

Project Greenlight White Paper



Summer, 2017



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Purpose

Controlled intersections tend to be a hindrance to bicyclists. Because bicycles rely on human-based power, having to stop at intersections increases the burden of travel for bicyclists. For this reason, some bicyclists may ignore, or discount the importance of, intersection controls such as stop signs and signals when there are not perceived conflicts. This is especially prevalent at T-intersections where a bike lane is present at the top of the T-intersection. It is a common interpretation that because motor vehicles do not cross the bike lane, it is safe for people riding a bicycle to continue through the intersection without adhering to the traffic signals. This is still illegal; however, and offers some safety concerns, outlined on the following page.

The purpose of this report is develop alternatives that allow people riding bicycles across the top of t-intersections to legally and safely bypass the traffic signals. This report will concentrates on options for signal controlled intersections, and some of the treatments presented may also apply to all-way stop controlled intersections.

Important Definitions:

Bicyclist, Pedestrian, Motorists: The terms bicyclist, pedestrian, and motorist in this report shall be in reference to how they are defined by the California Vehicle Code.

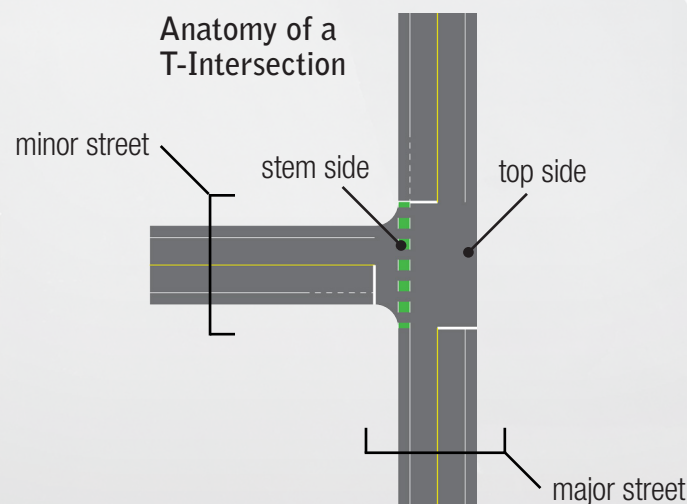
T-Intersection: An intersection where one roadway meets another roadway but does not continue through it.

Minor Street/Road: The corridor that terminates at the T-intersection.

Major Street/Road: The corridor that continues in both directions beyond the T-intersection.

Top Side: The side of a major street at a T-intersection opposite where the minor street meets the major street.

Stem Side: The side of a major street at a T-intersection where the minor street meets the major street.



Background

The following are legal restrictions and safety concerns associated with the exemption of bicyclists on the top side of a T-intersection from adhering to traffic signals.

Legal Restriction

According to California Vehicle Code, a bicycle is considered a vehicle and must adhere to vehicle laws while travelling on public streets. This includes adherence to traffic signals.

We recommend that legislation should not be passed to allow bicyclists to bypass these signals at T-intersections without infrastructure improvements due to these safety concerns.

Safety Concerns

Bicyclists ignoring red lights at T-intersections present several safety concerns to themselves, pedestrians, and motorists. While it is a common practice, and may appear to present no danger, a person riding a bicycle travelling through the intersection on a red light is unexpected for other roadway users and may result in collisions.

Pedestrian Conflicts

T-intersections may eliminate conflicts for the top of the T-intersection between people riding bicycles and motor vehicles. If a crosswalk is present, pedestrians may be legally crossing the bike lane, introducing conflicts with through moving bicyclists.

Motor Vehicle Movements

Conflicting movements between bicyclists and motor vehicles on the top of the T-intersection may not be apparent; however, collisions may still occur due to the unexpected nature of the bicyclists' movement. This is especially true in locations where large vehicles must use the bike lane to make left turns or where motorists may be enticed to pull to the curb, or access a driveway immediately after turning through the intersection.

Bicycle Merging

Bicycles turning left into the bike lane from the minor street will also not expect bicyclists to bypass the traffic signals, and could collide with through bicyclists.

Design Toolbox

Signage

There is no existing MUTCD signage to exempt bicyclists from obeying a traffic signal. Signage could be developed to indicate to bicyclists and motorists that bicyclists in the bike lane may be exempt from the approaching traffic signal. The signage may be a combination of sign R10-6 “STOP HERE ON RED” in the MUTCD with an “EXCEPT BIKES” plaque, or develop a new sign that accomplishes the same.

Striping

Striping can also be an important feature to reinforce expected behavior. It is recommended that a striped buffer with delineators and extruded curbs within the buffer should be installed through the intersection between the travel lanes and the bike lane. The addition of this striped buffer and vertical deflection will upgrade a Class II bike lane to a Class IV separated bicycle facility, and prevent vehicles from encroaching into the bike lane during large turning movements. Alternatives to the delineators and curb may include planters or jersey barriers. If such a separation already exists along the bike lane, then it should be continued through the intersection.

Other striping considerations should include the use of yield markings in the bike lane at pedestrian crossings, to emphasize that pedestrians still have the right-of-way, and applying green bike lane treatments through the intersection for increased visibility.



MUTCD R10-6 Sign



Separated Bike Lane Buffer with striping, flexible Delineators, and Green Traffic Paint.

Hardscape

in addition to signing and striping, raised medians may be used to channelize, deflect, and separate movements. This may be incorporated by installing a raised median between the bike lane and the travel lanes. The bike lane may also be raised through the use of bike ramps as it passes through the intersection, creating a raised bike lane or combining with the sidewalk to create a Class I Shared Use Path. Both options would exempt bicyclists from the traffic signals and physically separate them from the travel lanes.

If a Class I Shared Use Path has a significant number of pedestrians utilizing it, people riding bicycles that are ramped onto the path could enter at a high speed, which may present other challenges to be considered.



Median Separated Bikeway

Signals

Bicycle signals may be used for the implementation of a bike bypass of the traffic signals. Guidance for bicycle signals may be found in the Federal Highway Administration's Interim Approval for Optional Use of a Bicycle Signal Face (IA-16). Bike signals may be used to give bicyclists the legal right to travel through the intersection when motor vehicles are stopped by displaying a green bicycle signal face. At intersections with actuated pedestrian crossings, the bicycle signal would transition to red when the pedestrian signals are activated. If the pedestrian signals are not actuated and occur on recall during each cycle, the bicycle signal would not be used for this purpose.

Alternatively, experimentation may be pursued with the Federal Highway Administration to study the use of flashing yellow bicycle signal faces to instruct bicyclists to proceed through the intersection with caution and to yield to pedestrians. This is not currently addressed under IA-16.

Bicycle signals should be designed to limit confusion of the signals as much as possible by distinguishing the bicycle signal and reducing its visibility to adjacent vehicle lanes. This includes the installation of signal visors or louvers, contrasting signal housings, differing the size of bike signals compared to other traffic signals, and implementing signage that is outlined in IA-16.



Bicycle Signal Faces

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Design Matrix

Using the options from the design toolbox and through research on precedence and regulations, we developed several design options. Each option has strengths and weaknesses, and the appropriate option depends on the context. Table 1 summarizes design options for a variety of scenarios. Table 2 on the following page indicates compatibility of the design options with several conditions that may be found at different T-intersections.

Speed Ranges: the main street speed limits that are acceptable for intersections to utilize that option.

Pedestrian Signals: the pedestrian signal settings that are compatible with the design alternative.

Bikeway Classification: the relevant Caltrans bikeway classification.

Costs: planning level cost range for implementing the design alternatives in a typical intersection. These costs do not include pavement rehabilitation, utilities, right-of-way purchases, signal upgrades, drainage modifications, and other similar factors. Costs also do not account for traffic or parking analyses that may be required to assess the impacts of the treatment.

Geometric Precedence: whether or not the design alternative has been produced before either in part or in full in California, elsewhere in the United States, or internationally. Examples and precedence may include facilities that include all of, or part of, the design alternatives presented in this report. They may not necessarily allow for bicyclists to legally bypass the signals due to community-based policies, but illustrate some of the safety features outlined in this report.

Ease of Implementation: the difficulty associated with implementing that option at an average intersection, taking into account factors such as right-of-way impacts, signal changes, construction costs, and similar variables. One indicates a relatively easy implementation, while 5 indicates a relatively difficult implementation

Table 1: Design Matrix Summary

Option	Name	Speed	Pedestrian Signals	Bikeway Class	Cost	Geometric Precedence	Ease of Implementation
1	Separated Bike Lane	≤ 55 MPH	None	IV	≤\$5,000	California	●○○○○○
2	Separated Bike Lane with Bike Signals	≤ 55 MPH	Actuated	IV	\$60,000 - \$80,000	None/Unknown	●●○○○○
3	Raised Median	≤ 65 MPH	None	IV	\$120,000 - \$200,000	International	●●●○○○
4	Raised Median with Crosswalk	≤ 65 MPH	Actuated/Non-Actuated	IV	\$50,000 - \$130,000	International	●●●●○○
5	Actuated Urban Intersection	≤ 35 MPH	Actuated	IV	\$50,000 - \$75,000	California	●●●●○○
6	Non-Actuated Urban Intersection	≤ 35 MPH	Non-Actuated	IV	≤\$5,000	California	●●○○○○
7	Continuous Green Bypass	ALL RANGES	None	II	≥\$500,000	United States	●●●●●●
8	Shared Use Path Conversion	ALL RANGES	Actuated/Non-Actuated	I	≥\$200,000	United States	●●●●○○

Engineering judgement should be used to identify the appropriate design option, if any are appropriate, for each separate T-intersection.

If there are consecutive T-intersections along a corridor, a design option should be applied as consistently as possible or cyclists should be clearly warned where they are required to stop at a red light and where they are allowed to bypass them.

Table 2 below indicates the compatibility of each design option with individual variables that may or may not be present at T-intersections. If the table indicates yes for a given variable and design option, the condition indicated by the variable does not have to be present for the design option to work, but if it is present, the design option is compatible. If the table indicates no for a given design option and variable, the presence of the condition indicated by the variable is not compatible with the design option, and either the conditions will need to be changed at the intersection, or another option should be considered.

Pedestrian Crossings Present: indicates compatibility with pedestrian crossings on the major street

U-Turns Allowed: indicates compatibility with U-turns for any approach of the intersection

No Turn Lanes Present: indicates capability with a lack of turn lanes or turn bays on the major street

Medians Present: indicates compatibility with medians separating the two directions of travel on the major street

Speeds ≥ 35 MPH: indicates compatibility with speed limits set higher than 35 miles per hour on the major street

Left Turns on Red Allowed: indicates compatibility with permissive left turns on red for the major or the minor streets

On-Street Parking Present: indicates compatibility with on-street parking present near the intersection on the major street

No Sidewalks Present: indicates compatibility with locations that do not have sidewalks on the top side of the intersection

Table 2: Design Matrix Compatibility

Variables	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
Pedestrian Crossings Present	No	Yes	No	Yes	Yes	Yes	No	Yes
U-Turns Allowed	Yes	Yes	No	No	No	No	No	Yes
No Turn Lanes Present	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Medians Present	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Speeds ≥ 35 MPH	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Left Turns on Red Allowed	Yes	No	No	No	No	No	Yes	No
On Street Parking Present	No	No	No	Yes	Yes	No	No	Yes
No Sidewalks Present	Yes	No	Yes	No	Yes	No	Yes	No

OPTION 1: SEPARATED BIKE LANE

DESCRIPTION:

Implementing a Class IV separated bike way at a T-intersection will provide a buffer area that will reduce the risk of collisions from turning vehicles from the side street and remove the ability for motor vehicles to use the bike lane as a shoulder. This may be implemented on two lane or multi-lane roads but may not be desirable at intersections with pedestrian conflicts.

COST: ≤\$5,000

VEHICLE SPEED: ≤55 MPH

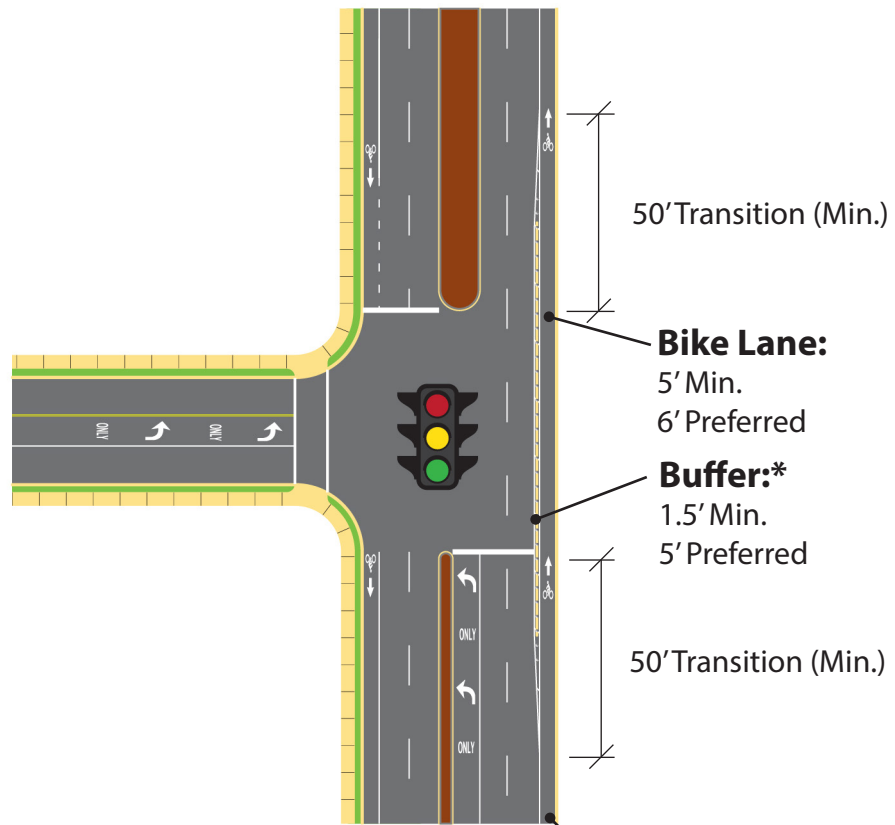
OTHER CONSIDERATIONS:

- If drainage grates are present in the bike lane, they should be replaced with bicycle friendly grates.
- Truck turning movements shall be considered to ensure they do not impede into the bike lane or buffer.
- If a buffer does not already exist between the bike lane and travel lane, a lane width rebalancing, road diet, or roadway widening may need to be implemented.
- Turning onto or off of the bike lane from the minor street is impossible with this configuration.

Geometric Precedence:

- Beach Street & Riverside Avenue, Santa Cruz, CA

(This example illustrates the design option for a two-way, Class IV bicycle facility.)



* Buffer shall include flexible delineators and channelizing curb.

OPTION 2: SEPARATED WITH BIKE SIGNAL

DESCRIPTION:

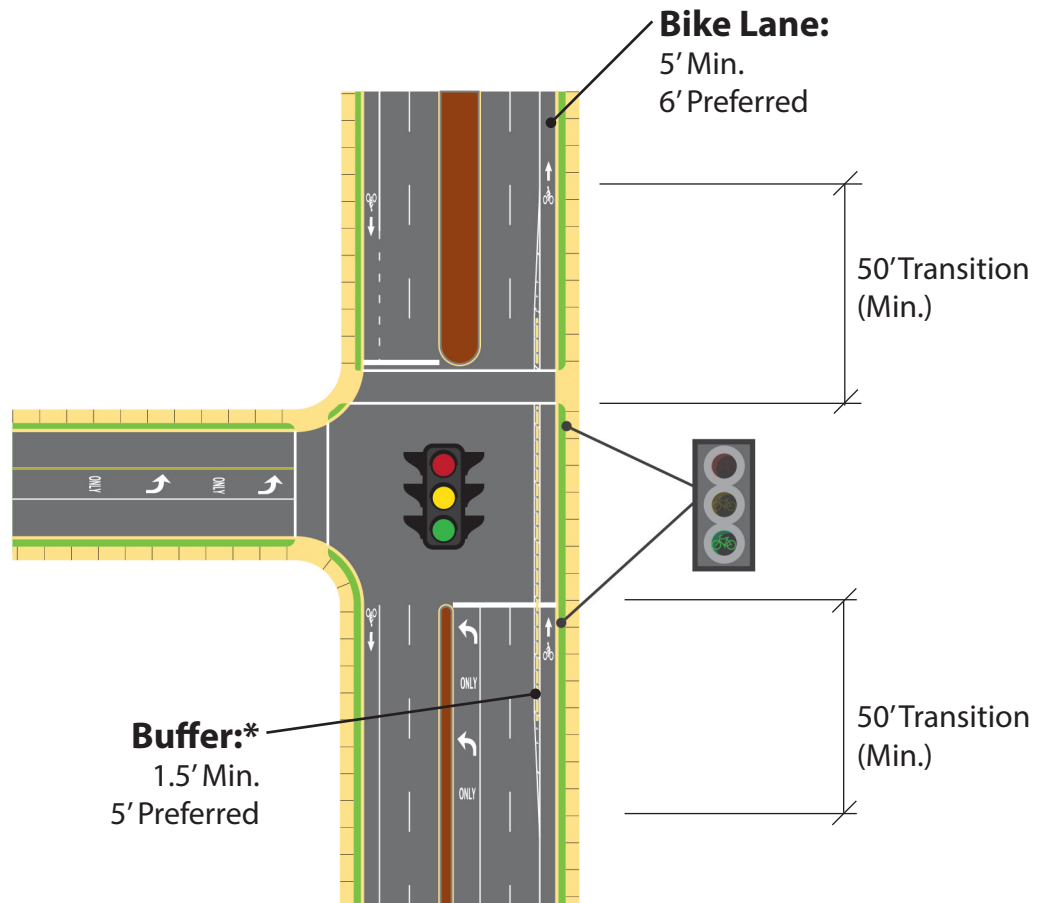
If an intersection on a multi-lane road includes a pedestrian crossing across the main road with actuated pedestrian signals, a bike signal shall be installed for the bypassing bike lane. During the walk phase of the actuated pedestrian signals, the bike signals would be red. All other times, the bike signals would be green.

COST: \$60,000 - \$80,000

VEHICLE SPEED: ≤55 MPH

OTHER CONSIDERATIONS:

- If drainage grates are present in the bike lane, they should be replaced with bicycle friendly grates.
- Truck turning movements shall be considered to ensure they do not impede into the bike lane or buffer.
- If a buffer does not already exist between the bike lane and travel lane, a lane width rebalancing, road diet, or roadway widening may need to be implemented.
- Turning onto or off of the bike lane from the minor street is impossible with this configuration.



* Buffer shall include flexible delineators and channelizing curb.

OPTION 3: RAISED MEDIAN

DESCRIPTION:

Installation of a raised median between the bypassing bike lane and travel lanes will create a more comfortable buffer for bicyclists, and reduce the chance of errant vehicle intrusion. Openings in the island would allow bicyclists to turn onto and off of the minor street. A bicycle signal or standard signal shall supplement this movement. If a crosswalk is present, see option 4.

COST: \$120,000 - \$200,000

VEHICLE SPEED: ≤65 MPH

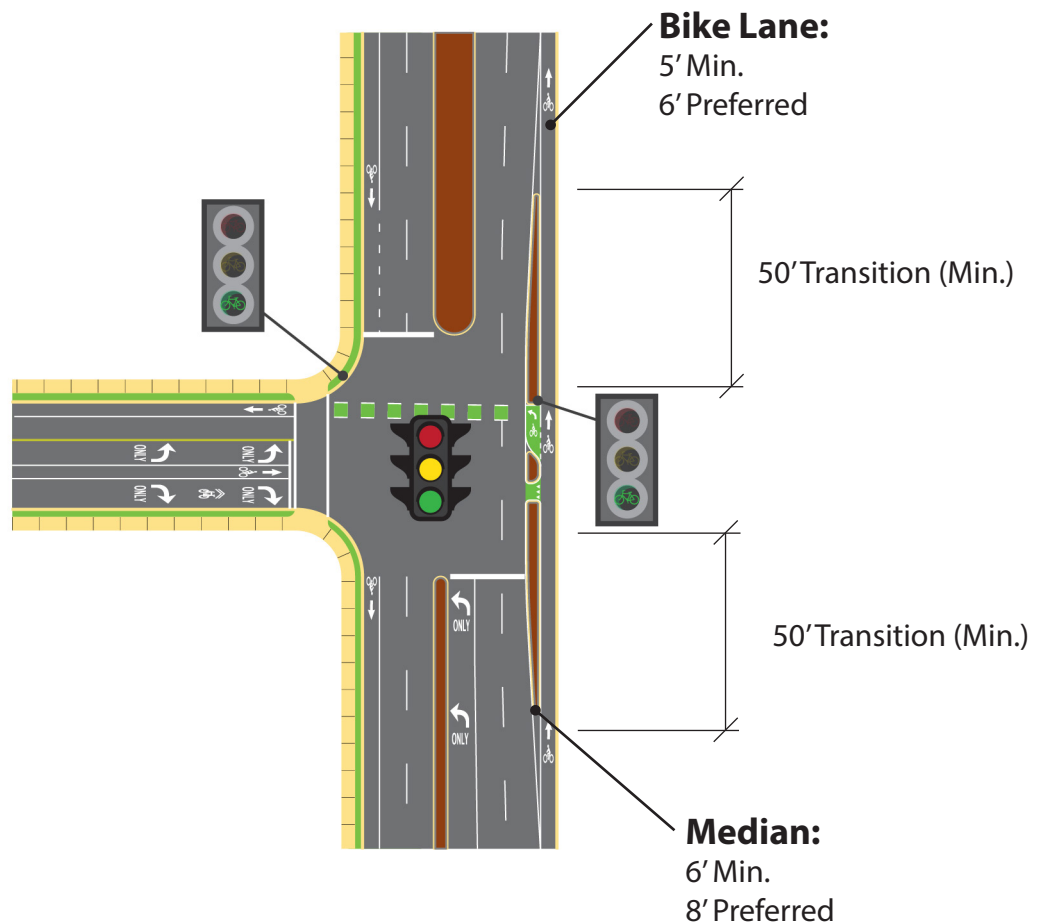
OTHER CONSIDERATIONS:

- Presence of utilities may increase the cost of this option and should be identified prior to the development of a preferred concept.
- A lane width rebalancing, road diet, or roadway widening may be required to incorporate the raised median into the intersection.
- Truck turning movements shall be considered to ensure they do not impede onto the median.

Geometric Precedence:

- Hudson River Greenway/West Street, New York City, NY
- Columbia Street, Brooklyn, NY

(These examples illustrate the design option for two-way, Class IV bicycle facilities.)



OPTION 4: MEDIAN WITH CROSSWALK

DESCRIPTION:

With the presence of a crosswalk, the bicyclists may be instructed to use the pedestrian signals. The pedestrian signals shall not be timed with any conflicting movements, such as turning vehicle movements. Openings in the median shall be made for the crosswalk and bicyclists merging into the bike lane. Bicycle signals may be installed for clarification for bicyclists, but are optional.

COST: \$50,000 - \$130,000

VEHICLE SPEED: ≤65 MPH

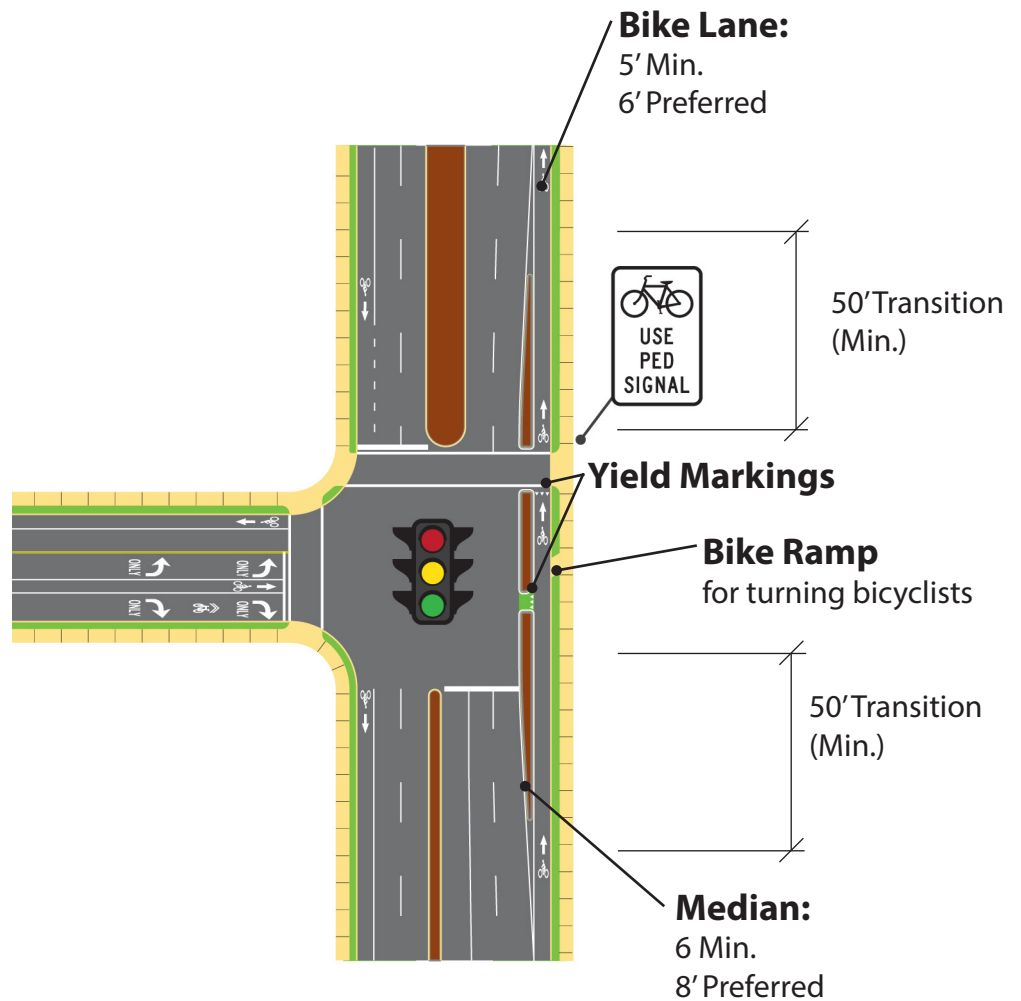
OTHER CONSIDERATIONS:

- Presence of utilities may increase the cost of this option and should be identified prior to the development of a preferred concept.
- A lane width rebalancing, road diet, or roadway widening may be required to incorporate the raised median into the intersection.

Geometric Precedence:

- Hudson River Greenway/West Street, Manhattan, NY
- Prospect Park West, Brooklyn, NY
- Columbia Street, Brooklyn, NY

(These examples illustrate the design option for two-way, Class IV bicycle facilities.)



OPTION 5: ACTUATED URBAN

DESCRIPTION:

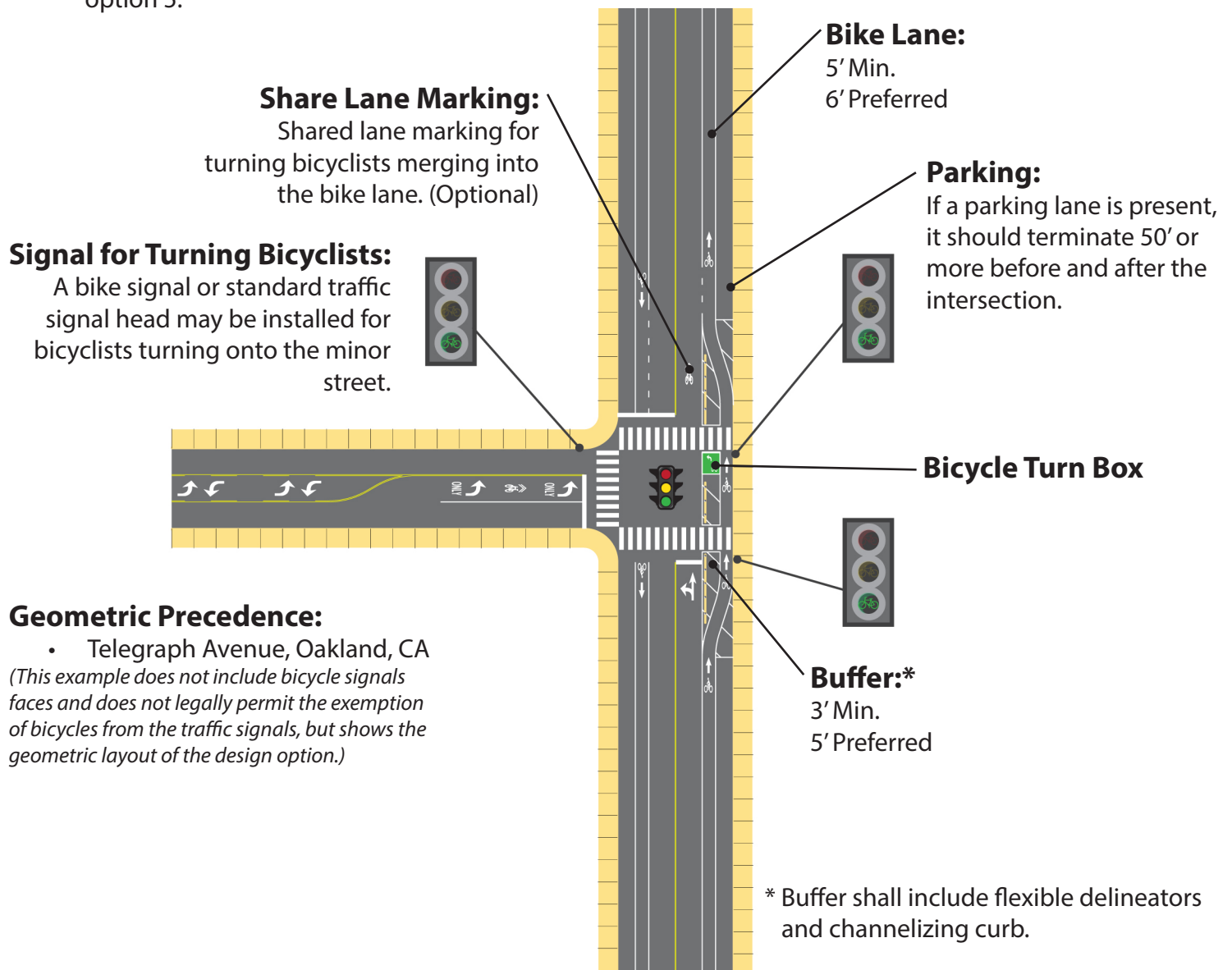
At an urban T-intersection with low travel speeds, low pedestrian crossings, and actuated pedestrian signals, a bypass with a striped or raised buffer should be installed with bicycle signals. During the walk phase of the pedestrian signals, the bike signals would be red. All other times, the bike signals would be green.

COST: \$50,000 - \$75,000

VEHICLE SPEED: ≤35 MPH

OTHER CONSIDERATIONS:

- If drainage grates are present in the bike lane, they should be replaced with bicycle friendly grates.
- Truck turning movements shall be run to ensure they do not impede into the bike lane or buffer.
- If a buffer does not already exist between the bike lane and travel lane, a lane width rebalancing, road diet, or roadway widening may need to be conducted.
- If a parking protected buffer already exists, the parking lane shall terminate before the intersection and transition into a buffer for the bikeway.
- If the pedestrian signals are recalled more than 50% during the peak hours for the intersection, see option 5.



Geometric Precedence:

- Telegraph Avenue, Oakland, CA
(This example does not include bicycle signal faces and does not legally permit the exemption of bicycles from the traffic signals, but shows the geometric layout of the design option.)

OPTION 6: NON-ACTUATED URBAN

DESCRIPTION:

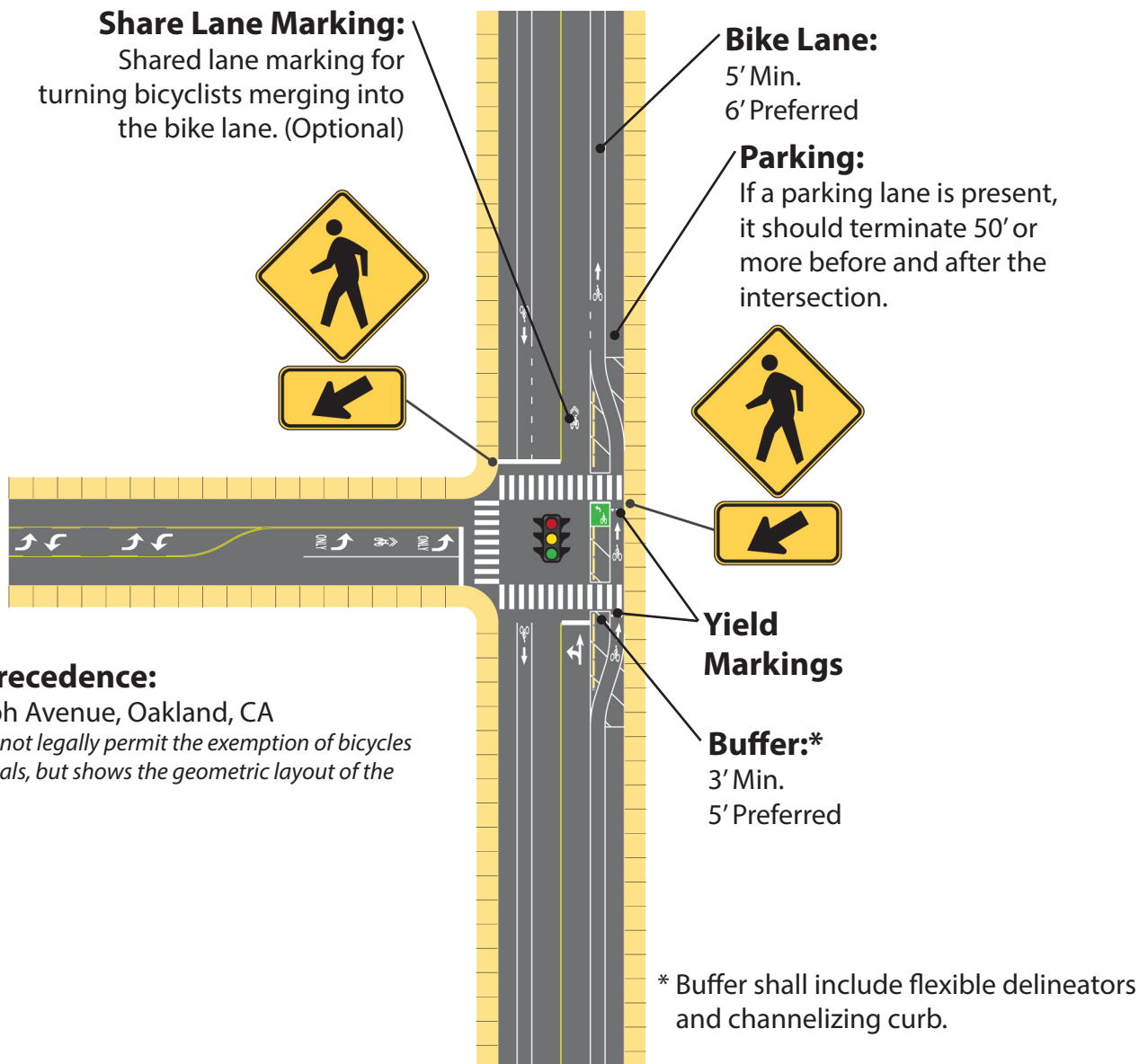
Where pedestrian signals are non-actuated and are pretimed, pedestrian crossing signage shall be installed and with yield lines in the bike lane to indicate to bicyclists that they are required to yield to pedestrians in the crosswalks.

COST: ≤\$5,000

VEHICLE SPEED: ≤35 MPH

OTHER CONSIDERATIONS:

- If catch basin grates are present in the bike lane, they should be replaced with bicycle friendly grates.
- Truck turning movements shall be run to ensure they do not require encroachment into the bike lane or buffer.
- If a buffer does not already exist between the bike lane and travel lane, a lane width rebalancing, road diet, or roadway widening may need to be conducted.
- If a parking protected buffer already exists, the parking lane shall terminate before the intersection and transition into a buffer for the bikeway.



OPTION 7: CONTINUOUS GREEN

DESCRIPTION:

The continuous green option has the highest precedence among the options. It allows the bike lane, as well as the through travel lanes, to bypass the signal. It has been implemented throughout the United States. However, it does create an uncomfortable turning movement for bicyclists who must transition from the bike lane to the turning lane.

COST: ≥\$500,000

VEHICLE SPEED: ≥35 MPH

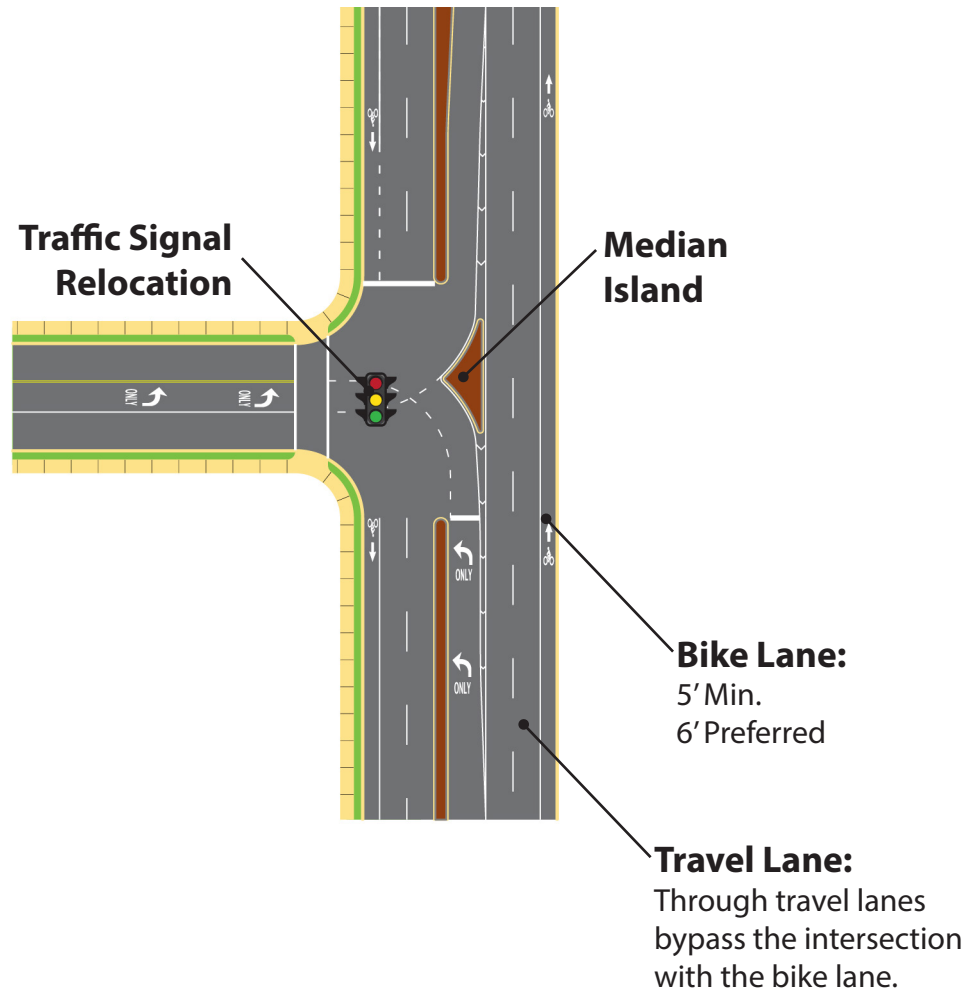
OTHER CONSIDERATIONS:

- Presence of utilities may increase the cost of this option and should be identified prior to the development of a preferred concept.
- A lane width rebalancing, road diet, or roadway widening may be required to incorporate the raised median at the intersection.
- This option is not compatible at intersections with pedestrian signals and/or crosswalks across the main road.

Geometric Precedence:

- US-15 (Westbranch Hwy), Harrisburg, PA
- US-50 & SH 141, Grand Junction, CO
- US-160 & US-550, Durango, CO
- US 17, Jacksonville, FL
- Normandy Blvd., Jacksonville, FL
- SR-201 & SR-111, Magna, UT
- 24th St. & Lincoln Dr., Phoenix, AZ

(These examples do not include the presence of bicycle facilities, but illustrate The signal exemption of top-side through movements)



OPTION 8: SHARED USE PATH

DESCRIPTION:

The shared use path option, separates bicyclists from the roadway completely, thus relinquishing the legal burden of bicyclists to adhere to the traffic signal. Bicyclists may be ramped up, and the sidewalk may be widened. Issues may arise with more confident bicyclists bypassing the ramps, and taking the travel lanes while still not complying with the signals.

COST: ≥\$200,000

VEHICLE SPEED: ALL

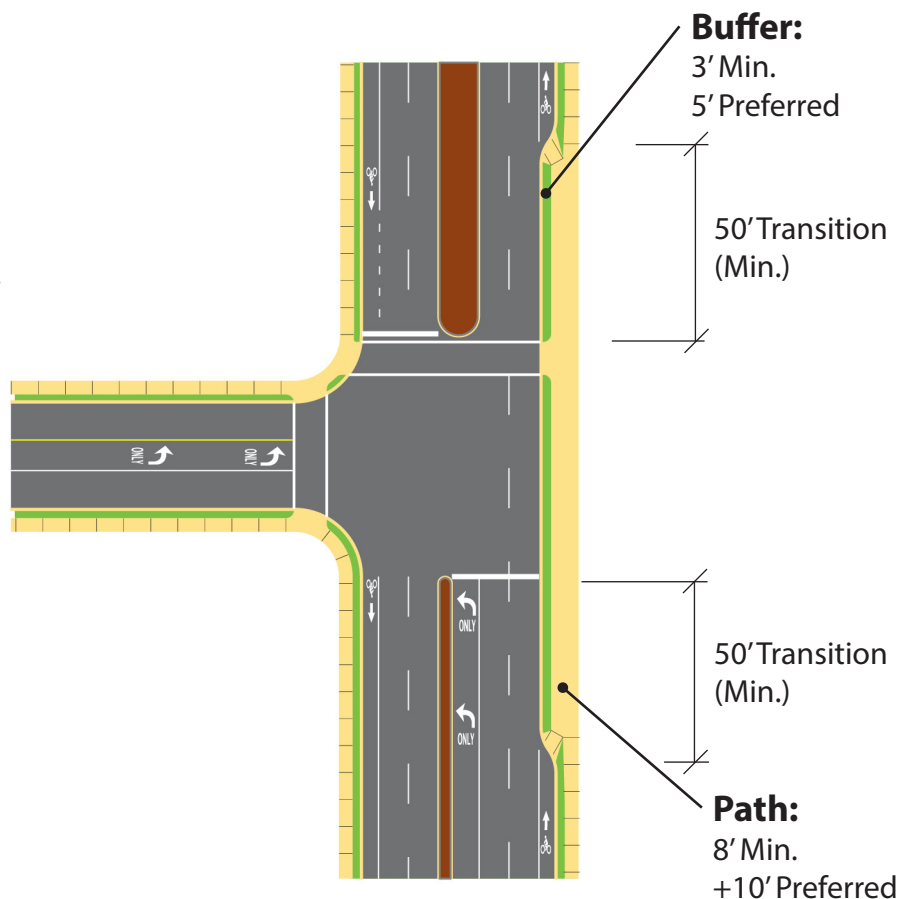
OTHER CONSIDERATIONS:

- Presence of utilities may increase the cost of this option and should be identified prior to the development of a preferred concept.
- If the vegetative buffer is less than 5' in width, a fence or guard-rail shall be installed within the buffer.
- Cost of installation may be reduced if an existing sidewalk already meets the minimum width for a shared use path.
- If no sidewalk is present, precedence should be given to the other options presented.
- Signage or markings may be developed for the end of the path to encourage people riding bicycles to ramp back down into the bike lane and discourage sidewalk riding.

Geometric Precedence:

- Hudson River
Greenway/West Street,
New York City, NY

(This example illustrates the design option for a two-way, Class IV bicycle facility.)



REFERENCES AND RESOURCES:

Alternative Intersections/Interchanges: Informational Report (AIIR). FHWA. <https://www.fhwa.dot.gov/publications/research/safety/09060/006.cfm>.

Appendix B: Active Travel Interventions and Options. Australian Transport Assessment and Planning. <https://atap.gov.au/mode-specific-guidance/active-travel/appendix-b-active-travel-interventions-and-options.aspx>.

Continuous Green T-Intersections. FHWA. <https://safety.fhwa.dot.gov/intersection/innovative/others/casestudies/fhwasa09016/fhwasa09016.pdf>.

Interim Approval for Optional Use of a Bicycle Signal Face (IA-16). FHWA. https://mutcd.fhwa.dot.gov/resources/interim_approval/ia16/.

Revised Standard Plan RSP ES-4C. Caltrans. http://www.dot.ca.gov/hq/esc/oe/project_plans/highway_plans/stdplans_US-customary-units_15/viewable_pdf/rspes-04c.pdf.

Urban Bikeway Design Guide. NACTO. <https://nacto.org/publication/urban-bikeway-design-guide/>.

Urban Street Design Guide. NACTO. <https://nacto.org/publication/urban-street-design-guide/>

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