The Old Standards
“The bicycle has become an important element for consideration in the highway design process. Fortunately, the existing street and highway system provides most of the mileage needed for bicycle travel.”

- 900 pages of guidance
- Less than 1 page on bicycles
SHARED LANES

PROTECTED BIKE LANES & SHARED USE PATHS

CONVENTIONAL BIKE LANES
Do you want separation from traffic?

How do you feel about riding in each of the conditions pictured?

Credit: Nicole Freedman, Boston
Emerging Guidelines

Urban Bikeway Design Guide
National Association of City Transportation Officials

Second Edition

Urban Street Design Guide
National Association of City Transportation Officials
## FHWA Status of Existing Bikeway Treatments

<table>
<thead>
<tr>
<th>Description of Bicycle Facilities</th>
<th>Status in the FHWA’s Manual on Uniform Traffic Control Devices (MUTCD)</th>
<th>Are FHWA Experiments in Progress?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bike Lanes</strong></td>
<td><strong>Signs and Markings</strong></td>
<td></td>
</tr>
<tr>
<td>Conventional bike lanes</td>
<td>Can be implemented at present time</td>
<td></td>
</tr>
<tr>
<td>Continuation of bike lanes up to intersections</td>
<td>Can be implemented at present time</td>
<td></td>
</tr>
<tr>
<td>Dashed bike lanes through intersections</td>
<td>Can be implemented at present time</td>
<td></td>
</tr>
<tr>
<td>Use of green pavement markings for bike lanes and cycle tracks within intersections</td>
<td>Interim approval has been granted. Requests to use green colored pavement need to comply with the provisions of Paragraphs 14 through 22 of Section 1A.10</td>
<td>Yes</td>
</tr>
<tr>
<td>Green bike lanes at conflict points such as heavy turning and merging locations</td>
<td>Interim approval has been granted. Requests to use green colored pavement need to comply with the provisions of Paragraphs 14 through 22 of Section 1A.10</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Protected cycle tracks, both one-way and two-way bicycle facilities are not a traffic control device, so there is no MUTCD restriction on its use.

<table>
<thead>
<tr>
<th>Cycle Tracks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected cycle tracks, both one-way and two-way</td>
</tr>
<tr>
<td>bicycle facilities</td>
</tr>
<tr>
<td>Not a traffic control device, so no MUTCD</td>
</tr>
<tr>
<td>restriction on its use</td>
</tr>
<tr>
<td>Raised cycle tracks, both one-way and two-way</td>
</tr>
<tr>
<td>bicycle facilities</td>
</tr>
<tr>
<td>Not a traffic control device, so no MUTCD</td>
</tr>
<tr>
<td>restriction on its use</td>
</tr>
<tr>
<td>Merging cycle track users with turn lanes in</td>
</tr>
<tr>
<td>advance of high volume turn locations, allowing</td>
</tr>
<tr>
<td>bicyclists to make a through movement at the</td>
</tr>
<tr>
<td>intersection in order to reduce conflicts with</td>
</tr>
<tr>
<td>the turning traffic</td>
</tr>
<tr>
<td>Can be implemented at present time if signs and</td>
</tr>
<tr>
<td>pavement markings that are compliant with the</td>
</tr>
<tr>
<td>MUTCD are used</td>
</tr>
</tbody>
</table>

www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design_guidance/mutc

d_bike.cfm
The Bike Guide: An Overview
The Bike Guide: An Overview

BIKE LANES
Conventional
Buffered
Contra-Flow
Left-side Bike

CYCLE TRACKS
One-way
Two-way
Raised

INTERSECTIONS
Cycle Track Intersections

SIGNALS
Bicycle Signals

SIGNS & MARKINGS
Shared Lane Markings
Green Color

BICYCLE BOULEVARDS
Guide Structure

Required
(Shall)

Recommended
(Should)

Optional
(May)
Defining Success

Comfortable/Safe
Separation is key

Cohesive & Connected
No bike lanes to nowhere

Intuitive
Bicyclists are window shoppers too

Direct
Avoid circuitous routing

Attractive
Commute = Recreation
Design for Every Mode
Bikeway Design = Complete Street Design
Don’t trade the sidewalk for the gutter

Elevation Matters
Avoid cluttered markings

Keep it simple
Design for Loading and Maintenance
An Overview of Bikeway Types in the NACTO Guide
## Choosing the Right Facility for the Right Street

<table>
<thead>
<tr>
<th>Street Classification</th>
<th>Bikeway Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Volume, High Intensity Arterial</td>
<td>Shared Use Path</td>
</tr>
<tr>
<td></td>
<td>Cycle Track</td>
</tr>
<tr>
<td>Mixed Use Medium Volume Collector</td>
<td>Cycle Track</td>
</tr>
<tr>
<td></td>
<td>(Buffered) Bike Lane</td>
</tr>
<tr>
<td>Low-volume Residential</td>
<td>Bike Lane</td>
</tr>
<tr>
<td></td>
<td>Shared Lane Marking</td>
</tr>
</tbody>
</table>
## Bicycle Facility Contextual Guidance

### Average Annual Daily Traffic (1,000 veh/day or 100 veh/peak hr)

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Street Class</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>15+</th>
<th>20+</th>
<th>25+</th>
<th>30+</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Neighborhood Greenway</strong></td>
<td>Local</td>
<td></td>
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<tr>
<td>Description: Comfortable and attractive bicycling environment without utilizing physical separation; typically employs techniques to prioritize bicycling.</td>
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</tr>
<tr>
<td><strong>Shared Lane Marking</strong></td>
<td>Local</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Description: Marking that is applicable on roadways where speed differential between motorists and bicyclists is low and/or to fill short gaps in the bikeway network.</td>
<td></td>
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</tr>
<tr>
<td><strong>Bike Lane</strong></td>
<td>Collector Arterial</td>
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</tr>
<tr>
<td>Description: Exclusive space for bicyclists through the use of pavement markings and signage (without buffers or barriers).</td>
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<tr>
<td><strong>Buffered Bike Lane</strong></td>
<td>Collector Arterial</td>
<td></td>
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<tr>
<td>Description: Traditional bike lane separated by painted buffer to vehicle travel lanes and/or parking lanes.</td>
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</tr>
<tr>
<td><strong>Cycle Track</strong></td>
<td>Collector Arterial</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Description: Physically separated bikeway. Could be one or two way and protected by a variety of techniques.</td>
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<tr>
<td><strong>Shared Use Path</strong></td>
<td>Arterial Freeway</td>
<td></td>
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</tr>
<tr>
<td>Description: Completely separated from roadway, typically shared with pedestrians.</td>
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</tbody>
</table>

### Additional Factors

- Emergency Route
- Percent Heavy Traffic
- Multiple Travel Lanes
- Sufficient Road Space
- Sufficient Roadways
- High Turnover Parking
- Front-In Diagonal Parking
- Percent Heavy Traffic
- Multiple Travel Lanes
- Sufficient Road Space
- Insufficient Road Space
- Illegal Parking/Loading
- Sidewalk Riding
- Sufficient Roadways
- Frequent Driveways
- Park or linear corridor
- Insufficient width for Sidewalk
- Frequent Intersections
- High Pedestrian Volume
- Sufficient Roadways

### Legend

- **Minimal Separation**
- **Moderate Separation**
- **Good Separation**
- **High Separation**

<table>
<thead>
<tr>
<th>Separation</th>
<th>Min VOLUME</th>
<th>Max VOLUME</th>
<th>Min SPEED</th>
<th>Max SPEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptable</td>
<td>Desired</td>
<td>Acceptable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Instructions:

This chart offers guidance as to what types of treatments are recommended depending on street classification, speed, and volume. No matter where bikeway treatments are applied, special care needs to be paid to intersections, driveways, on-street parking, sight distance, and additional factors.

### Notes:

1. Refers to specific bicycle facilities described in the NACTO Urban Bikeway Design Guide. See [http://www.nacto.org](http://www.nacto.org) for detailed design guidance. Many local roads function just fine as they are due to their low traffic volume and speed.
2. Categories from [http://www.fhwa.dot.gov/planning/fcsec2_1.htm](http://www.fhwa.dot.gov/planning/fcsec2_1.htm). The use of functional classes provides some general context for the cases in which bicycle facilities are most likely to be implemented. Land use and additional factors (see 4) should always take precedence in determining which facility type to select.
3. Urban peak hour factors typically range from 8 to 12 percent of AADT. For the purposes of this chart, the peak hour is assumed to be 10 percent of AADT.
4. Noted additional factors include a selection of considerations that may influence the selection of bicycle facility type where roadway speed/volume values overlap over multiple facilities. Many of the factors that suggest increasing separation are common across multiple facility types like bike lanes, buffered bike lanes and cycle tracks.
5. Design guidance for shared use paths can be found in the AASHTO Guide for the Development of Bicycle Facilities.
6. Increased separation of bicycle facilities from motor vehicle traffic typically results in higher levels of user comfort and appeals to wider skill levels of bicyclists.
7. This chart considers posted speed limit only. The 85th percentile speed may vary, and may change with implementation of a bikeway.
Shared Lane Markings
...and we’re done!

On streets with posted 35 mph speeds or faster and motor vehicle volumes higher than 3,000 vpd, shared lane markings are not a preferred treatment.
Bicycle Boulevards
Streets formally designated as bicycle boulevards should meet strict targets of fewer than 3,000 motor vehicles per day (1,500 preferred) and an 85th percentile speed of no more than 25 mph (20 mph preferred).
Streets formally designated as bicycle boulevards should meet strict targets of fewer than 3,000 motor vehicles per day (1,500 preferred) and an 85th percentile speed of no more than 25 mph (20 mph preferred).
Volume Management Tools

- Forced Turns
- Diagonal or Full Diverters
- Right-in/Right-out island
- Partial Closure

Speed Management Tools

- Speed Humps
- Speed Cushions
- Speed Tables
- Curb extensions
- Neighborhood Traffic Circles
- Chicanes
- Pinchpoints
- Neckdowns
- Center Islands
- Skinny Streets
Bicycle Boulevards
Conventional Bike Lanes

- Wider is better
- 6’ preferred
- Mark through the intersection
Green Bike Lanes

- Choose your material wisely
- Use consistent applications
- Differentiate corridor and conflict green
Left-side Bike Lanes

- Great for transit routes
- Use two-stage turns or bike boxes to facilitate transition from left to right
Buffered Bike Lanes

- 3’ buffer preferred
- Parking-side buffer optional
- Add buffer if you have the width
Contra-Flow Bike Lanes

- Short connections ideal
- Combine with bike signals
- Use physical barrier where appropriate
One-way Cycle Track

- Separate using striped buffer, planters, or curbs
- Stakeholder outreach critical
- Pay attention to road’s crown
One-way Cycle Track
Austin, TX

- Take advantage of pedestrian benefits
- Wrap around transit stops
Raised Cycle Track

- Should feel like part of the sidewalk
- Asphalt overlay can be cheaper
- Consider mountable curb
Raised Cycle Track (two-way)
Indianapolis, IN
5 Desired minimum: 12 feet (in constrained conditions: 8 feet)

6 Desired minimum: 3 feet
• Two signals per movement (Minimum one far side)
• Recommend 12” lenses
• Recommend vehicle turns on arrow only
Traffic Signal Phasing

Phase A: Bikes, Thrus and Rights
Traffic Signal Phasing

Phase B: Bike Clearance
Traffic Signal Phasing

Phase C: Lefts and Thrus
Traffic Signal Phasing

Phase D: Vehicle Clearance
Cyclist Signal Compliance at Red & Green Lights

BEFORE INSTALLATION

31% 69%

AFTER INSTALLATION

19% 81%

Bikers entering Intersection on Red Lights
Mixing Zone
Mixing Zone
New York, NY
Cycle Track Intersection Approach Strategies
## Cycle Track Intersection Decision Matrix

<table>
<thead>
<tr>
<th>Intersection Characteristics</th>
<th>Intersection Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Intersection with high turning volumes</td>
<td>Bicycle Signal (Full Separation) or Bikes with Peds</td>
</tr>
<tr>
<td>Medium volume intersections</td>
<td>Bicycle Signal, Mixing Zone, or other treatment</td>
</tr>
<tr>
<td>Minor Intersections and Driveways</td>
<td>Highlight conflict and ensure good sightlines</td>
</tr>
</tbody>
</table>
David Vega-Barachowitz
Director, Designing Cities Initiative
david@nacto.org
Application of the Guide on San Francisco Bikeways
Goal of continuous, cross-town routes with few/no gaps
Oak Street and Fell Street Cycle Tracks

- from Scott Street to Baker Street
- directly connects existing east-west bike routes
Fell St: Remove Parking for Cycletrack
NACTO Guidance on Cycle Tracks

Recommended Features

The minimum desired width for a cycle track should be 5 feet. In areas with high bicyclist volumes or uphill sections, the minimum desired width should be 7 feet to allow for bicyclists passing each other.

+ Click for more information

Three feet is the desired width for a parking buffer to allow for passenger loading and to accommodate maneuvering for turning.
Green Bike Box with Signal Work

Task: Improve left turn into cycletrack

Tools: Bike Box and Leading, Protected Left Turn Phase
NACTO Guidance on Bike Boxes
Guidance on Bike Boxes

A box formed by transverse lines shall be used to hold queuing bicyclists, typically 10-16 feet deep. Deeper boxes show less encroachment by motor vehicles.

+ Click for more information

In cities that permit right turns on red signal indications, a “No Turn on Red” sign shall be installed overhead to prevent vehicles from entering the Bike Box.

+ Click for more information
Entry to Cycle Track

Separate bikeway from traffic stream

Painted Buffer, Delineators, Green, and Planters (future)
Handle an intersection with relatively few right turns.

Combine Turn Lane, Bike Box and Bike Signal Head Start.
Combined Turn Lane Design using Sharrows
Box and Signal gets cyclists ahead of traffic and reduces right hook potential at next intersection.
Design Guidance

Combined Bike Lane/Turn Lane

Guidance for conventional bicycle lanes and intersection crossing markings may also apply. When configured as a mixing zone for a cycle track, additional guidance for a cycle track intersection approach may also apply.

Required Features

1. Some form of bicycle marking shall be used to clarify bicyclist positioning within the combined lane.

Recommended Features

2. Within the combined lane, the bicycle area width should be 4 feet minimum.

3. Width of combined lane should be 9 feet minimum, 13 feet maximum. A full bicycle through lane can be accommodated if the vehicle right turn only lane can be made 14 feet or wider.

Optional Features

4. A dotted 4 inch line and bicycle lane marking should be used to clarify bicyclist positioning within the combined lane.

5. If the right lane is signed for "Right Turn Only," or if a sign is otherwise needed to make it legal for through bicyclists to use a right turn lane, signage should be installed in advance alerting the start of the combined turn lane.

6. If configured as a mixing zone on a cycle track corridor, the following features are recommended:
   - A Turning Vehicles Yield to Bikes (modified R10-15) sign should be used in advance of the mixing zone.
   - A yield line should be used in advance of the mixing zone.
   - The transition to the mixing zone should begin a minimum of 70 feet in advance of the intersection. Mixing zones that are shorter in length and begin abruptly encourage slower vehicle speed.

7. A shared lane marking (MUTCD figure 9C-9) may be used as an alternative to dotted striping to clarify bicyclist position within the combined lane.
Combined Turn Lane with Bike Box

Handle an intersection with moderate right turns

Bike box and combined turn lane w 9’ turn lane and 4’ through bike lane
Combined Turn Lane design w color

Colored Bike Facility Benefits

- Promotes the multi-modal nature of a corridor.
- Increases the visibility of bicyclists.
- Discourages illegal parking in the bike lane.
  + Click for more information
- When used in conflict areas, raises motorist and bicyclist awareness to potential areas of conflict.
  + Click for more information
- Increases bicyclist comfort though clearly delineated space.
  + Click for more information
- Increases motorist yielding behavior.
  + Click for more information
- Helps reduce bicycle conflicts with turning motorists.
  + Click for more information
Combined Turn Lane with Bike Box
Clearly designate space: RTs to right, through bikes to left

Lower all speeds via signal timing

Get cyclists to front of queue via signal head start upstream and bike box
Combined Turn Lane with Bike Box
Colored Bike Box to Left Turn Bike Lane

Reduce encroachment by motorists

Add green for visibility

Proportion of Motor Vehicle Encroachment in Crosswalk

- Colored Bike Box
  - BEFORE
  - AFTER

- Control
  - BEFORE
  - AFTER

Handle two left turns in three blocks by cyclists
NACTO Guidance on Left Side Bike Lane
Signal Separation using Bike Signal

Reduce conflicts between path users and heavy turn movements
Two Stage Turn Queue Area: “Jug Handle” turn

Improve challenging left turns for cyclists across three lanes and tracks
Two Stage Turn Queue Area with Bike Signal
Make bikeway in park more inviting
Masonic Ave Raised Cycletrack

Safe and Comfortable Cycling on an Arterial w Transit

Section showing typical cycle track layout

Proposed “Bus Bulb Plaza” seeks to reduce conflict between bikes and buses at bus stops
Raised Cycle Track Guidance

If used, the mountable curb should have 4:1 slope edge without any seams or lips to interfere with bike tires to allow for safe entry and exit of the roadway. This curb should not be considered a ridable surface when determining cycle track width.

Vertical separation between the roadway and the cycle track should be between 1 and 6 inches. Higher separation values discourage illegal parking.

Vertical separation between the cycle track and the sidewalk should be between zero (flush with the sidewalk surface) and 5 inches. A separation of 3 inches or greater discourages conflicts with pedestrians.
Polk Street Contraflow Lane

Improve Connectivity along One-Way Arterial
Polk Street Contraflow Lane

Improve connection between median bikeway and intersecting bikeways

Bike channel, bike signal, and two-stage turn box
Polk Street Contraflow Lane

Get people to contraflow lane where left turns are prohibited

Two-stage turn box and bike signal
Market and Duboce

Connect a two-way path with one-way bike lanes

Intersection Crossing Markings and Bike Boxes
Traditional Manuals vs NACTO Guide

With the right tools, you can address so many more challenges!

or
Thank You!

Market Street, Typical PM Rush Hour

Contact: Mike Sallaberry, mike.sallaberry@sfmta.com