APPENDIX A: TOOLBOX - DESIGN GUIDELINES

This appendix is intended to assist in the selection and design of bicycle and trail facilities through illustrating best practices by facility type from public agencies and municipalities nationwide. Design treatments are addressed within a single sheet tabular format relaying important design information and discussion, example photos, schematics (if applicable) and existing summary guidance from current or upcoming draft standards.

Existing standards are referenced throughout and should be the first source of information when seeking to implement any of the treatments featured here. Several agencies and organizations provide bike and pedestrian facilities design standards for the US, including the most commonly used manuals shown below.
**NATIONAL STANDARDS**

The Federal Highway Administration's Manual on Uniform Traffic Control Devices (MUTCD) defines the standards used by roadway managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways and private roadways open to public traffic. The FHWA MUTCD forms the basis of the California MUTCD.

To further clarify the MUTCD, the FHWA created a table of contemporary bicycle facilities that lists various bicycle related signs, markings, signals and other treatments and identifies their official status, such as whether it can be implemented or is currently experimental. See Bicycle Facilities and the Manual on Uniform Traffic Control Devices.

Bikeway treatments not explicitly covered by the MUTCD are often subject to experiments, interpretations and official rulings by the FHWA. The MUTCD Official Rulings is an online resource that allows website visitors to obtain information about these supplementary materials. Copies of various documents (such as incoming request letters, response letters from the FHWA, progress reports and final reports) are available on this website.

American Association of State Highway and Transportation Officials (AASHTO) Guide for the Development of Bicycle Facilities, updated in June 2012 provides guidance on dimensions, use and layout of specific bicycle facilities. The standards and guidelines presented by AASHTO provide basic information, such as minimum sidewalk widths, bicycle lane dimensions, detailed striping requirements and recommended signage and pavement markings.

The National Association of City Transportation Officials' (NACTO) 2014 Urban Bikeway Design Guide is the newest publication of nationally recognized bikeway design standards and offers guidance on current design state of the practice. Its intent is to offer substantive guidance for cities seeking to improve bicycle transportation in places where competing demands for the use of the right-of-way present unique challenges. All of the NACTO Urban Bikeway Design Guide treatments are in use internationally and in many cities around the US.

Meeting the requirements of the Americans with Disabilities Act (ADA) is an important part of any bicycle and pedestrian facility project. The United States Access Board’s proposed Public Rights-of-Way Accessibility Guidelines (PROWAG) and the 2010 ADA Standards for Accessible Design (2010 Standards) contain standards and guidance for the construction of accessible facilities. This includes requirements for sidewalk curb ramps, slope requirements and pedestrian railings along stairs. Some of these treatments are not directly referenced in the current versions of the AASHTO Guide or the MUTCD, although many of the elements of these treatments are found within these documents. In all cases, engineering judgment is recommended to ensure that the application makes sense for the context of each treatment, given the many complexities of urban streets.

**ADDITIONAL REFERENCES AND GUIDELINES**

MUTCD Official Rulings, FHWA.
STATE STANDARDS AND GUIDELINES

CALIFORNIA HIGHWAY DESIGN MANUAL (HDM) (2012)
This manual establishes uniform policies and procedures to carry out highway design functions for the California Department of Transportation. The 2012 edition incorporated Complete Streets focused revisions to address the Department Directive 64 R-1.

COMPLETE INTERSECTIONS: A GUIDE TO RECONSTRUCTING INTERSECTIONS AND INTERCHANGES FOR BICYCLISTS AND PEDESTRIANS (2010)
This California Department of Transportation reference guide presents information and concepts related to improving conditions for bicyclists and pedestrians at major intersections and interchanges. The guide can be used to inform minor signage and striping changes to intersections, as well as major changes and designs for new intersections.

MAIN STREETS: FLEXIBILITY IN DESIGN & OPERATIONS (2005)
This Caltrans booklet is an informational guide that reflects many of the recent updates to the Caltrans manuals and policies that improve multimodal access, livability and sustainability within the transportation system. The document will help users locate information about standards and procedures described in the Caltrans Highway Design Manual (HDM), the California Manual on Uniform Traffic Control Devices (California MUTCD) and the Project Development Procedures Manual (PDPM).

NEW LEGISLATION ALLOWING SAFETY STANDARDS OTHER THAN CALTRANS HDM
AB-1193, signed into law in September 2014, allows local agencies to adopt, by resolution, safety standards for bikeways other than Caltrans' Highway Design Manual. According to the Legislative Analyst, AB-1193 “allows local governments to deviate from state criteria when designing bikeways, but does not give them complete control. Cities and counties that elect to use design criteria not contained within the HDM would have to ensure that the alternative criteria have been reviewed and approved by a qualified engineer, are adopted by resolution at a public meeting and adhere to guidelines established by a national association of public agency transportation officials, such as the National Association of City Transportation Officials.” The bill also expands the definition of bikeways to include cycle tracks or separated bikeways, also referred to as “Class IV bikeways,” which promote active transportation and provide a right-of-way designated exclusively for bicycle travel adjacent to a roadway and which are protected from vehicular traffic. Types of separation include, but are not limited to, grade separation, flexible posts, inflexible physical barriers, or on-street parking.

NCHRP LEGAL DIGEST 53: LIABILITY ASPECTS OF BIKEWAYS (2010)
This digest is a useful resource for city staff considering innovative engineering solutions to localized issues. The document addresses the liability of public entities for bicycle collisions on bikeways as well as on streets and highways. The report will be useful to attorneys, transportation officials, planners, maintenance engineers and all persons interested in the relative rights and responsibilities of drivers and bicyclists on shared roadways.
BICYCLE FACILITY STANDARDS COMPLIANCE

Some of these bicycle facilities covered by these guidelines are not directly referenced in the current versions of the AASHTO Guide or the California MUTCD, although many of the elements of these treatments are found within these documents. An “X” in the following table identifies the inclusion of a particular treatment within the national and state design guides. No marking indicates a treatment is not specifically mentioned, but is allowable assuming MUTCD-compliant signs and markings are used. In all cases, engineering judgment is recommended to ensure that the application makes sense for the context of each treatment, given the potential complexities of any specific site.

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MULTIMODAL LEVEL OF SERVICE

DESCRIPTION
Multimodal Level of Service (MMLOS) methods are used to inventory and evaluate existing conditions, or to forecast future conditions for roadway users under different design scenarios. While automobile-oriented LOS measures vehicle delay, Bicycle, Pedestrian and Transit LOS is oriented toward user comfort. MMLOS scores different modes independently, but their results are interdependent, allowing an understanding of trade-offs between modes for different street designs. A compatible A-F scoring system makes comparison between modes simple.

There are a variety of Multimodal or Bicycle/Pedestrian LOS tools available for use. Different tools require different data and may present different or conflicting results. Despite potential limitations of MMLOS methodology, the results help jurisdictions better plan for all road users.

GUIDANCE
MMLOS modeling is an emerging practice and current methods continue to be improved and revised. Local resident and planner knowledge should be used to verify MMLOS model results. The current standard for MMLOS calculation is described in the 2010 Highway Capacity Manual (HCM 2010). This method has limitations, particularly for Bicycle LOS modeling (See Discussion). An alternative MMLOS method/tool should be considered if HCM 2010 is not appropriate for the community. Other multimodal “Service Quality” tools include:

- Florida DOT LOSPLAN
- LOS+
- Mineta Level of Traffic Stress (LTS) Analysis (Bicycle-only scoring)

DISCUSSION
HCM 2010 model for Bicycle LOS calculation limitations include:
- Calculations do not address gradients.
- Contemporary facility types included in this guide, such as shared lane markings, bike boxes or cycle tracks, are not included in the HCM (Florida LOSPLAN update does feature cycle tracks).
- Scoring is for a “typical” adult bicyclist and heavily weighs the presence of bike lanes. Results may not be appropriate in communities that seek to encourage bicycle travel by people of varying ages and abilities where bike lanes may not be adequate.

ADDITIONAL REFERENCES AND GUIDELINES
Florida Department of Transportation, LOSPLAN, 2012.
Fehr&Peers, LOS+ Multi-Modal Roadway Analysis Tool.
Mineta Transportation Institute, Low-Stress Bicycling and Network Connectivity, 2011.
BICYCLE FACILITY SELECTION

There are no “hard and fast” rules for determining the most appropriate type of bicycle facility for a particular location – roadway speeds, volumes, right-of-way width, presence of parking, adjacent land uses and expected bicycle user types are all critical elements of this decision. Studies find that the most significant factors influencing bicycle use are motor vehicle traffic volumes and speeds. Additionally, most bicyclists prefer facilities separated from motor vehicle traffic or located on local roads with low motor vehicle traffic speeds and volumes. Because off-street pathways are physically separated from the roadway, they are perceived as safe and attractive routes for bicyclists who prefer to avoid motor vehicle traffic. Consistent use of treatments and application of bikeway facility standards allows users to anticipate whether they would feel comfortable riding on a particular facility and plan their trips accordingly. This section provides guidance on various factors that affect the facility types that should be provided.
Facility Continua
The following continua illustrate the range of bicycle facilities applicable to various roadway environments, based on the roadway type and desired degree of separation. Engineering judgment, traffic studies, previous municipal planning efforts, community input and local context should be used to refine criteria when developing bicycle facility recommendations for a particular street. In some corridors, it may be desirable to construct facilities to a higher level of treatment than those recommended in relevant planning documents in order to enhance user safety and comfort. In other cases, existing and/or future motor vehicle speeds and volumes may not justify the recommended level of separation and a less intensive treatment may be acceptable.
**Facility Classification**

**Description**

Consistent with bicycle facility classifications throughout the United States, these design guidelines identify the following facility classes by degree of separation from motor vehicle traffic.

Shared Roadways (No bikeway designation) are bikeways where bicyclists and cars operate within the same travel lane, either side by side or in single file depending on roadway configuration. In some instances, streets may be fully adequate and safe without bicycle specific signing and pavement markings.

**Class III (Bike Routes)** are Shared Roadways configured with pavement markings, signage and other treatments including directional signage, traffic diverters, chicanes, chokers and/or other traffic calming devices to reduce vehicle speeds or volumes. Such enhanced treatments often are associated with Bicycle Boulevards.

**Class II (Bike Lanes)** use signage and striping to delineate the right-of-way assigned to bicyclists and vehicle drivers. Bike lanes encourage predictable movements by both bicyclists and drivers.
Class IV (Cycle Tracks) are exclusive bike facilities that combine the user experience of a separated path with the on-street infrastructure of conventional bike lanes.

Class I (Multi-use Paths) are facilities separated from roadways for use by primarily bicyclists and pedestrians, as well as other users.
**Shared Roadways**

On shared roadways, bicyclists and motor vehicles use the same roadway space. These facilities are typically on roadways with low speeds and traffic volumes, but they can be used on higher volume roads with wide outside lanes or shoulders. A vehicle driver will usually have to cross over into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

Typical shared roadways often employ a variety of treatments, primarily signage and lane markings. Bicycle boulevards are a special class of shared roadways designed for a broad spectrum of bicyclists. They are low-volume local streets where drivers and bicyclists share the same travel lane. Bicycle boulevards treatments are selected as necessary to support appropriate vehicle volumes and speeds and to provide safe crossing opportunities of busy streets. Bicycle boulevards usually employ more complex treatments than other shared roadways, including traffic diverters, chicanes, chokers and other traffic calming devices to reduce vehicle speeds or volumes. See Pages 14-15 for examples.
**Signed Shared Roadway**

**Description**

Class III facilities are generally located on roadways with lower speeds and traffic volumes. Class III facilities are designated as roadways with no striped bicycle lanes, but include signage to indicate the roadway is a bicycle route. Shared roadways can be used on higher volume roads with wide outside lanes or shoulders. A vehicle driver will usually have to cross over into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

**Guidance**

“BIKE ROUTE” - This sign (D11-1) is intended for use where no unique route designation is desired. However, when used alone, this sign conveys very little information. Directional changes should be signed with appropriate arrow sub-plaques (D1-1b) or directional signage.

“BICYCLES MAY USE FULL LANE” (BMUFL) - This sign (R4-11) may be used:
- On roadways without bicycle lanes or adjacent shoulders usable by cyclists and where travel lanes are too narrow for cyclists and motor vehicles to safely operate side-by-side.
- In locations where it is important to inform all road users that cyclists may occupy the travel lane.

**Discussion**

A BICYCLE MAY USE FULL LANE sign (R4-11) may be used on a lane too narrow for a bicycle and an automobile to share the road side by side within the same lane).

**Materials and Maintenance**

Maintenance needs for bicycle wayfinding signs are similar to other signs and will need periodic replacement due to wear and fading.

**Additional References and Guidelines**

California MUTCD, 2014.
Marked Shared Roadway

Description

The shared lane marking (SLM) or “Sharrow” is commonly used where vehicle parking is provided adjacent to the travel lane. The center of the marking should be located a minimum of 11 feet from the curb face or edge of the road. If used on a street without on-street parking that has an outside travel lane less than 14 feet wide, the centers of the Shared Lane Markings should be at least four feet from the face of the curb, or from the edge of the pavement where there is no curb. (Note that these criteria are evolving and that it is now common practice to place SLMs in the center of the rightmost travel lane.)

Guidance

Shared lane markings may be considered in the following situations:

- On roadways with speeds of 40 mph or less (CA MUTCD).
- On constrained roadways too narrow to stripe with bicycle lanes.
- To delineate space within a wide outside lane where cyclists can be expected to ride.
- On roadways where it is important to increase vehicle driver awareness of cyclists.
- On roadways where cyclists tend to ride too close to parked vehicles.

Minimum placement
11’ from curb

When placed adjacent to parking, SLMs should be outside “Door Zone”

Placement in center of travel lane is preferred in constrained conditions
**Discussion**

Bike lanes should be considered on roadways with outside travel lanes wider than 15 feet, or where other lane narrowing or removal strategies may provide adequate road space. SLMs can not be used in shoulders, designated bike lanes, or to designate bicycle detection at signalized intersections. (MUTCD 9C.07)

**Materials and Maintenance**

Placing SLMs between vehicle tire tracks will increase the life of the markings and minimize the long-term cost of the treatment.

**Additional References and Guidelines**

Caltrans HDM Chapter 300.
California MUTCD 2014.
FHWA MUTCD, Interim Approval for Optional Use of Green Colored Pavement for Bike Lanes (IA-14).
BICYCLE BOULEVARD

DESCRIPTION

Bicycle boulevards are low-volume, low-speed streets modified to enhance bicyclist comfort by using treatments such as signage, pavement markings, traffic calming and/or traffic reduction and intersection modifications. These treatments allow through movements of bicyclists while discouraging similar through-trips by non-local motorized traffic.

GUIDANCE

- Signs and pavement markings are minimum treatments necessary to designate a street as a bicycle boulevard.
- Bicycle boulevards should have a maximum posted speed of 25 mph. Use traffic calming to maintain an 85th percentile speed below 22 mph.
- Implement volume control treatments based on bicycle boulevard context, using engineering judgment. Target motor vehicle volumes range from 1,000 to 3,000 vehicles per day.
- Intersection crossings should be designed to enhance safety and minimize delay for bicyclists.

Shared lane markings are MUTCD compliant and widely used to mark bicycle boulevards.

Enhanced Crossings: Use signals, beacons and road geometry to increase safety at major intersections.

Signs identify street as a bicycle priority route.

Partial closures and other volume management tools limit the number of cars traveling on the bicycle boulevard.


**Discussion**

The term “bicycle boulevard” implies a facility that encourages bicycle usage while reducing motor vehicle volumes and/or speeds to a greater extent than on a typical Class III route. Methods used may include preferential treatment such as turn restrictions, contra-flow access through one-way streets, exclusive traffic signal phases, or the reorientation of stop sign control to favor the bicycle boulevard. Traffic calming techniques may include curb extensions, chokers, traffic circles, roundabouts, speed humps, turn restrictions or barricades.

**Materials and Maintenance**

Vegetation should be regularly trimmed to maintain visibility and attractiveness.

**Additional References and Guidelines**

- Caltrans HDM Chapter 300.
- California MUTCD 2014.
**Separated Bikeways**

Designated exclusively for bicycle travel, separated bikeways are segregated from vehicle travel lanes by striping (Class II - Bicycle Lane), or physical measures such as bollards or curbs (Class IV - Cycle Tracks). Separated bikeways are most appropriate on arterial and collector streets where higher traffic volumes and speeds warrant greater separation. Separated bikeways can increase safety and promote proper riding by:

- Defining road space for bicyclists and drivers, reducing the possibility that drivers will stray into the bicyclists’ path.
- Discouraging bicyclists from riding on the sidewalk.
- Reducing the incidence of wrong way riding.
- Reminding drivers that bicyclists have a right to the road.
BICYCLE LANE

DESCRIPTION
This facility provides an exclusive lane for one-way bicycle travel on a street or highway, installed along streets in corridors where there is significant bicycle demand and where there are distinct needs that can be served by them. On streets with on-street parking, bicycle lanes are located between the parking area and the traffic lanes and used in the same direction as motor vehicle traffic.

Many bicyclists, particularly less experienced riders, are more comfortable riding on a busy street if it has a striped and signed bikeway than if they are expected to share a lane with vehicles.

GUIDANCE
Provide five foot minimum width for bicycle lanes located between parking and traffic lanes. Six feet desired.
• Provide four foot minimum width if no gutter exists. With a normal two foot gutter, minimum bicycle lane width is five feet.
• 14.5 feet preferred from curb face to edge of bike lane (12 foot minimum).
• Seven foot maximum width for use adjacent to arterials with high travel speeds. Greater widths may encourage motor vehicle use of bike lane.
When approaching an intersection with right turn only lanes, the bike lane should be transitioned to a through bike lane to the left of the right turn only lane.

DISCUSSION
Wider bicycle lanes are desirable in certain situations such as on higher speed arterials (45 mph+) where use of a wider bicycle lane would increase separation between passing vehicles and bicyclists. Consider buffered bicycle lanes when further separation is desired.

MATERIALS AND MAINTENANCE
Paint can wear more quickly in high traffic areas.

ADDITIONAL REFERENCES AND GUIDELINES
Caltrans California HDM, 2012.
California MUTCD, 2014.
BICYCLE LANES AND DIAGONAL PARKING

DESCRIPTION
The back-in/head-out parking is considered safer than conventional head-in/back-out parking due to better visibility when leaving. This is particularly important on busy streets or where vehicle drivers may find their views blocked by large vehicles or tinted windows in adjacent vehicles. The presence of raised median islands helps prevent drivers from using a back-in stall for head-in parking.

GUIDANCE
Based on existing dimensions from test sites and permanent facilities, provide 16 feet from curb edge to inner bicycle lane stripe and a five foot bicycle lane.

DISCUSSION
Test the facility on streets with existing head-in angled parking and moderate to high bicycle traffic. Additional signs to direct vehicle driver in how the back-in angled parking works is recommended.

MATERIALS AND MAINTENANCE
Paint can wear more quickly in high traffic areas.

ADDITIONAL REFERENCES AND GUIDELINES
City of Los Angeles Bicycle Plan Update, City of Los Angeles.
Buffered Bicycle Lane

Description

Buffered bike lanes are defined in the Urban Bikeway Guide as “conventional bike lanes paired with a buffered space separating the bike lane from the adjacent motor vehicle travel lane and/or parking lane.” Buffered bike lanes are allowed per California 2014 MUTCD guidelines for buffered preferential lanes (Section 3D-01).

Conventional bike lanes typically provide 5 to 6 foot wide space between the curb and travel lane. However, many bicyclists are uncomfortable riding this close to moving traffic particularly on higher speed and/or higher volume roadways. A recent Portland State University study titled “Evaluation of Innovative Bicycle Facilities,” shows that bicyclists feel a lower risk of being “doored” in a buffered bike lane and nearly nine in ten bicyclists prefer buffered lanes to standard lanes. Seven in ten bicyclists indicated they would go out of their way to ride on a buffered bike lane over a standard lane.

The NACTO Urban Bikeway Design guides list several advantages of buffered lanes including:

- Providing “shy” distance between motor vehicles and bicyclists.
- Providing space for bicyclists to pass another bicyclist without encroaching into the adjacent motor vehicle travel lane.
- Encouraging bicyclists to ride outside the door zone when buffer is between parked cars and the bike lane.
- Providing a greater space for bicycling without making the bike lane appear so wide that it might be mistaken for a travel or parking lane.
- Appealing to a wider cross-section of bicycling users.
- And encouraging bicycling by contributing to the perception of safety among users of the bicycle network.

There are three types of buffers:

- Parking or side or curb buffer
- Travel lane side buffer
- Combined side or double buffer

Parking Side or Curb Buffers

Parking or curb side buffers provide space between the bicyclist and parked cars or the gutter pan. This (1) reduces the potential for a bicyclist to strike a car door being opened by a driver, (2) eliminates use of the gutter pan as part of the bike lane and (3) moves the bicyclist out of the blind spots of drivers approaching on the side streets or driveways. The limitation to the parking side or curb side buffer is that they do not provide the “shy space” that makes bicyclists feel more comfortable, but they do reduce the risk of dooring and the use of the gutter pan as part of the bike lane.

Travel Side Buffer

Travel side buffers provide space between the bicyclist and motor vehicles in the travel lane. High speed, high volume roadways make many bicyclists uncomfortable. Recent studies from the Portland State have shown that a simple buffer substantially increases the level of comfort for most bicyclists.

Combined Side or Double Sided Buffer

The combined side or double sided buffer offers the advantage of guiding the bicyclists away from the door zone while providing a perceived safer distance between the bicyclist and the motor vehicles.
GUIDANCE
According to California MUTCD 2014 Section 3D, buffered bike lanes are considered “allowable” treatments. Signage and dimensional guidelines are the same as for Class II bicycle lanes. Additional guidance is included in the NACTO Urban Bikeway Design Guide.
- Bike lane word and/or symbol shall be used (MUTCD Figure 9C-3).
- The buffer shall have interior diagonal cross hatching or chevron markings if it is three feet in width or wider.
- The buffer shall be marked with two white lines. California MUTCD 2014 standards (Section 3D.01) indicate that for a bicyclist to be allowed to cross a double white line, it must be dashed (these are the same standards applied to buffered HOV Lanes). Therefore, it is recommended that the inside line be dashed instead of solid.
- Buffers should be at least 24 inches wide.

DISCUSSION
Add diagonal striping on the outer buffer adjacent to the traffic lanes every 10 feet. However longitudinal spacing should be determined by engineering judgment considering factors such as speed and desired visual impacts.
- On-street parking remains adjacent to the curb.
- A travel lane may need to be eliminated or narrowed to accommodate buffers.

MATERIALS AND MAINTENANCE
Paint can wear more quickly in high traffic areas.

ADDITIONAL REFERENCES AND GUIDELINES
CA MUTCD, 2014.
**Cycle Track**

**Description**
Cycle tracks, which were recently officially designated as Class IV bikeway facilities in California, are an exclusive bike facility that combines the user experience of a separated path with the on-street infrastructure of a conventional bike lane. Cycle tracks are physically separated from motor traffic and distinct from the sidewalk. They differ from buffered lanes in that the bicyclist is separated from travel lanes by a physical barrier.

Cycle tracks have different forms but all share common elements. They provide space exclusively or primarily used by bicycles and are separated from motor vehicle travel lanes, parking lanes and sidewalks. Raised cycle tracks may be at the level of the adjacent sidewalk or set at an intermediate level between the roadway and sidewalk to separate the cycle track from the pedestrian area.

Over the past five years, more than 100 new separated bike facilities have been added in the US. This relatively new type of facility has been shown to be effective in increasing the number of bicyclists using the street, increasing safety for bicyclists, pedestrians and drivers and increasing access to local businesses (Lessons from the Green Lanes: Evaluating Protected Bike Lanes in the US, National Institute for Transportation and Communities, 2014)

Separated bikeways can increase safety and promote proper riding by:
- Defining road space for bicyclists and drivers, reducing the possibility that drivers will stray into the bicyclists’ path.
- Discouraging bicyclists from riding on the sidewalk.

**Guidance**
Cycle tracks should ideally be placed along streets with long blocks and few driveways or mid-block motor vehicle access points.

**One-Way Cycle Tracks**
NACTO Guidelines recommend seven foot minimum width to allow passing and five foot minimum in constrained locations. Note: In accordance with AB-1193, local agency must pass a resolution to adopt NACTO Guidelines in lieu of Caltrans Highway Design Manual if one-way cycle track width is less than nine feet.

- One way cycle tracks can be either conventional flow (go the same direction as the adjacent traffic) or contra-flow (opposite direction of adjacent traffic flow, such as to the left side of traffic on a one-way street).
TWO-WAY CYCLE TRACKS

- Cycle tracks on one-way streets have fewer potential conflict areas than those on two-way streets.
- 12 foot recommended minimum for two-way facility. Eight foot minimum in constrained locations. 
  Note: In accordance with AB-1193, local agency must pass resolution to adopt NACTO Guidelines in lieu of Caltrans Highway Design Manual if two-way cycle track is less than 12 feet wide.

DISCUSSION

Special consideration should be given at transit stops to manage bicycle and pedestrian interactions. Driveways and minor street crossings are unique challenges to cycle track design. Parking should be prohibited within 30 feet of the intersection to improve visibility.

MATERIALS AND MAINTENANCE

Depending on the width, barrier-separated and raised cycle tracks may require smaller sweeping equipment.

ADDITIONAL REFERENCES AND GUIDELINES

**Separated Bikeways at Intersections**

Intersections are junctions at which different modes of transportation meet and facilities overlap. Intersection facilitate the interchange between bicyclists, drivers, pedestrians and other modes to advance traffic flow in a safe and efficient manner. Designs for intersections with bicycle facilities should reduce conflict between bicyclists (and other vulnerable road users) and vehicles by heightening the level of visibility, denoting clear right-of-way and facilitating eye contact and awareness with other modes. Intersection treatments can improve both queuing and merging maneuvers for bicyclists and are often coordinated with timed or specialized signals. The configuration of a safe intersection for bicyclists may include elements such as color, signage, medians, signal detection and pavement markings.

Intersection design should take into consideration existing and anticipated bicyclist, pedestrian and driver movements. In all cases, the degree of mixing or separation between bicyclists and other modes is intended to reduce the risk of crashes and increase bicyclist comfort. The level of treatment required for bicyclists at an intersection will depend on the bicycle facility type used, whether bicycle facilities are intersecting and the adjacent street function and land use.
BIKE BOX

DESCRIPTION
A bike box is a designated area located at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible space to get in front of queuing motorized traffic during the red signal phase. Motor vehicles must queue behind the white stop line at the rear of the bike box.

GUIDANCE
Bike boxes are currently experimental treatments and require more data before an official ruling is made by the FHWA. Obtaining experimental approval is a 4-6 week process and evaluation of the treatment is performed for a minimum of one year.

- 10-16 foot depth. Deeper boxes help to prevent motor vehicle encroachment.
- “STOP HERE ON RED” sign should be post mounted at stop line to reinforce stop line observance.
- “YIELD TO BIKES” sign should be post-mounted in advance of and in conjunction with an egress lane to reinforce that bicyclists have the right-of-way going through the intersection.
- An ingress lane should be used to provide access to the box.
- Supplemental “WAIT HERE” legend can be provided in advance of stop bar to increase visibility.
- Requires permission to experiment from Federal Highway Administration.

DISCUSSION
Bike boxes should be placed only at signalized intersections and motor vehicle right turns on red shall be prohibited. Bike boxes should be used in locations that have a large volume of bicyclists and are best utilized in central areas where traffic is usually moving more slowly.

MATERIALS AND MAINTENANCE
Because the effectiveness of markings depends entirely on their visibility, maintaining markings should be a high priority.

ADDITIONAL REFERENCES AND GUIDELINES
FHWA MUTCD Interpretations, Experimentations, Changes and Interim Approval (IA-14), 2011.
Colored pavement can be used in box for increased visibility

Wide stop lines used for increased visibility

May be combined with intersection crossing markings and colored bike lanes in conflict areas

If used, colored pavement should extend 50' from the intersection
**Bike Lanes at Right Turn Only Lanes**

**Description**

The appropriate treatment at right-turn lanes is to place the bike lane between the right-turn lane and the right-most through lane or, where right-of-way is insufficient, to use a shared bike lane/turn lane. The design (right) illustrates a bike lane pocket, with signage indicating that drivers should yield to bicyclists through the conflict area.

**Discussion**

For other potential approaches to providing accommodations for bicyclists at intersections with turn lanes, please see combined bike lane/turn lane, bicycle signals and colored bike facilities.

**Materials and Maintenance**

Because the effectiveness of markings depends entirely on their visibility, maintaining markings should be a high priority.

**Guidance**

At auxiliary right turn only lanes (add lane):
- Continue existing bike lane width; standard width of 5 to 6 feet (4 feet in constrained locations).
- Use signage to indicate that drivers should yield to bicyclists through the conflict area.
- Consider using colored conflict areas to promote visibility of the mixing zone. Where a through lane becomes a right turn lane:
  - Do not define a dotted line merging path for bicyclists.
  - Drop bicycle lane in advance of merge area.
  - Use shared lane markings to indicate shared use of the lane in the merging zone.

**Additional References and Guidelines**

California MUTCD, 2014.
Caltrans California HDM, 2012.
Caltrans Complete Intersections, 2010.
**Colored Bike Lanes in Conflict Areas**

**Description**

The Federal Highway Administrative (FHWA) has granted the State of California approval for optional use of green colored pavement in marked bicycle lanes and in extensions of bicycle lanes through intersections and other traffic conflict areas. It should be noted that the green colored pavement as described under this approval is used for two different situations:

- To denote a lane exclusively for bicyclists.
- To advise drivers and bicyclists that they are sharing the same patch of pavement and should be aware of each other’s presence.

Local agencies have adopted different philosophies on the usage of green colored pavement. Some agencies use green colored pavement only for Class II lanes where bicyclists have exclusive use and leave the conflict zones uncolored. Other agencies use the green colored pavement only in conflict zones, such as the weave shown in the figure below.
GUIDANCE
Jurisdictions must notify Caltrans where the treatment is being installed as part of FHWA’s conditions to maintain an inventory list.

At auxiliary right turn only lanes (add lane):
- Continue existing bike lane width; standard width of 5 to 6 feet (4 feet in constrained locations).
- Use signage to indicate that drivers should yield to bicyclists through the conflict area.
- Consider using colored conflict areas to promote visibility of the mixing zone. Where a through lane becomes a right turn lane:
  - Do not define a dotted line merging path for bicyclists.
  - Drop the bicycle lane in advance of the merge area.
  - Use shared lane markings to indicate shared use of the lane in the merging zone.

DISCUSSION
The best practices for green colored pavement are still evolving. As of this date, more agencies use green colored pavement for conflict zones than for exclusive bicyclist lanes. The amount of green paint used by such agencies varies dramatically. Some agencies fill the entire conflict zone with solid green paint, while others use a pattern of green stripes. Some agencies use green colored pavement across every driveway, alley and cross streets, while others reserve the use of green colored pavement for conflict zones that merit special attention. The precise design of green colored pavement remains at the discretion of the local agencies.

It should be noted that combing a shared lane marking (“sharrow”) within green colored pavement is no longer approved for new experimentation by the FHWA. However, the FHWA may accept for experimentation the use of green colored pavement as a “background conspicuity enhancement.”

MATERIALS AND MAINTENANCE
Because the effectiveness of markings depends entirely on their visibility, maintaining markings should be a high priority.

ADDITIONAL REFERENCES AND GUIDELINES
California MUTCD, 2014
Caltrans California HDM, 2012.
Caltrans Complete Intersections, 2010.
**Combined Bike Lane/Turn Lane**

**Description**
The combined bicycle/right turn lane places a standard-width bike lane on the left side of a dedicated right turn lane. A dotted line delineates the space for bicyclists and drivers within the shared lane. This treatment includes signage advising drivers and bicyclists of proper positioning within the lane. This treatment is recommended at intersections lacking sufficient space to accommodate both a standard through bike lane and right turn lane.

**Guidance**
The FHWA has disallowed the experimental use of combined bike lane/turn lane markings. Previously, installations were as follows: Maximum shared turn lane width is 13 feet; narrower is preferable.

- Bike lane pocket should have a minimum width of 4 feet with 5 feet preferred.
- Dotted 4 inch line and bicycle lane marking should be used to clarify bicyclist positioning within the combined lane, without excluding cars from the suggested bicycle area.
- “RIGHT TURN ONLY” sign with an “EXCEPT BICYCLES” plaque may be needed for through bicyclists to legally use a right turn lane.

**Discussion**
Unless the FHWA resumes granting permission to experiment with a combined bike lane/turn lane, this treatment will not be recommended.

**Materials and Maintenance**
Because the effectiveness of markings depends on their visibility, maintaining markings should be a high priority.

**Additional References and Guidelines**
INTERSECTION CROSSING MARKINGS

DESCRIPTION
Bicycle pavement markings through intersections indicate the intended path of bicyclists through an intersection or across a driveway or ramp. They guide bicyclists on a safe and direct path through the intersection and provide a clear boundary between the paths of through bicyclists and either through or crossing motor vehicles in the adjacent lane.

GUIDANCE
- See MUTCD Section 3B.08: “dotted line extensions”
- Crossing striping shall be at least six inches wide when adjacent to motor vehicle travel lanes.
- Dotted lines should be two-foot lines spaced two to six feet apart.
- Chevrons, shared lane markings, or colored bike lanes in conflict areas may be used to increase visibility within conflict areas or across entire intersections.

DISCUSSION
Additional markings such as chevrons, shared lane markings, or colored bike lanes in conflict areas are strategies currently in use in the United States and Canada. Cities considering the implementation of markings through intersections should standardize future designs to avoid confusion.

MATERIALS AND MAINTENANCE
Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority.

ADDITIONAL REFERENCES AND GUIDELINES
California MUTCD, 2014.
**Two-Stage Turn Box**

**Description**
Many bicyclists are reluctant to cross traffic lanes to turn left. Two-stage turn boxes offer bicyclists a safe way to make left turns at multi-lane signalized intersections from a right side cycle track or bike lane. Bicyclists continue straight while the traffic signal displays green for the original direction of travel during the first stage of a traffic signal and then wait for the second stage when the cross street receives a green light to complete the move.

**Discussion**
While two stage turns may increase bicyclist comfort in many locations, it results in higher average signal delay for bicyclists versus a vehicular style left turn maneuver.

**Materials and Maintenance**
Paint can wear more quickly in high traffic areas or in winter climates.

**Additional References and Guidelines**

**Guidance**
- Two-stage turn box to facilitate jughandle turn at T-intersection is presently allowed in the Federal and California MUTCDs.
- Two-stage turn box for use other than for jughandle turn at T-intersection is experimental. Required design elements include bicycle symbol pavement marking, a pavement marking turn or through arrow, full-time turn on red prohibition for the cross street and passive detection of bicycles if the signal phase that permits bicyclists to enter the intersection during the second stage of their turn is actuated.
- Green colored pavement is optional.

Turns from a bicycle lane may be protected by an adjacent parking lane or crosswalk setback.
Bike Lanes at Diverging Ramp Lanes

Description
Some arterials may include high speed freeway-style design, such as merge lanes and exit ramps, which can create difficulties for bicyclists. These entrance and exit lanes typically have intrinsic visibility problems because of low approach angles and high speed differentials between bicyclists and motor vehicles. Strategies to improve safety focus on increasing sight distances, creating formal crossings and minimizing crossing distances.

Guidance
Entrance Ramps:
Angle bike lane to increase approach angle with entering traffic. Position crossing to draw drivers’ attention prior to being focused on upcoming merge.

Exit Ramps:
Use a jug handle turn to increase bicyclists approach angle with exiting traffic and add yield striping and signage to the bicycle approach.

Discussion
Green colored pavement is optional.

Materials and Maintenance
Paint can wear more quickly in high traffic areas or in winter climates. Locate crossing markings out of wheel tread when possible to minimize wear and maintenance costs.

Additional References and Guidelines
California MUTCD, 2014.
Caltrans Complete Intersections, 2010.
Freeway Interchange Design

Description
Freeway Interchanges can be significant obstacles to bicycling if they are poorly designed. Travel through some interchange designs may be particularly challenging for youth bicyclists. Key design features at conflict areas through interchanges should be included to improve the experience for bicyclists.

Guidance
Entrance Ramps:
- Right-turn lane should be configured with a taper as an “add-lane” for drivers turning right onto the freeway entrance ramp.
- Bike lane should be provided along left side of right turn lane. Dotted through bike lane striping provides clear priority for bicyclists at right turn “add lane” on-ramps.

Exit Ramps:
- Drivers existing freeway and turning onto crossroad should be controlled by a stop sign, signal, or yield sign, rather than allowing free flowing movement.

Discussion
The on-ramps should be configured as a right-turn-only “add lane” to assert through bicyclist priority. Designs that function for bicycle passage typically encourage slowing or require motor vehicle traffic to slow or stop. Designs that encourage high-speed traffic movements are difficult for bicyclists to negotiate.

Materials and Maintenance
Locate crossing markings out of wheel tread when possible to minimize wear and maintenance costs.

Additional References and Guidelines
California MUTCD, 2014.
Caltrans Complete Intersections, 2010.
**Signalization**

Determining which type of signal or beacon to use for a particular intersection depends on a variety of factors. These include speed limits, Average Daily Traffic (ADT), anticipated bicycle crossing traffic and the configuration of planned or existing bicycle facilities. Signals may be necessary as part of the construction of a protected bicycle facility such as a cycle track with potential turning conflicts, or to decrease vehicle or pedestrian conflicts at major crossings. An intersection with bicycle signals may reduce stress and delays for a crossing bicyclist and discourage illegal and unsafe crossing maneuvers.
BICYCLE DETECTION AND ACTUATION

LOOP DETECTORS OR VIDEO DETECTORS
For signalized intersection movements that do not normally receive a green light unless actuated by a car or pedestrian, the California Vehicle Code requires installation of detectors capable of detecting bicyclists at the limit line. This is most commonly done with either inductive loop detectors or video detection. Traffic actuated signals should be sensitive to bicycles, should be located in the bicyclist’s expected path and stenciling should direct the bicyclist to the point where the bicycle will be detected. This allows the bicyclist to stay within the lane of travel without having to maneuver to the side of the road to trigger a push button.

PUSH BUTTON ACTUATION
A bicyclist pushbutton may be used to supplement the required limit line detectors. These buttons should be mounted in a location that permits their activation by a bicyclist without having to dismount.

REMOTE TRAFFIC MICROWAVE SENSOR DETECTION (RTMS)
RTMS is uses radio signals to detect objects and marks the detected object with a time code to determine its distance from the sensor. The RTMS system is unaffected by temperature and lighting, which can affect standard video detection.

DISCUSSION
Bicycle detection should meet two primary criteria:
- Accurately detect bicyclists.
- Provide clear guidance to bicyclists on how to actuate detection (e.g., what button to push, where to stand).

Requirement for bicycle detection at all new and modified approaches to traffic signals is included in 2014 California MUTCD.

MATERIALS AND MAINTENANCE
Signal detection and actuation for bicyclists should be maintained with other traffic signal detection and roadway pavement markings.

ADDITIONAL REFERENCES AND GUIDELINES
California MUTCD, 2014.
Caltrans Complete Intersections, 2010.
**BICYCLE SIGNAL HEADS**

**DESCRIPTION**

The California MUTCD authorizes bicycle signal heads only at locations that meet Caltrans Bicycle Signal Warrants. FHWA’s Interim Approval IA-16 specifies a more detailed application of bicycle signal indications. Bicycle signal heads may be used for a movement not in conflict with any simultaneous motor vehicle movements at a signalized intersection, including right or left turns on red. The bicycle movement may not be modified by lane-use signs, turn prohibition signs, pavement markings, separate turn signal indications, or other traffic control devices. The signal lens size may be 4 inches, 8 inches, or 12 inches, with 4 inch lens size reserved only for supplemental near-side mountings.

**DISCUSSION**

For improved visibility, smaller (4 inch lens) near-side bicycle signals should be considered to supplement far-side signals.

**MATERIALS AND MAINTENANCE**

Bicycle signal heads require the same maintenance as standard traffic signal heads, such as lamp replacement and responding to power outages.

**GUIDANCE**

California MUTCD Bicycle Signal Warrant is based on bicyclist volumes, collision history, or geometric warrants:

- Those with high peak hour bicyclist volumes.
- Those with high bicycle/motor vehicle collision numbers, especially those caused by turning vehicle movements.
- Where a multi-use path intersects a roadway.
- At locations to facilitate a bicycle movement not permitted for a motor vehicle.
- Bicycle signals must utilize appropriate detection and actuation.

**ADDITIONAL REFERENCES AND GUIDELINES**

FHWA Interim Approval IA-16, 2013.
California MUTCD, 2014.
**ACTIVE WARNING BEACONS**

**DESCRIPTION**
Active warning beacons are user actuated illuminated devices designed to increase motor vehicle yielding compliance at crossings of multi lane or high volume roadways. Types of active warning beacons include conventional circular yellow flashing beacons, in roadway warning lights, or Rectangular Rapid Flash Beacons (RRFB). RRFBs have blanket approval in California per FHWA MUTCD IA11.

**GUIDANCE**
Warning beacons shall not be used at crosswalks controlled by YIELD signs, STOP signs or traffic signals.
- Warning beacons shall initiate operation based on pedestrian or bicyclist actuation and shall cease operation at a predetermined time after actuation or, with passive detection, after the pedestrian or bicyclist clears the crosswalk.

**DISCUSSION**
Rectangular rapid flash beacons have the highest compliance of all warning beacon enhancement options. A study of the effectiveness of going from a no-beacon arrangement to a two-beacon RRFB installation increased yielding from 18 percent to 81 percent. A four-beacon arrangement raised compliance to 88 percent.

**MATERIALS AND MAINTENANCE**
Depending on power supply, maintenance can be minimal. Solar-powered RRFBs can operate for years without issue.

**ADDITIONAL REFERENCES AND GUIDELINES**
- California MUTCD, 2014.
- FHWA Interim Approval (IA-11), 2008.
**Pedestrian Hybrid Beacons**

**Description**
A pedestrian hybrid beacon (PHB), previously known as a high-intensity activated crosswalk (HA WK), consists of a signal head with two red lenses over a single yellow lens on the major street and pedestrian and/or bicycle signal heads for the minor street. There are no signal indications for motor vehicles on the minor street approaches. Pedestrian hybrid beacons are used to improve non-motorized crossings of major streets in locations where side-street volumes do not support installation of a conventional traffic signal or where there are concerns that a conventional signal will encourage additional motor vehicle traffic on the minor street. Hybrid beacons may also be used at mid-block crossing locations.

**Guidance**
Pedestrian hybrid beacons may be installed without meeting traffic signal control warrants. The need should be considered on the basis of an engineering study that considers speed, major-street volumes and gaps:

- If installed within a signal system, signal engineers should evaluate the need for the pedestrian hybrid beacon to be coordinated with other signals.
- Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk.

**Discussion**
An alternative to a pedestrian hybrid beacon is a standard signal face that displays a flashing red indication during the pedestrian clearance phase. The advantage of a standard signal face is that it displays no dark indications that could be interpreted by a driver to be a symptom of a power outage that requires coming to a stop.

**Materials and Maintenance**
Signing and striping need to be maintained to help users understand any unfamiliar traffic control.

**Additional References and Guidelines**
California MUTCD, 2014.
RETROFITTING EXISTING STREETS TO ACCOMMODATE BIKEWAYS

Most major streets are characterized by high vehicle speeds and/or volumes for which dedicated bike lanes are the most appropriate facility to accommodate safe and comfortable riding. Although opportunities to add bike lanes through roadway widening may exist in some locations, many major streets have physical and other constraints that would require street retrofit measures within existing curb-to-curb widths. As a result, much of the guidance provided in this section focuses on effectively reallocating existing street width through striping modifications to accommodate dedicated bike lanes.

Although largely intended for major streets, these measures may be appropriate for any roadway where bike lanes would be the best accommodation for bicyclists.
LANE NARROWING ("LANE DIET")

DESCRIPTION
Lane narrowing utilizes roadway space that exceeds minimum standards to provide the needed space for bike lanes. Many roadways have existing travel lanes wider than those prescribed in local and national roadway design standards, or which are not marked. Most standards allow for the use of 11 foot and sometimes 10 foot wide travel lanes to create space for bike lanes.

GUIDANCE

VEHICLE LANE WIDTH
- Before: 10-15 feet
- After: 10-11 feet

BICYCLE LANE WIDTH
- Bicycle lane guidance applies to this treatment.

DISCUSSION
Special consideration should be given to the amount of heavy vehicle traffic and horizontal curvature before the decision is made to narrow travel lanes. Center turn lanes can also be narrowed in certain situations to provide space for bike lanes.

MATERIALS AND MAINTENANCE
Repair rough or uneven pavement surface.

ADDITIONAL REFERENCES AND GUIDELINES
Caltrans California HDM, 2012.
Caltrans Main Streets, 2005.
LANE RECONFIGURATION ("ROAD DIET")

DESCRIPTION
The removal of a single travel lane will generally provide sufficient space for bike lanes on both sides of a street. Streets with excess vehicle capacity provide opportunities for bike lane retrofit projects.

GUIDANCE
Width depends on project. No narrowing may be needed if a lane is removed.

BICYCLE LANE WIDTH:
- Bicycle lane guidance applies to this treatment.

DISCUSSION
Depending on a street’s existing configuration, traffic operations, user needs and safety concerns, various lane reduction configurations may apply. For instance, a four-lane street (with two travel lanes in each direction) could be modified to provide one travel lane in each direction, a center turn lane and bike lanes.

ADDITIONAL REFERENCES AND GUIDELINES
FHWA Evaluation of Lane Reduction “Road Diet” Measures on Crashes, 2010.
Caltrans Main Streets, 2005.

MATERIALS AND MAINTENANCE
Repair rough or uneven pavement surface.
Shared Use Path

Shared-use paths allow for two-way, off-street bicycle use and also may be used by pedestrians, skaters, wheelchair users, joggers and other non-motorized users. These facilities are frequently found in parks, along rivers, beaches and in greenbelts or utility corridors where there are few conflicts with motorized vehicles. Path facilities can also include amenities such as lighting, signage and fencing (where appropriate).

Key features of greenways include:
- Frequent access points from the local road network.
- Directional signs to direct users to and from the path.
- Limited number of at-grade crossings with streets or driveways.
- Terminating path where it is easily accessible to and from the street system.
- Separate treads for pedestrians and bicyclists when heavy use is expected.
**General Design Practices**

**Description**
Shared-use paths can provide a desirable facility, particularly for recreation and for users of all skill levels preferring separation from traffic. Paths should generally provide directional travel opportunities not provided by existing roadways.

**Discussion**
AASHTO Guide for the Development of Bicycle Facilities generally recommends against development of shared use paths along roadways.

**Materials and Maintenance**
Asphalt is the most common surface for Class I paths, but concrete has proven to be more durable over the long term.

**Additional References and Guidelines**
California MUTCD, 2014.
Caltrans California HDM, 2012.

**Guidance**

**Width**
- 9 feet is minimum allowed by HDM for one-way Class I multi-use path consisting of a five foot paved width with two foot shoulders.
- 12 feet is minimum allowed by HDM for two-way Class I multi-use path consisting of two four foot lanes and two foot shoulders. On structures, Class I multi-use path clear width between railings shall not be less than 10 feet.

**Lateral Clearance**
- Minimum separation between edge of pavement of one-way or a two-way multi-use path and edge of travel way of parallel road or street shall be five feet plus standard shoulder width. Prior to 2012, the Highway Design Manual allowed narrower separation if a physical barrier was included. Since 2012, however, physical barrier would not result in reduced separation.

**Overhead Clearance**
- Minimum vertical clearance allowed by HDM to obstructions across width of multi-use path is eight feet and seven feet over shoulders.

**Striping**
- When striping is required, use a four inch dashed yellow centerline stripe with four inch solid white edge lines.
- Solid centerlines can be provided on tight or blind corners and on the approaches to roadway crossings.
PATHS IN RIVER AND UTILITY CORRIDORS

DESCRIPTION
Utility and waterway corridors often offer excellent shared-use path development and bikeway gap closure opportunities. Utility corridors typically include power line and sewer corridors, while waterway corridors include canals, drainage ditches, rivers and beaches. These corridors offer excellent transportation and recreation opportunities for bicyclists of all ages and skills.

DISCUSSION
Similar to railroads, public access to flood control channels or canals is undesirable by all parties. Appropriate fencing may be required to keep path users within the designated travel way. Creative design of fencing is encouraged to make the path facility feel welcoming to the user.

MATERIALS AND MAINTENANCE
For paths susceptible to flooding or ponding, permeable pavement is an option to reduce water collection, but will require additional regular maintenance to maintain effectiveness.

GUIDANCE
Shared-use paths in utility corridors should meet or exceed general design practices and must conform to the Caltrans Highway Design Manual if designated as a Class I multi-use path. If additional width allows, wider paths and landscaping are desirable.

ACCESS POINTS
Any access point to the path should be well-defined with appropriate signage designating the pathway as a bicycle and pedestrian facility and prohibiting motor vehicles.

PATH CLOSURE
Public access to the path may be prohibited during the following events:
- Canal/flood control channel or other utility maintenance activities
- Inclement weather or the prediction of storm conditions
Local Neighborhood Accessways

Description

Neighborhood accessways provide residential areas with direct bicycle and pedestrian access to parks, trails, green spaces and other recreational areas. They most often serve as small trail connections to and from the larger trail network, typically having their own rights-of-way and easements.

Additionally, these smaller trails can be used to provide bicycle and pedestrian connections between dead-end streets, cul-de-sacs and access to nearby destinations not provided by the street network.

Guidance

- Neighborhood access should remain open to the public
- Trail pavement should be at least 8 feet wide to accommodate emergency and maintenance vehicles, meet ADA requirements and be considered suitable for multi-use
- Trail widths should be designed to be less than 8 feet wide only when necessary to protect large mature native trees over 18 inches in caliper, wetlands or other ecologically sensitive areas.
- Access trails should slightly meander whenever possible to take advantage of available right-of-way space.

Discussion

Neighborhood access should be designed into new subdivisions wherever possible.

Materials and Maintenance

For paths susceptible to flooding or ponding, permeable pavement is an option to reduce water collection, but will require additional regular maintenance to maintain effectiveness.

Additional References and Guidelines

California MUTCD, 2014.
Flink, C. Greenways, 1993.
PATH/ROADWAY CROSSING

At-grade roadway crossings can create potential conflicts between path users and drivers, but well-designed crossings can mitigate many operational issues and provide a higher degree of safety and comfort for path users. This is evidenced by the thousands of successful facilities around the United States with at-grade crossings. In most cases, at-grade path crossings can be properly designed to provide a reasonable degree of safety and can meet existing traffic and safety standards.

Path facilities that cater to bicyclists require additional considerations due to the higher travel speed of bicyclists versus pedestrians. In addition to guidance presented in this section, see previous entries for active warning beacons and pedestrian hybrid beacons (PHBs) for other methods for enhancing trail crossings.
MARKED/UN_SIGNALIZED MID BLOCK CROSSINGS

DESCRIPTION
Marked/unsignalized mid block crossings typically consist of a marked crossing area, signage and other markings to slow or stop traffic. Designing crossings at mid-block locations depends on an evaluation of vehicular traffic, line of sight, pathway traffic, use patterns, vehicle speed, road type, road width and other safety issues such as proximity to major attractions.

When space is available, using a median refuge island can improve user safety by providing pedestrians and bicyclists space to safely cross one side of the roadway at a time.

GUIDANCE
MAXIMUM TRAFFIC VOLUMES
- <9,000-12,000 Average Daily Traffic (ADT) volume
- Up to 15,000 ADT on two-lane roads, preferably with a median
- Up to 12,000 ADT on four-lane roads with median
- Maximum travel speed: 35 mph

MINIMUM LINE OF SIGHT
- 25 mph zone: 155 feet
- 35 mph zone: 250 feet
- 45 mph zone: 360 feet

DISCUSSION
Unsignalized crossings of multi-lane arterials over 15,000 ADT may be possible with features such as sufficient crossing gaps (more than 60 per hour), median refuges and/or active warning devices like rectangular rapid flash beacons.

ADDITIONAL REFERENCES AND GUIDELINES
California MUTCD, 2014
Caltrans California HDM, 2012

MATERIALS AND MAINTENANCE
Locate markings out of wheel tread when possible to minimize wear and maintenance costs.
OVERCROSINGS

DESCRIPTION
Bicycle/pedestrian overcrossings provide critical non-motorized system links by joining areas separated by barriers such as deep canyons, waterways or major transportation corridors. In most cases, these structures are built in response to user demand for safe crossings where they previously did not exist.

Grade-separated crossings may be needed where existing bicycle/pedestrian crossings do not exist, where ADT exceeds 25,000 vehicles and where 85th percentile speeds exceed 45 miles per hour.

GUIDANCE
- 10 foot minimum width between railings, 14 feet preferred. If overcrossing has any scenic vistas additional width should be provided to allow for stopping. A separate 5 foot pedestrian area may be provided for facilities with high bicycle and pedestrian use.
- 10 foot headroom on overcrossing; clearance below will vary depending on feature being crossed.
- Roadway: 17 feet
- Freeway: 18.5 feet
- Heavy Rail Line: 23 feet

DISCUSSION
Overcrossings for bicycles and pedestrians typically fall under the Americans with Disabilities Act (ADA), which strictly limits ramp slopes to 8.33 percent (1:12) with landings every 30 feet. Title 24 of the California Code of Regulations requires gradients up to five percent (1:20) with five foot landings at 400 foot intervals.

ADDITIONAL REFERENCES AND GUIDELINES

MATERIALS AND MAINTENANCE
Potential vandalism may be addressed with sacrificial coatings.
Signalized Crossings

Description
Path crossings within approximately 300 feet of an existing signalized intersection with pedestrian crosswalks are typically diverted to the intersection to avoid traffic operation problems when located so close to an existing signal. For this restriction to be effective, barriers and signing may be needed to direct path users to the signalized crossing. If no pedestrian crossing exists at the signal, modifications should be made.

Guidance
Mid block crosswalks shall not be signalized if they are located within 300 feet of the nearest traffic control signal and should not be controlled by a traffic control signal if the crosswalk is located within 100 feet from side streets or driveways controlled by STOP signs or YIELD signs. If possible, offset the path to the intersection.

Discussion
In the US, the minimum distance a marked crossing can be from an existing signalized intersection varies from approximately 250 to 660 feet. Engineering judgment and location context should be taken into account when choosing the appropriate allowable setback.

Materials and Maintenance
If a sidewalk is used for crossing access, it should meet ADA guidelines.

Additional References and Guidelines
California MUTCD, 2014.
BICYCLE SUPPORT FACILITIES

BICYCLE PARKING
Bicyclists expect a safe, convenient place to secure their bicycle when they reach their destination. This may be short-term parking of two hours or less, or long-term parking for employees, students, residents or commuters.

ACCESS TO TRANSIT
Safe and easy access to bicycle parking facilities is necessary to encourage commuters to access transit via bicycle. Providing bicycle access to transit and space for bicycles on buses and rail vehicles can increase the feasibility of transit in lower-density areas, where transit stops are beyond walking distance of many residences. People are often willing to walk only a quarter-to half-mile to a bus stop, but they may bike as much as two or more miles to reach a transit station.
BICYCLE RACKS

DESCRIPTION
Secure bicycle parking at likely destinations is an integral part of a bikeway network. Adequate bicycle parking should be incorporated into any new development or redevelopment project. Bicycle parking should be given a balanced level of importance when considering car parking improvements or development. In commercial areas where bicycle traffic is more prevalent, as well as parks and shopping centers, increased bicycle parking is recommended.

Bicycle rack type plays a major role in the utilization of the bicycle racks. Only racks that support the bicycle at two points and allow convenient locking should be used. The Association for Pedestrian and Bicycle Professionals (APBP) recommends selecting bicycle racks that:

- Supports the bicycle in at least two places, preventing it from falling over.
- Allow locking of the frame and one or both wheels with a U-lock.
- Are securely anchored to ground.
- Resist cutting, rusting, bending or deformation.

GUIDANCE
Acceptable racks:
- Do not bend wheels or damage other bicycle parts
- Accommodate high security U-locks.
- Accommodate securing the frame and wheels.
- Do not trip pedestrians.
- Are easily accessed yet protected from motor vehicles.
- Are covered if users will leave their bicycles for long periods.
- Are located where cyclists are most likely to travel.

DISCUSSION
Where bicycle parking is very limited, an occasional parking space could be converted into a bicycle corral to increase the attraction of cycling to the commercial district instead of driving there. See bike corrals.

MATERIALS AND MAINTENANCE
Use proper anchors to prevent vandalism or theft.

ADDITIONAL REFERENCES AND GUIDELINES
BICYCLE LOCKERS

DESCRIPTION

Bicycle parking facilities intended for long-term parking must protect against theft of the entire bicycle and its components and accessories. Three common ways of providing secure long-term bicycle parking are:

- Fully enclosed lockers accessible only by the user, either coin-operated, or by electronic, on-demand locks operated by “smartcards” equipped with touch-sensitive imbedded RFID chips.
- A continuously monitored facility that provides at least medium-term type bicycle parking facilities generally available at no charge.
- Restricted access facilities in which short-term type bicycle racks are provided and access is restricted only to the owners of the bicycles stored there.

Perhaps the easiest retrofit is the bicycle locker. Generally, they are as strong as the locks on their doors and can secure individual bicycles with their panniers, computers, lights, etc, left in place. Some bicycle locker designs can be stacked to double the parking density.

DISCUSSION

Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Although many bicycle commuters would be willing to pay a nominal fee to guarantee the safety of their bicycle, long-term bicycle parking should be free wherever automobile parking is free.

MATERIALS AND MAINTENANCE

Regularly inspect moving part function and enclosures. Change keys and access codes periodically to prevent access by unapproved users.

GUIDANCE

- Minimum dimensions: width (opening) 2.5 feet; height four feet; depth six feet.
- Four foot side and six foot end clearance.
- Seven foot minimum distance between facing lockers.
- Locker designs that allow visual inspection are recommended for security.
- Access controlled by a key or access code.

ADDITIONAL REFERENCES AND GUIDELINES

**On-Street Bicycle Corral**

**Description**
Bicycle corrals are generally former vehicle parking stalls converted to bicycle parking. Most have been on-street conversions, but they are now being incorporated into shopping center parking lots as well. Corrals can accommodate up to 20 bicycles per former vehicle parking space. On-street bicycle corrals provide many benefits where bicycle use is high and/or growing:

- Businesses - Corrals provide a much higher customer to parking space ratio and advertise “bicycle friendliness.” They also allow more outdoor seating for restaurants by moving the bicycle parking off the sidewalk. Some cities have instituted programs that allow local businesses to sponsor or adopt a bicycle corral to improve bicycle parking in front of their business.
- Pedestrians - Corrals clear sidewalks and those installed at corners also serve as curb extensions.
- Cyclists - Corrals increase cycling visibility and greatly expand bicycle parking options.
- Vehicle drivers - Corrals improve visibility at intersections by preventing large vehicles from parking at street corners and blocking sight lines.

**Guidance**
See bicycle rack guidelines section.
- Bicyclists should have an entrance width from the roadway of 5–6 feet.
- Desirable to put bicycle corrals near intersections.
- Can be used with parallel or angled parking.
- Parking stalls adjacent to curb extensions are good candidates for bicycle corrals since the concrete extension serves as delimitation on one side.

Lockers can be custom designed and fabricated to complement specific locations.

**Materials and Maintenance**
Physical barriers may obstruct drainage and collect debris. Establish a maintenance agreement with neighboring businesses.

**Discussion**
In many communities, the installation of bicycle corrals is driven by requests from adjacent businesses and is not a city-driven initiative. In other areas, the city provides corrals and business associations take responsibility for maintenance.

**Additional References and Guidelines**
SECURE PARKING AREAS (SPA)

DESCRIPTION
A Secure Parking Area for bicycles, also known as a Bike SPA or Bike & Ride (when located at transit stations), is a semi-enclosed space that offers a higher level of security than ordinary bike racks. Accessible via key-card, combination locks, or keys, Bike SPAs provide high-capacity parking for 10 to 100 or more bicycles. Increased security measures create an additional transportation option for those whose biggest concern is theft and vulnerability.

GUIDANCE
Key features may include:
- Closed-circuit television monitoring
- Double high racks and cargo bike spaces
- Bike repair station with bench
- Maintenance item vending machine
- Bike lock “hitching post” – allows people to leave bike locks
- Secure access for users

DISCUSSION
Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Although many bicycle commuters would be willing to pay a nominal fee to guarantee the safety of their bicycles, long-term bicycle parking should be free wherever automobile parking is free.

MATERIALS AND MAINTENANCE
Regularly inspect moving part function and enclosures. Change keys and access codes periodically to prevent access by unapproved users.

ADDITIONAL REFERENCES AND GUIDELINES
Bike Fix-It Stations

Description
A bike fix-it station is a public work stand complete with tools to perform basic bike repairs and maintenance including fixing a flat to adjusting brakes. While there are several stand designs, they all provide an ergonomic work environment for any rider. The tools are attached to the stand via stainless steel gauge cables to prevent theft. Hanging the bike from the arm hangar allows the pedals and wheels to move freely while making adjustments to the bike.

Discussion
Stations employ universal bike mounting and should be ADA compliant. Common bike tools are tethered to the station by stainless steel cables. The stations’ tubing are generally powder coated, galvanized or stainless steel anchored into concrete or another proper base material specified by vendor. Stations can be color customized from a variety of colors available by vendor. Many stations have a QR code with repair instructions should the rider need additional information.

Materials and Maintenance
Stations are built for outdoor use and sealed from the elements. Some vendors provide a warranty for service and repair should vandalism or mechanical failure occur.

Guidance
Stations are best placed in public areas with a significant amount of bicycle traffic or at popular trailheads.

Wall Setbacks
- Minimum of 48 inches from side of station to wall or other objects
- Minimum of 12 inches from back of station to wall or other objects

Street or Trail Setback
- Minimum of 60 inches from perpendicular street/trail
- Minimum of 96 inches from parallel street/trail.
**BICYCLE ACCESS TO TRANSIT**

**DESCRIPTION**
Safe and easy access to transit stations and secure bicycle parking facilities is necessary to encourage commuters to access transit via bicycle. Bicycling to transit reduces the need to provide expensive and space consuming car parking spaces. Many people who ride to a transit stop will want to bring their bicycle with them on the transit portion of their trip, so buses and other transit vehicles should be equipped accordingly.

For staircases at bus or rail transit stations, bicycle access could be facilitated with bicycle staircase side ramps. These consist of narrow channels just wide enough to accommodate typical bicycle tires, installed below the handrails of staircases. Cyclists place their bicycle tires onto the side ramps and walk them up or down the stairs, so the bicycles roll within the channels.

**DISCUSSION**
Providing bicycle routes to transit helps combine the long-distance coverage of bus and rail travel with the door-to-door service of bicycle riding. Transit use can overcome large obstacles to bicycling, including distance, hills, riding on busy streets, night riding, inclement weather and breakdowns.

**GUIDANCE**

**WAYFINDING**
- Provide direct and convenient access to transit stations and stops from bicycle and pedestrian networks.
- Provide maps, wayfinding signage and pavement markings from bicycle network to transit stations.

**BICYCLE PARKING**
- Route from bicycle parking locations to station/stop platforms should be well-lit and visible.
- Signing should note bicycle parking location, rules for use and instructions, as needed.
- Provide safe and secure long-term parking such as bicycle lockers at transit hubs. Parking should be easy to use and well maintained.

**MATERIALS AND MAINTENANCE**
Regularly inspect the functioning of long-term parking moving parts and enclosures.

**ADDITIONAL REFERENCES AND GUIDELINES**
FHWA University Course on Bicycle and Pedestrian Transportation.
**Bikeway Facility Maintenance**

Regular bicycle facility maintenance includes sweeping, maintaining a smooth roadway, ensuring that the gutter-to-pavement transition remains relatively flat and installing bicycle-friendly drainage grates. Pavement overlays are a good opportunity to improve bicycle facilities. The following recommendations provide a menu of options to consider enhancing a maintenance regimen.
Sweeping

Description
Bicyclists often avoid shoulders and bike lanes filled with gravel, broken glass and other debris; they will ride in the roadway to avoid these hazards, potentially causing conflicts with drivers. Debris from the roadway should not be swept onto sidewalks (pedestrians need a clean walking surface), nor should debris be swept from the sidewalk onto the roadway. A regularly scheduled inspection and maintenance program helps ensure that roadway debris is regularly picked up or swept.

Guidance
Establish a seasonal sweeping schedule that prioritizes roadways with major bicycle routes.

• Sweep walkways and bikeways whenever there is an accumulation of debris on the facility.
• In curbed sections, sweepers should pick up debris; on open shoulders, debris can be swept onto gravel shoulders.
• Pave gravel driveway approaches to minimize loose gravel on paved roadway shoulders.
• Perform additional sweeping in the Spring to remove debris from the Winter.
• Perform additional sweeping in the Fall in areas where leaves accumulate.

Note: Some separated bike facilities (cycle tracks) that employ curbs or other physical barriers for separation may be too narrow for a standard street sweeper, which requires 10 foot clearance. If this is the case, smaller sweepers are available.

Gutter to Pavement Transition

Description
On streets with concrete curbs and gutters, 1 to 2 feet of the curbside area is typically devoted to the gutter pan, where water collects and drains into catch basins. On many streets, bikeway is situated near the transition between gutter pan and pavement edge. This transition can be susceptible to erosion, creating potholes and a rough surface for travel. These areas can also be prone to standing water during and after rains.

Guidance

• Ensure that gutter-to-pavement transitions have no more than a ¼” inch vertical difference.
• Examine pavement transitions during every roadway project for new construction, maintenance activities and construction project activities that occur in streets.
• Inspect the pavement two to four months after trenching construction activities are completed to ensure that excessive settlement has not occurred.
• Provide at least three feet of pavement outside of the gutter seams.
• When adding new bike facilities such as separated lanes, roundabouts and traffic circles, check for potential drainage issues. Installing bioswales to capture runoff and avoid standing water in bike lanes is becoming a standard part of building bike facilities in bike-friendly communities.
ROADWAY SURFACE

DESCRIPTION
Bicycles are much more sensitive to changes in roadway surface than motor vehicles. Various materials are used to pave roadways and some are smoother than others. Uneven settlement after trenching can affect roadway surface nearest the curb where bicycles travel. If compaction is not achieved to a satisfactory level, uneven pavement surface can result due to settling. When resurfacing streets, use the smallest chip size and ensure that the surface is as smooth as possible for bicyclist safety and comfort.

GUIDANCE
- Maintain a smooth pothole-free surface.
- Ensure that on new roadway construction, the finished surface on bikeways does not vary more than ¼ inch.
- Maintain pavement so ridge buildup does not occur at the gutter-to-pavement transition or adjacent to railway crossings.
- Inspect the pavement two to four months after trenching construction activities are completed to ensure that excessive settlement has not occurred.
- If chip sealing is to be performed, use the smallest possible chip on bike lanes and shoulders. Sweep loose chips regularly following application.
- During chip seal maintenance projects, if bike lane pavement condition is satisfactory, it may be appropriate to chip seal the travel lanes only. However, use caution when doing so as not to create an unacceptable ridge between the bike lane and travel lane.

DRAINAGE GRATES

DESCRIPTION
Drainage grates are typically located in the gutter area near the curb of a roadway. Drainage grates typically have slots through which water drains into the municipal storm sewer system. Some older grates were designed with linear parallel bars spread wide enough for a tire to become caught so that if a bicyclist were to ride on them, the front tire could become caught in the slot, causing the bicyclist to go over the handlebars and sustain potentially serious injuries.

GUIDANCE
Require all new drainage grates be bicycle-friendly, including grates with horizontal slats to prevent bicycle and assistive device tires from falling through.

- Create a program to inventory all existing drainage grates and replace hazardous grates as necessary – temporary modifications such as installing re-bar horizontally across the grate should not be an acceptable alternative to replacement.
Bikeway Maintenance and Operations

Description

Motor vehicle traffic tends to “sweep” debris like litter and broken glass toward the roadway edges where it can accumulate in bicycle lanes. Maneuvering to avoid such hazards can cause a cyclist to fall. In this way, proper maintenance directly affects safety and street sweeping must be a priority on roadways with bicycle facilities, especially in curb lanes and along curbs themselves. Law enforcement can assist by requiring towing companies to fully clean up crash sites to prevent glass and debris from being left in place or simply swept to the curb or shoulder after collisions.

When any roadwork repairs are done by the city or other agencies, the roadway must be restored to satisfactory quality with particular attention to surface smoothness suitable for cycling. Striping must be restored to the prior markings, or new markings if called in for a project. Bicycle facilities also sometimes seem to “disappear” after roadway construction occurs. This can happen incrementally as paving repairs are made over time and are not promptly followed by proper re-striping. When combined with poor surface reconstruction following long periods of no service due to road work, bikeway facilities can be “lost”, which can discourage cycling in general. Construction projects that require the demolition and rebuilding of adjacent roadways can cause problems maintaining and restoring bikeway function.

Construction activities controlled through permits, such as driveway, drainage and utility work can have an important effect on roadway surface quality where cyclists operate in the form of mismatched pavement heights, rough surfaces or longitudinal gaps in adjoining pavements, or other pavement irregularities. Permit conditions should ensure that pavement foundation and surface treatments are restored to their pre-construction conditions, that no vertical irregularities will result and that no longitudinal cracks will develop. Strict specifications, standards and inspections designed to prevent these problems should developed. A five year bond should be held to assure correction of any deterioration that might occur as a result of faulty reconstruction of the roadway surface.

Bicycle facilities should be swept regularly, at least twice a month and preferably more often for heavily traveled routes. Also, adjacent shrubs and trees should be kept trimmed back to prevent encroachment into the pathway or obstructing cyclists’ views.
GUIDANCE FOR COLORED PAVEMENTS:

WATERBORNE PAINTS
Over the past 10 years, transportation agencies in the United States have gradually replaced conventional solvent paints with waterborne paints that have low volatile organic compounds (VOC) and other newer pavement marking materials. Waterborne traffic paints are the most widely used and least expensive pavement marking material available. Glass beads are either pre-mixed into the paint or dropped onto the waterborne paint to provide retro-reflectivity. Waterborne paints generally provide equal performance on asphalt and concrete pavements, but have the shortest service life of all pavement marking materials. This paint type tends to wear off rapidly and lose retro-reflectivity quickly after being exposed to factors such as high traffic volumes. Although still a widely used material, waterborne paint is also used as an interim marking material until they can apply something more durable.

REGULAR SOLVENT PAINT
This type of paint can be used universally for any pavement needing paint and is the least expensive. Additives such as reflective glass beads for reflectivity and sand for skid resistance are widely used to mark road surfaces. This is typically considered a non-durable pavement marking and is easily worn by vehicle tires and often requires annual re-application.

DURABLE LIQUID PAVEMENT MARKINGS
Durable liquid pavement markings (DLPM) include epoxy and methyl methacrylate (MMA). Epoxy paint has traditionally been viewed as a marking material that provides exceptional adhesion to both asphalt and concrete pavements when the pavement surface is properly cleaned before application. The strong bond that forms between epoxy paints and both asphalt and concrete pavement surfaces results in the material being highly durable when applied on both pavement surfaces. These markings are highly durable and can be sprayed or extruded but generally require long no-track times.

THERMOPLASTICS
Thermoplastics are a durable pavement marking material composed of glass beads, pigments, binders (plastics and resins) and fillers. There are two types of thermoplastics: hydrocarbon and alkyd. Hydrocarbon thermoplastics are made from petroleum-derived resins; and alkyd thermoplastics are made from wood-derived resins. One of the added advantages of using thermoplastic is that the material can be re-applied over older thermoplastic markings, thereby refurbishing the older marking as well as saving on the costs of removing old pavement markings. Although thermoplastic materials usually perform very well on all types of asphalt surfaces, there have been mixed results when they have been applied on concrete pavements.

USE OF GREEN PAINT
A significant recent change is the FHWA’s interim approval for the use of green colored pavement within bicycle lanes in mixing or transition zones, such as at intersections and in other potential conflict zones where motor vehicles may cross a bicycle lane. They are intended to warn drivers to watch for and to yield to cyclists when they encounter them within the painted area. FHWA studies have also shown that green bicycle lanes improve cyclist positioning as they travel across intersections and other conflict areas. Jurisdictions must notify Caltrans before proceeding with green bicycle lane projects because the agency is required to maintain an inventory, but since Caltrans has requested to participate in this interim approval, the process has been streamlined because FHWA experimental treatment protocol is no longer required.
**Product Life Estimates for Paint**
- 9-36 months
- Inexpensive
- Quick-drying
- Longer life on low-volume roads
- Easy clean-up and disposal
- Short life on high-volume roads
- Subject to damage from sand/abrasives
- Pavement must be warm or will not adhere

**Durable Liquids for Pavement Markings:**

**Epoxy**
- 4 years
- Longer life on low-volume roads
- More retro-reflective
- Slow drying
- Requires coning and/or flagging during application
- Heavy bead application—may need to be cleaned off of roadway
- High initial cost
- Subject to damage from sand/abrasives

**Thermoplastic**
- 3-6 years
- Long life on low-volume roads
- Retro-reflective
- No beads needed
- Any temperature for application
- Recommended use for symbols and spot treatments
- Subject to damage from sand/abrasives
- Cost prohibited if used for large scale applications
- Shown to wear quickly in conflicts areas
- Life of pavement marking will depend on traffic volume, road condition and application time of year

**Additional References and Guidelines**
FHWA Durability and Retro-Reflectivity of Pavement Markings (Synthesis Study), 2008.
ON-STREET BIKEWAY SIGNING

The following signage system guidelines specifically address on-street bicycle routes. Such signage is regulated by the Manual of Uniform Traffic Control Devices (MUTCD), which establishes national standards for traffic signs and related traffic control devices. This ensures MUTCD-compliant signs are familiar to all roadway users.

The MUTCD should therefore govern sign design and placement technical aspects, such as dimensions, font size and ground clearance. It guidance is intended to improve cyclists’ experience and to help encourage people to ride more frequently, or to begin riding.

The ability to navigate through a city’s streets is informed by landmarks, natural features and other visual cues. Signs throughout the system should indicate:

- Travel direction
- Destinations locations
- Travel time/distance to those destinations

These signs will increase users’ comfort and bikeway system accessibility. Signage can serve both wayfinding and safety purposes including:

- Helping to familiarize users with the bicycle network
- Helping users identify the best routes to destinations
- Helping to address misconceptions about time and distance
- Helping overcome a “barrier to entry” for people who are not frequent bicyclists (e.g., “interested but concerned” bicyclists)

A community-wide bicycle wayfinding signage plan identifies:

- Sign locations
- Sign types – what information should be included and design features
- Destinations to be highlighted on each sign – key destinations for bicyclists
- May include approximate distance and travel time to each destination bicycle wayfinding signs also visually cue drivers that they are driving along a bicycle route and should use caution.
- Sign placement such as at key locations leading to and along bicycle routes, including intersection of multiple routes.

Too many road signs tend to clutter the right-of-way and it is recommended that these signs be posted at a level most visible to bicyclists rather than per vehicle signage standards.
ON-STREET BIKEWAY SIGN TYPES

DESCRIPTION
A on-street bicycle wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bicycle routes. There are three general on-street bikeway wayfinding sign types:

CONFIRMATION
• Indicate to bicyclists that they are on a designated bikeway.
• Make drivers aware of the bicycle route.
• May include destinations and distance/time, but not arrows.

DECISION
• Mark junctions of two or more bikeways.
• Inform bicyclists of the designated bike route to access key destinations.
• Destinations and arrows are required, distances are optional, but recommended.
• Travel time is nonstandard, but recommended.

TURN
• Indicate where a bikeway turns from one street onto another street. Can include pavement markings.
• Include destinations and arrows.

DISCUSSION
There is no standard color for bicycle wayfinding signage. Section 1A.12 of the MUTCD establishes the general meaning for signage colors. Green is the color used for directional guidance and is the most common color of bicycle wayfinding signage in the US, including those in the MUTCD.

MATERIALS AND MAINTENANCE
Maintenance needs for bicycle wayfinding signs are similar to other signs and will need periodic replacement due to wear and fading, to which south-facing signs are especially prone.

ADDITIONAL REFERENCES AND GUIDELINES
California MUTCD, 2014.
ON-STREET BIKEWAY SIGN PLACEMENT

GUIDANCE

Signs are typically placed at decision points along bicycle routes – typically at the intersection of two or more bikeways and at other key locations leading to and along bicycle routes.

DECISIONS SIGNS

- Near-side of intersections in advance of junction with another bicycle route.
- Along route to indicate nearby destination.

CONFIRMATION SIGNS

- Every two or three blocks along on-street bicycle facilities, unless another sign type is used (e.g., within 150 feet of a turn or decision sign).
- Should be placed soon after turns to confirm destination(s). Pavement markings can also be used for confirmation that a bicyclist is on a preferred route.

TURN SIGNS

- Near-side of intersections where bike routes turn (e.g., where the street ceases to be a bicycle route or does not go through). Pavement markings can also indicate the need to turn to the bicyclist.

DISCUSSION

A list of destinations on signs should be based on their relative distance to users from a particular sign’s location. A particular destination’s ranking in the hierarchy can be used to infer the physical distance from which the location is signed.

MATERIALS AND MAINTENANCE

Maintenance needs for bicycle wayfinding signs are similar to other signs and will need periodic replacement due to wear.

ADDITIONAL REFERENCES AND GUIDELINES

California MUTCD, 2014.
APPENDIX B: PROJECT PRIORITIZATION

OVERVIEW

The purpose of project prioritization is to determine which projects will provide the most benefit from among the list of projects defined within a master plan, and should therefore be expedited for implementation. Prioritizing projects is also a requirement of the State of California’s bicycle master planning enabling legislation, Streets and Highways Code (SHC) Section 891.2, Items a-k. Bicycle master plans must be approved by Caltrans for the municipality to be eligible for future Bicycle Transportation Account (BTA) funding. Item j is written as follows:

A description of the projects proposed in the plan and a listing of their priorities of implementation.

Directly associated with this, it is becoming common for grant funding programs to require an explanation of a municipality’s prioritization methodology as part of grant scoring inputs. This is intended to help verify that the municipality carefully considered and can therefore justify the specific project’s priority relative to the rest of the municipality’s projects listed in its bicycle master plan.

An important example is the State of California’s recently developed Active Transportation Plan (ATP) Grant Program, which has the potential to be a significant source of future funding for the types of projects listed in this master plan. Item n of ATP Guidelines is worded very similarly to the SHC Section 891.2’s Item j, but takes the prioritization requirement a substantial step further by requiring the applicant to not just list the projects by prioritization, but to describe the prioritization methodology:

A description of the projects and programs proposed in the plan and a listing of their priorities of implementation, including the methodology for prioritization and a proposed timeline for implementation.

METHODOLOGY

Project prioritization is primarily a data-driven process underpinned as much as possible by objective information. It is therefore subject to the availability of suitable data, supplemented with other information sources where applicable. Initial prioritization model results are generally ported to carefully designed spreadsheets where they are combined and evaluated with other available data types to yield the best results for a specific location and project type.

No matter what criteria are employed, the initial prioritization model run’s results are evaluated to determine which criteria should continue to be employed in subsequent refinement. This is because analyzing the initial run often reveals that certain criteria did not help to differentiate between alternatives. Eliminating them streamlines the analysis process.

Once the criteria have been selected, they are differentially weighted relative to each other, primarily to take advantage of expert knowledge to help address specific local issues, conditions and values. For example, City of Eastvale staff felt that public input requesting specific facilities should be given high priority. In addition, the City agreed with a strong public preference that a facility’s proximity to schools should also be given higher consideration and relative weighting compared to other criteria.

The following appendix section describes the six criteria determined to be most useful to prioritize recommended projects in Eastvale, with each one’s normalized (rounded) score and its cumulative percent effect on the total of all six per facility.
Future facility ranking and implementation should be fine-tuned and adjusted accordingly based on any changing circumstances. Prioritized projects can be re-ranked within the State's mandated five year bicycle master plan update cycle, or at whatever interval best fits future funding cycles. Prioritization updates could be scheduled to take into consideration the availability of new information, new funding sources, updated crash statistics, updated CIP lists, etc.

**Gap Closure**
This criterion addressed potential bicycle connectivity improvements by evaluating each recommended facility's overall contribution to system completeness.

- Closes gap in an existing bicycle facility = 3
- Upgrades facility to higher classification (ex. Class 3 bike route to Class bike lane) = 2
- New facility connecting existing and proposed bicycle facilities = 1

Normalized score: 1.0 of 6 points (17 percent of total)

**Reported Collisions**
This criterion addressed safety through five years of collision data, normalized by collisions per mile of recommended facility. Compared to automobile collisions, the lower number of bike crashes and lack of robust, long term exposure data (i.e. number of bicyclists using each corridor) means that this dataset is not as statistically sound. However, it is still commonly reported and easily understood. Dataset was derived from the California Highway Patrol’s Statewide Integrated Traffic Records System (SWITRS). This criteria uses collisions per mile and gives points to recommended facilities that have high collision rates along their segments.

Normalized score: 1.0 of 6 points (17 percent of total)

**Economic Efficiency**
Economic efficiency measured the financial benefits associated with a corridor, normalized by the number of anticipated users (in turn a product of the facility type and length), and divided by the rough order construction cost estimates.

Using National Cooperative Highway Research Program (NCHRP) Report 552 methods, 1/4, 1/2 and one mile buffers were drawn around each corridor to obtain American Community Survey (ACS) population and journey to work mode share data. An extrapolation of all bicycle trips was made and estimates of potential ridership developed, based on multi-use path or bicycle lane attractiveness functions as defined by the NCHRP research. Using the existing and estimated ridership, annual mobility, health, recreation and reduced auto use, cost saving benefits were calculated. Economic efficiency is further explained through sample projects in Appendix C.

Normalized score: 0.25 of 6 points (4 percent of total)
**Required vs. Existing Width Constraints**

This criterion looked at the common constraint of existing right-of-ways for adding bicycle facilities, particularly for on-street bicycle lanes and cycle tracks. However, any recommendations that included adjacent shared-use off-street paths would also be affected.

- 0 feet needed = 4
- 1-4 feet needed = 3
- 5-9 feet needed = 2
- 10+ feet needed = 1

Normalized score: 0.5 of 6 points (8 percent of total)

**Proximity to Schools**

This criterion addressed the distance from schools for each recommended facility and was given the highest weighting based on strong community preference.

Normalized score: 1.75 of 6 points (29 percent of total)

**Public Outreach Input**

Public outreach conducted for this plan consisted of three public workshops and an online survey available throughout the course of the project. The survey was filled out by almost 500 respondents. In both the survey and at the public meetings, City staff and residents were asked to identify the projects they felt were most important by facility type. Like the previous criterion, this one was highly weighted based on City guidance.

- >6 points = 3
- 3-6 points = 2
- <3 points = 1

Normalized score: 1.5 of 6 points (25 percent of total)
APPENDIX C: BENEFIT-COST ANALYSIS

To illustrate the benefit-cost relationship, three sample projects representing high, moderate and low benefit-cost ratios are shown below. These are real projects selected from the 30 projects recommended by this plan (See “Table 9-2: Inputs - Benefit-Cost Analysis” on page A-70 for benefit-cost information for all projects). The high “benefit to cost” project (Sample Project 1) is a bike boulevard along Blossom Way; the moderate “benefit to cost” project (Sample Project 2) is a protected bike lane on Citrus Street; and the low “benefit to cost” project (Sample Project 3) is a multi-use path along the Cucamonga River/Flood Control Path.

While these benefit-cost ratios do provide some information about projects – and a means of comparison – it is important to note that they are relatively insensitive to facility type. On other words, they do not distinguish between facilities types other than multi-use paths (e.g. bike routes vs. protected bike lanes). For this reason, benefit-cost ratios have only a minor influence on overall project ranking, with reported collisions, proximity to schools and community input playing much larger roles.

<table>
<thead>
<tr>
<th>Sample Project 1</th>
<th>Sample Project 2</th>
<th>Sample Project 3</th>
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| **High**
  “Benefit to Cost” Project |
| **Moderate**
  “Benefit to Cost” Project |
| **Low**
  “Benefit to Cost” Project |

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<th>COST</th>
<th>BENEFIT*</th>
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<td>Sample Project 2</td>
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<td>Sample Project 3</td>
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*“Benefit” is a combination of several financial benefits associated with the given projects: mobility benefits, health benefits, recreation benefits and reduced automobile use.
**Table 9-2: Inputs - Benefit-Cost Analysis**

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* Combined benefit is a combination of several financial benefits associated with the given projects: mobility benefits, health benefits, recreation benefits and reduced automobile use.

**Note:**
- Total Length of Existing Class 1 Facilities in Project (mi)
- Total Length of Project (mi)
- Estimated cost of project
- Benefit Cost Ratio (BCR)
APPENDIX D: APPLICABLE LEGISLATION

OVERVIEW
Several pieces of legislation support increased cycling in the State of California. Much of the legislation concerns greenhouse gas (GHG) reduction and employs cycling as a means to achieve GHG reduction targets. Other legislation highlights the intrinsic worth of cycling and treats the safe and convenient accommodation of cyclists as a matter of equity. The most relevant legislative acts for bicycle policy, planning, infrastructure and programs are discussed below.

STATE LEGISLATION AND POLICIES

AB-32 Global Warming Solutions Act
This bill specifies greenhouse gas emissions reduction and codifies the 2020 emissions reduction goal. This act also directs the California Air Resources Board to develop specific early actions to reduce greenhouse gases while also preparing a scoping plan to identify how best to reach the 2020 limit.

AB-902 Diversion Programs
This bill was signed in September 2015 and sponsored by the California Bicycle Coalition. It allows local jurisdictions to create diversion programs that allow ticketed cyclists to have their tickets removed from their records if they successfully complete a bicycle training course. This type of program has been available for children for some time, but this legislation expands availability to adults. It also offers all cyclists, ticketed or not, more opportunities to learn the rules of the road and safe bicycle handling skills.

AB-1096 Redefine Electric Bikes
The bill was passed by the California Senate in September 2015 and awaiting the Governor’s signature. It would replace California’s existing vehicle law that does not allow motorized bicycles on non-motorized paths. The updated law splits e-bikes from other motorized bikes and divide them into three categories:

- **Class I:** pedal-assisted electric bike with a top assisted speed of 20mph
- **Class II:** pedal-assisted or propelled unassisted with a top motor-driven speed of 20mph
- **Class III:** pedal-assisted electric bike with a top assisted speed of 28mph

Of those three categories, the first two will now be allowed on any infrastructure where conventional bicycles are allowed, but the bill also provides local authorities the specific ability to limit or prohibit those uses. Class III electric bikes or any bikes with a non-electric motor would not be allowed on off-street paths, but could still be used on on-street bike lanes. The changes apply to the state’s vehicle code and would not affect open space trails or public lands access rules.
AB-1193 Bikeways
This act amends various code sections, all relating to bikeways in general, specifically by recognizing a fourth class of bicycle facility, cycle tracks. However, the following may be even more significant to future bikeway development: Existing law requires Caltrans, in cooperation with county and city governments, to establish minimum safety design criteria for the planning and construction of bikeways, and requires the department to establish uniform specifications and symbols regarding bicycle travel and traffic related matters. Existing law also requires all city, county, regional and other local agencies responsible for the development or operation of bikeways or roadways to utilize all of those minimum safety design criteria and uniform specifications and symbols. This bill revises these provisions and required Caltrans to establish minimum safety design criteria for each type of bikeway and also authorizes local agencies to utilize different minimum safety criteria if adopted by resolution at a public meeting.

AB-1358 Complete Streets Act
This bill requires the legislative body of a city or county, upon revision of the circulation element of their general plan, to identify how the jurisdiction will provide for the routine accommodation of all users of the roadway including motorists, pedestrians, cyclists, individuals with disabilities, seniors and users of public transportation. The bill also directs the OPR to amend guidelines for the development of general plan circulation elements so that the building and operation of local transportation facilities safely and conveniently accommodate everyone, regardless of their mode of travel.

AB-1371 Passing Distance/3 Feet for Safety Act
This statute, widely referred to as the “3 Foot Passing Law,” requires drivers to provide at least three feet of clearance when overtaking cyclists. If traffic or roadway conditions prevent drivers from giving cyclists three feet of clearance, they must “slow to a speed that is reasonable and prudent” and wait until they reach a point where passing can occur without endangering the cyclist. Violations are punishable by a $35 base fine, but drivers who collide with cyclists and injure them in violation of the law are subject to a $220 fine.

AB-1581 Bicycle and Motorcycle Traffic Signal Actuation
This bill defines a traffic control device as a traffic-actuated signal that displays one or more of its indications in response to the presence of traffic detected by mechanical, visual, electrical or other means. Upon the first placement or replacement of a traffic-actuated signal, the signal would have to be installed and maintained, to the extent feasible and in conformance with professional engineering practices, so as to detect lawful bicycle or motorcycle traffic on the roadway. Caltrans has adopted standards for implementing the legislation.

SB-375 Redesigning Communities to Reduce Greenhouse Gases
This bill seeks to reduce vehicle miles traveled through land use and planning incentives. Key provisions require the larger regional transportation planning agencies to develop more sophisticated transportation planning models, and to use them for the purpose of creating “preferred growth scenarios” in their regional plans that limit greenhouse gas emissions. The bill also provides incentives for local governments to incorporate these preferred growth scenarios into the transportation elements of their general land use plans.
SB-743 CEQA Reform
Just as important as the pieces of legislation described in this section that support increases in cycling infrastructure and accommodation, is one that promises to remove a longstanding roadblock to cycling infrastructure and accommodation. That roadblock is vehicular Level of Service (LOS) and the legislation with the potential to remove it is SB-743. For decades, vehicular congestion has been interpreted as an environmental impact and has often stymied bicycle projects. Projections of degraded Level of Service have, at a minimum, driven up project costs and, at a maximum, precluded projects altogether. SB-743 could completely remove LOS as a measure of car traffic congestion that must be used to analyze environmental impacts under the California Environmental Quality Act (CEQA). This is extremely important because adequately accommodating cyclists, particularly in built-out environments, often requires reallocation of right-of-way and the potential for increased vehicular congestion. The reframing of Level of Service as a matter of motorist inconvenience, rather than an environmental impact, will allow planners to assess the true impacts of transportation projects and will help support cycling projects that improve mobility for all roadway users.

According to the Association of Environmental Professionals 2014 CEQA Guidelines 229, a project involving only feasibility or planning studies for possible future actions that an agency has not approved, adopted or funded, does not require an EIR or Negative Declaration, but does require consideration of environmental factors. This has been supported by numerous cities and counties, as well as State agencies. Planning projects such as this bicycle master plan are therefore exempt from CEQA analysis since they are comprised of planning and conceptual recommendations. However, as individual recommendations move forward through design and implementation, the City will need to determine if there are impacts associated with them for which environmental review may be necessary.

Caltrans’ Deputy Directive 64-R1
Deputy Directive 64-R1 is a policy statement affecting Caltrans mobility planning and projects requiring the agency to: “...provide for the needs of travelers of all ages and abilities in all planning, programming, design, construction, operations, and maintenance activities and products on the State highway system. The Department views all transportation improvements as opportunities to improve safety, access, and mobility for all travelers in California and recognizes bicycle, pedestrian, and transit modes as integral elements of the transportation system.” The directive goes on to mention the environmental, health and economic benefits of more Complete Streets.

Federal Legislation
Safe Streets Act (S-2004/HR-2468)
HR2468 encourages safer streets through policy adoption at the state and regional levels, mirroring an approach already being used in many local jurisdictions, regional agencies and states governments. The bill calls upon all states and metropolitan planning organizations (MPOs) to adopt Safe Streets policies for federally funded construction and roadway improvement projects within two years. Federal legislation will ensure consistency and flexibility in road-building processes and standards at all levels of governance.
APPENDIX E: BTA REVIEWER CHECKLIST

For reviewer convenience, California Streets and Highways Code Section 891.2, items a-k code text and associated document sections and/or responses are listed below.

(a) The estimated number of existing bicycle commuters in the plan area and the estimated increase in the number of bicycle commuters resulting from implementation of the plan.

Current estimate of bicycle commuters is 662 using industry standard calculation methods. Expected increase as a result of this plan was based on other jurisdictions’ experience with bikeway system development. This also addresses forecasted future employment increase of seven percent to 18,305, yielding 1,274 commuting cyclists, or 612 additional cyclists, a 92 percent increase resulting from implementation of this plan. This includes students and transit users.

This document recommends establishing a cycling activity baseline using annual count locations.

(b) A map and description of existing and proposed land use and settlement patterns which shall include, but not be limited to, locations of residential neighborhoods, schools, shopping centers, public buildings and major employment centers.

See Chapter 2 maps and tables.

(c) A map and description of existing and proposed bikeways.

See Chapter 4 maps and tables.

(d) A map and description of existing and proposed end-of-trip bicycle parking facilities. These shall include, but not be limited to, parking at schools, shopping centers, public buildings and major employment centers.

See Chapter 4 maps and tables.

(e) A map and description of existing and proposed bicycle transport and parking facilities for connections with and use of other transportation modes. These shall include, but not be limited to, parking facilities at transit stops, rail and transit terminals, ferry docks and landings, park and ride lots, and provisions for transporting cyclists and bicycles on transit or rail vehicles of ferry vessels.

See Chapter 2 maps and tables.

(f) A map and description of existing and proposed facilities for changing and storing clothes and equipment. These shall include, but not be limited to, locker, restroom and shower facilities near bicycle parking facilities.

See Chapters 2 and 4 maps and tables.
(g) A description of bicycle safety and education programs conducted in the area included in the plan, efforts by the law enforcement agency having primary traffic law enforcement responsibility in the area to enforce provisions of the Vehicle Code pertaining to bicycle operation, and the resulting effect on accidents involving cyclists.

The Eastvale Police Department, in conjunction with the Public Works Department and Corona-Norco Unified School District, provides parents and students with safety pamphlets that specifically address safe driving practices. In addition to the training brochures, police traffic team and School Resource Officers conduct traffic enforcement in school zones before and after school. Many violations are related to bicyclist and/or helmet violations. The City also posts driving safety tips on its website. Eastvale Police Department also pass out free “slurpee” coupons to students wearing bicycle helmets and cite those who are not.

Bike Month is promoted by the regional bicycle advocacy organization, Inland Empire Bike Alliance.

(h) A description of the extent of citizen and community involvement in development of the plan including, but not be limited to, letters of support.

See Appendix C, Community Input Summary.

(i) A description of how the bicycle transportation plan has been coordinated and is consistent with the local or regional transportation, air quality or energy conservation plans, including, but not be limited to, programs that provide incentives for bicycle commuting.

Encouraging bicycle commuting is addressed throughout the document, particularly Chapter 5: Recommended Programs and Policies.

(j) A description of the projects proposed in the plan and a listing of their priorities of implementation. See Chapter 4 maps, tables and recommendations text.

(k) A description of past expenditures for bicycle facilities and future financial needs for projects that improve safety and convenience for bicycle commuters in the plan area.

The City of Eastvale was only incorporated in 2010. This master plan is its inaugural bicycle planning effort and intended to be a comprehensive blueprint for future system development.