be phased so that only the equivalent of one block will be worked on at a time (as shown in detour plan).

Construction ahead may have worried some cyclists, but the City of Cupertino let them know that the bike lane would be retained.

The bike lane and one travel lane on N. First Street were closed due to construction of condominiums, but space for bikes was preserved.

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