Designing for Bicyclist Safety

Module D

DESIGN POLICIES & SAFETY EVALUATION

LEARNING OUTCOMES

- Discuss why we should include bicycles in the transportation network
- Explain the challenges and opportunities to analyze bicyclist safety

Designing for Bicyclist Safety

DESIGN POLICIES

FEDERAL LAW

- Consider bicycle facilities, where appropriate, with new construction and reconstruction.
- Consider safety and contiguous routes for bicyclists in plans and projects.

What does* consider *mean?

USDOT POLICY

Signed on March 11, 2010 and announced March 15, 2010

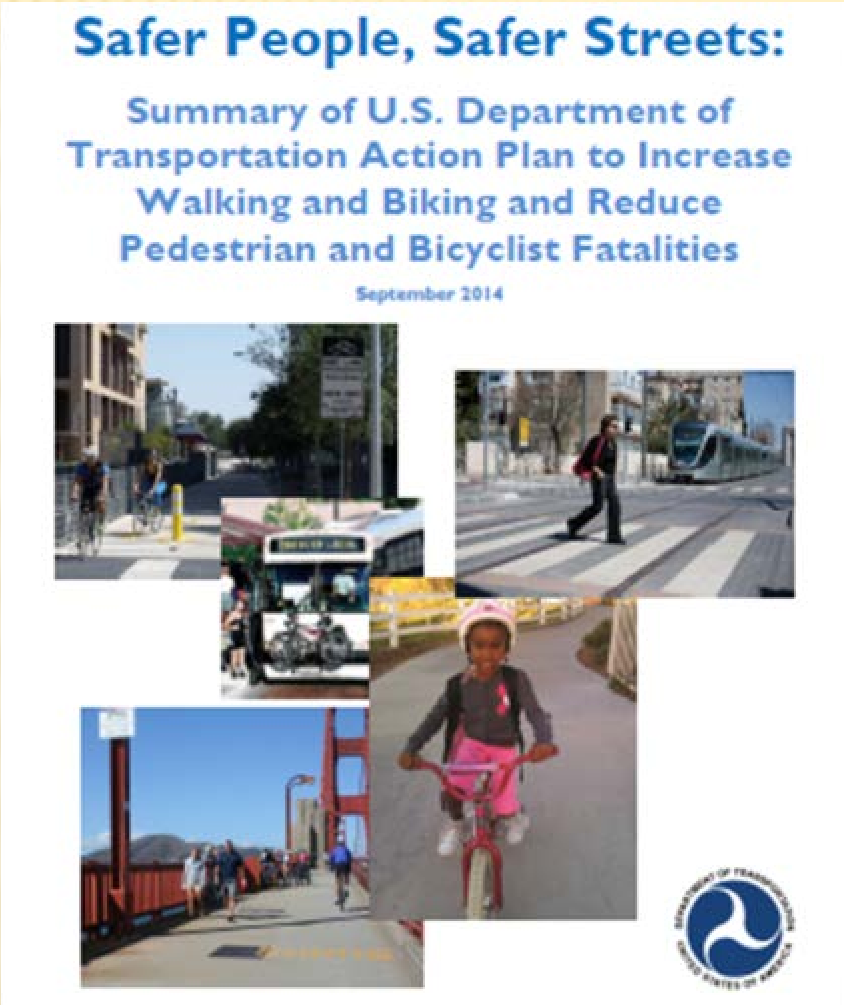
Every transportation agency, including DOT, has the responsibility to improve conditions and opportunities for walking and bicycling and to integrate walking and bicycling into their transportation systems.

USDOT POLICY

Recommended Actions:

- Consider bicycling as equal with other modes
- Ensure transportation choices for all ages and abilities, especially children
- Go beyond minimum design standards
- Integrate bicycle accommodation on bridges
- Collect data on bicycle trips
- Remove snow – same maintenance as roads required for facilities built with federal funds
- Improve bicycle facilities during maintenance projects

USDOT POLICY



The Department will promote the development of multimodal networks which include interconnected pedestrian/and or bicycle transportation facilities that allow people of all ages and abilities to safely and conveniently get where they want to go.

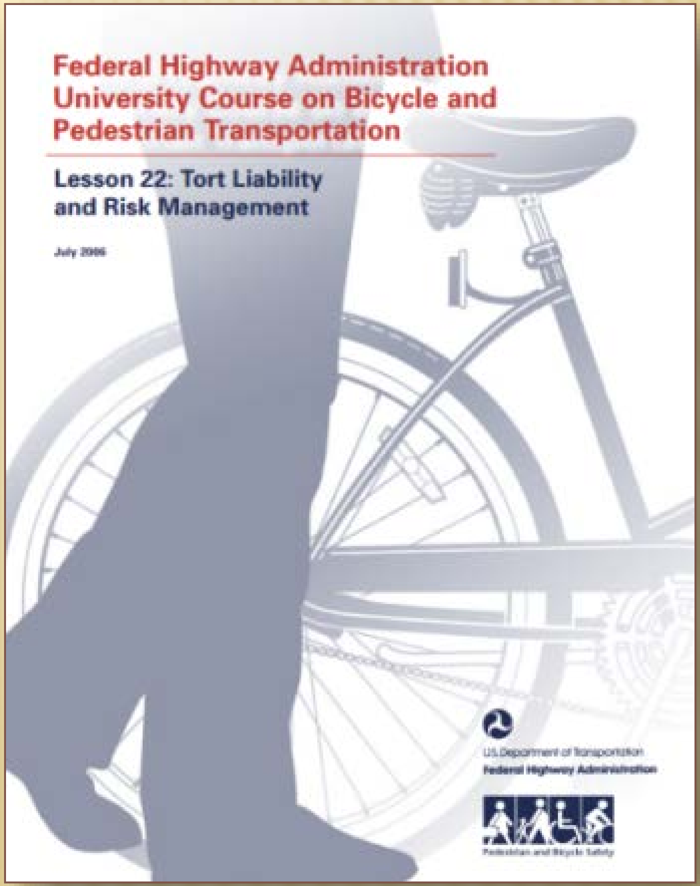
USDOT, September 2014

FHWA PROGRAM GUIDANCE

- Bikeways established in all **urban** area construction/reconstruction projects, unless:
  - bicyclists prohibited by law
  - cost excessively disproportionate
  - absence of need
- Paved shoulders included in all **rural** area construction/reconstruction projects with 1,000 vehicles per day

REDUCES LIABILITY

"It is no longer acceptable to plan, design, or build roadways that do not fully accommodate use by bicyclists and pedestrians…
With every passing year, the courts become less and less sympathetic to agencies that have not understood the message: bicyclists and pedestrians are intended users of the roadway. "



Designing for Bicyclist Safety

EVALUATING NEEDS

DATA COLLECTION GOALS

- Identify high crash locations, corridors, areas
- Identify locations, corridors, areas with high crash potential
- Prioritize high crash locations, corridors, areas
- Identify appropriate treatments

DATA COLLECTION GUIDELINES

- Collect only what you need
- Collect only what you can use
  - Do you need 5 years' worth of data if 3 years' worth give you a good idea of the problem?
  - Do you need crash data for the entire state to be collected if you're focused on a small area?
  - Do you need detailed reports if the raw numbers give a good picture of the problem?
  - But don't jump to conclusions too soon: incomplete data could give a false perspective of the problem

DATA COLLECTION GUIDELINES

- Timely crash data
  - Try to get the most recent data possible
  - Make sure they go back far enough to be representative (min 3 years)
  - Don’t go too far back: conditions change over time

TYPES OF SAFETY PROJECTS

1. Spot Locations *(individual intersections and non-intersections)*
2. Corridors *(½ mile to 5 or more miles in length)*
3. Targeted Areas *(neighborhood, business district, or large area where pedestrian crashes are high)*
4. Entire Jurisdictions *(addressed through system-wide changes)*

CRASH DATA ANALYSIS

Crash data analysis can:

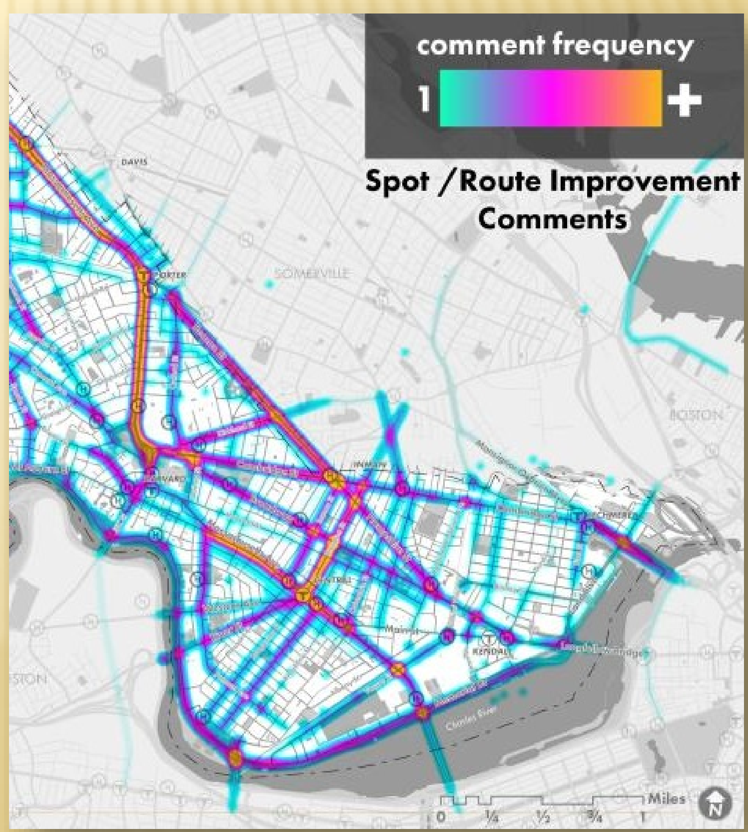
- Discover prevalent crash types and behaviors
- Target specific areas
- Inform selection of bicycle facility

City of Denver

CRASH DATA

Understanding the limitations:

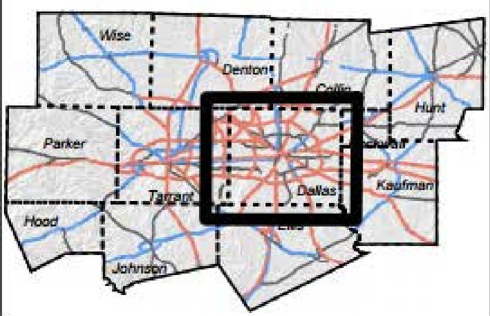
- Crashes usually dispersed
- Data does not include “near-misses”
- Public may perceive locations without a crash history as being unsafe
- Data may be incomplete or inaccurate

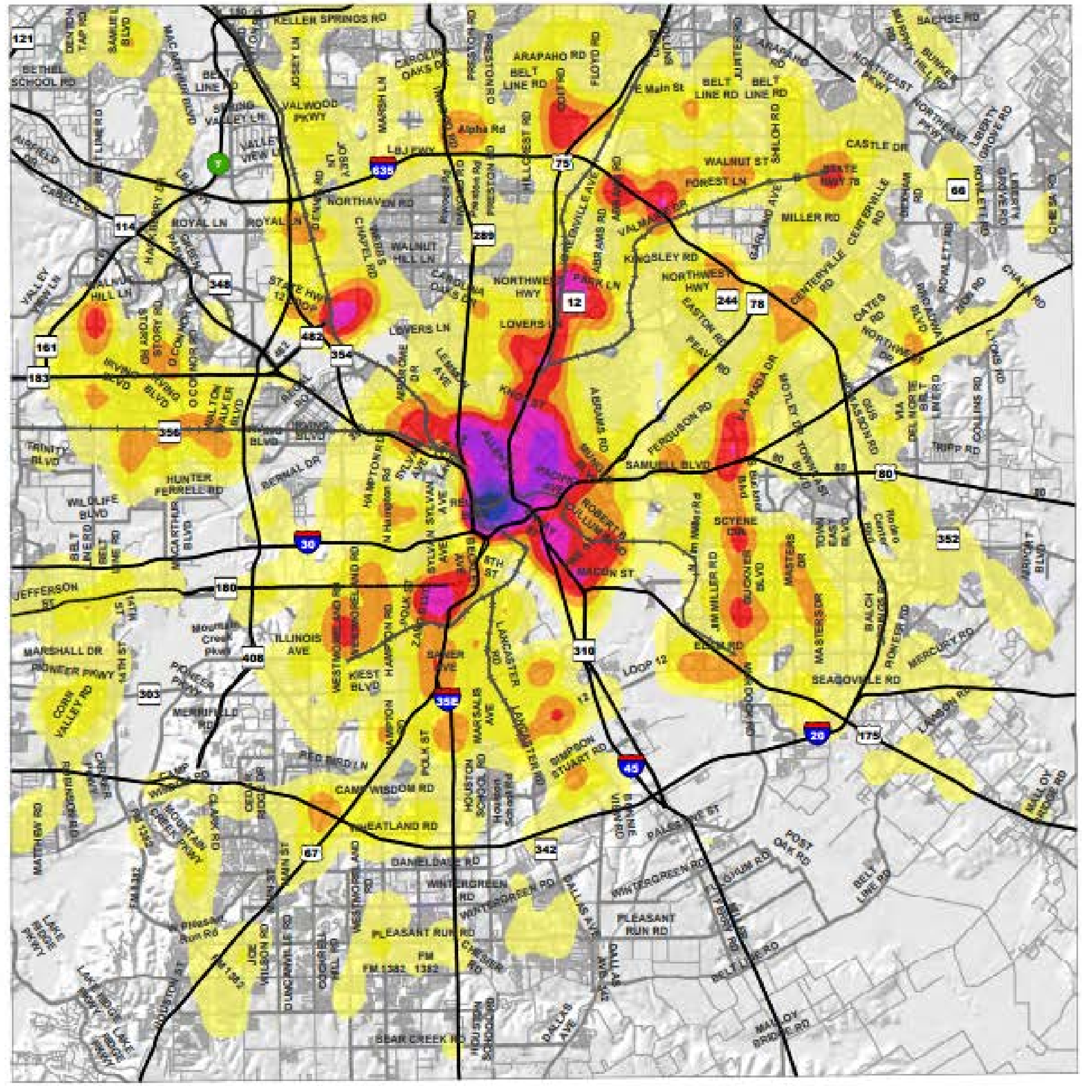


Dallas County
Bicycle & Pedestrian Crash Density (2010 - 2014)

- No Crash Density
- Low Crash Density
- Medium Crash Density
- High Crash Density
- Very High Crash Density
- Highway
- Major Arterial
- Minor Arterial
- Passenger Rail

NCTCOG 12 County Metropolitan Planning Area





Note: Density concentration is calculated as a magnitude per unit area from crash point features and is based on each county's geography. Blue symbolizes higher concentration of crashes and yellow displays lower concentrations.

Dallas County
Bicycle and Pedestrian Crash Locations and Density (2010 - 2014)

- ★ Bicycle and Pedestrian Fatal Crash Location - (263)
- ● Bicycle Crash Location - (995)
- ● Pedestrian Crash Location - (3,064)
- No Crash Density
- Low Crash Density
- Medium Crash Density
- High Crash Density
- Very High Crash Density
- Highway
- Major Arterial
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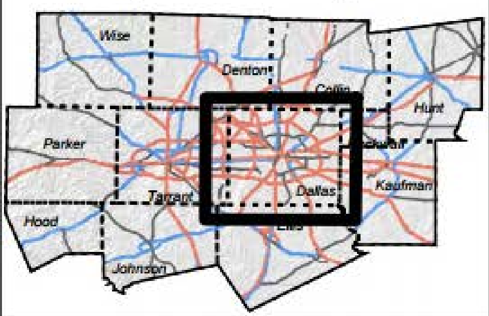
- Passenger Rail

NCTCOG 12 County Metropolitan Planning Area



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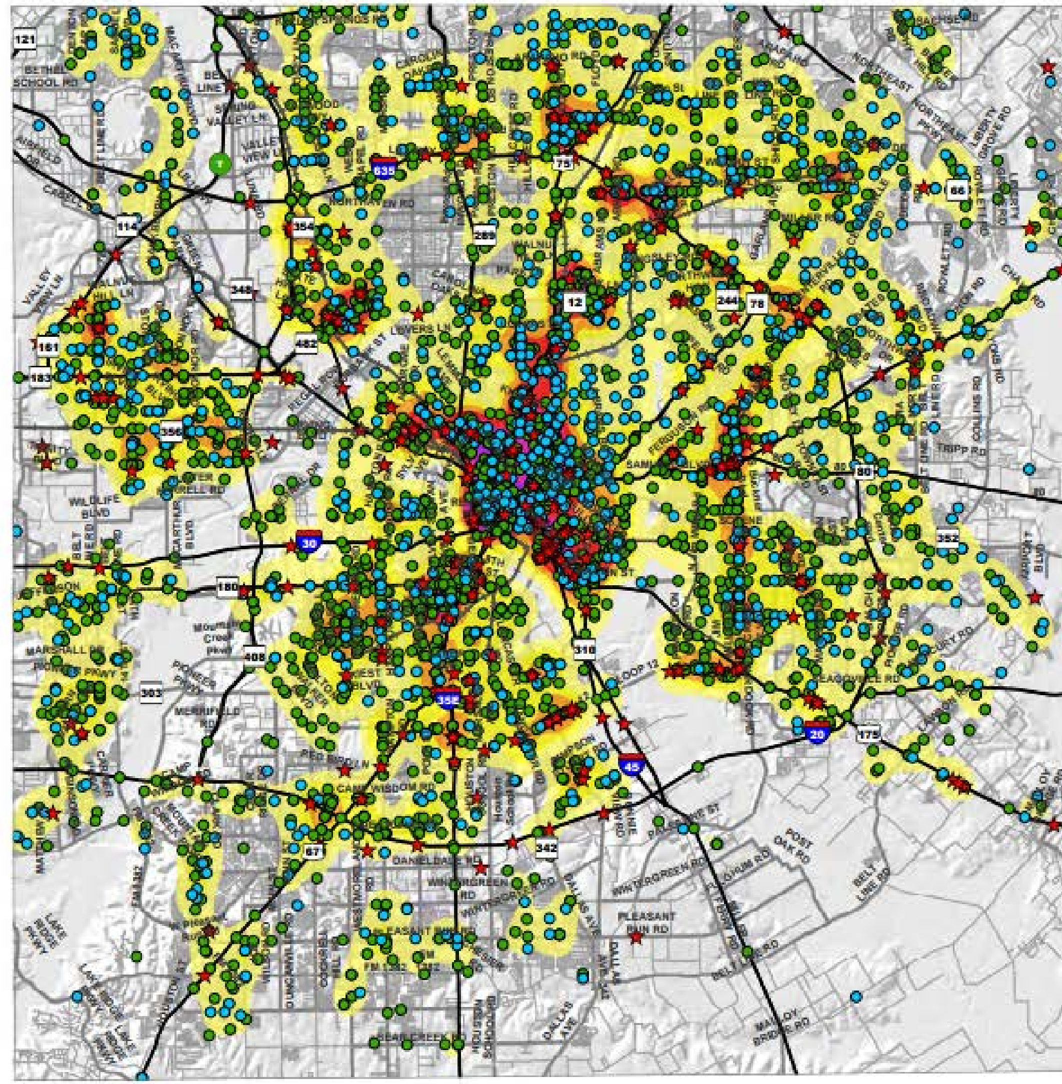


SAFETY EVALUATION TOOLS

- Highway Safety Manual
- Bicycle Intersection Safety Indices
- Highway Capacity Manual
- Road Safety Audit
- BIKESAFE

HSM METHODOLOGY

- Urban & Suburban Segments

$$N_{biker} = N_{br} \times f_{biker}$$

  - N_{biker} – vehicle-bicycle collision frequency
  - N_{br} – crash frequency, excluding bikes and peds
  - f_{biker} – bicycle crash adjustment factor

    -- < or > 30 mph posted speed

    -- road type (2U, 3T, 4U, 4D, 5T)

    -- values range from 0.002 to 0.050

HSM METHODOLOGY

- Urban & Suburban Intersections

$$N_{bikei} = N_{bi} \times f_{bikei}$$

- N_{bikei} -- vehicle-bicycle collision frequency
- N_{bi} -- predicted intersection crashes (no bikes/peds)
- f_{bikei} – bicycle crash adjustment factor

  -- intersection type (3ST, 3SG, 4ST, 4SG)

  -- values range from 0.011 to 0.018

CMF LIMITATIONS

Countermeasure: Install bicycle lanes

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
1.05	-5		All	All	Urban	Jensen, 2008	
0.944	5.6		All	All	Urban	Chen et al., 2012	
1.509	-50.9		Vehicle/bicycle	All	Urban	Chen et al., 2012	
1.057	-5.7		All	All	Urban	Chen et al., 2012	Includes signalized, all-way stop controlled, ... [*read more*]
1.281	-28.1		Vehicle/bicycle	All	Urban	Chen et al., 2012	Includes signalized, all-way stop controlled, ... [*read more*]

CMF LIMITATIONS

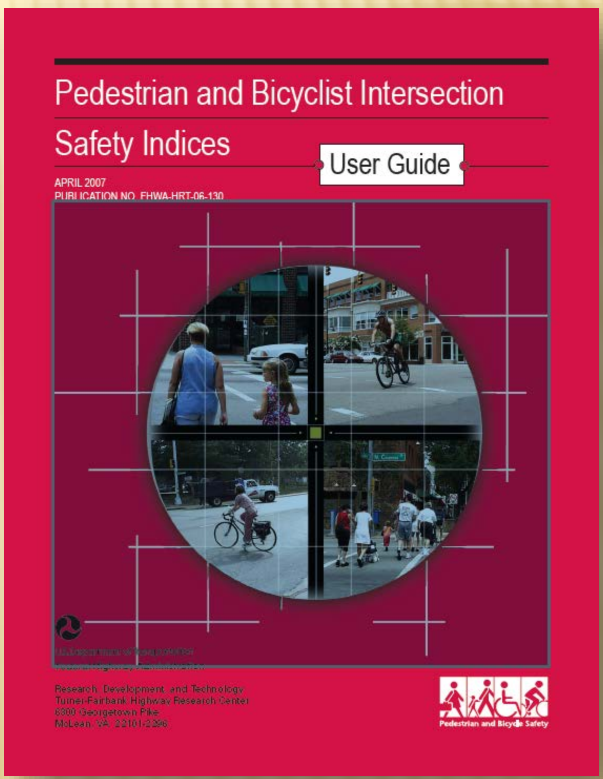
▾ Countermeasure: Installation of bicycle lanes at signalized intersections

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
1.37	-37	★★☆☆☆	Vehicle/bicycle	All	Urban and suburban	Turner et al., 2011	
0.8	20	★★☆☆☆	Vehicle/bicycle	All	Urban and suburban	Turner et al., 2011	
0.63	37	★★☆☆☆	Vehicle/bicycle	All	Urban and suburban	Turner et al., 2011	Crossing crashes at 90 degrees ... [*read more*]
1.33	-33	★★☆☆☆	Vehicle/bicycle	All	Urban and suburban	Turner et al., 2011	Crash Type: Cyclist through, left ... [*read more*]
1.01	-1	★★☆☆☆	Vehicle/bicycle	All	Urban and suburban	Turner et al., 2011	Crash Type: Rear end & ... [*read more*]

BICYCLIST INTERSECTION SAFETY INDICES

Prioritize intersections crossings and intersection approaches for bicycle safety improvements

- Score of 1 (safest) to 6 (least safe)
- Score for each movement (thru, left turn, right turn)



BICYCLIST INTERSECTION SAFETY INDICES

Select Sites to Evaluate

Gather Data

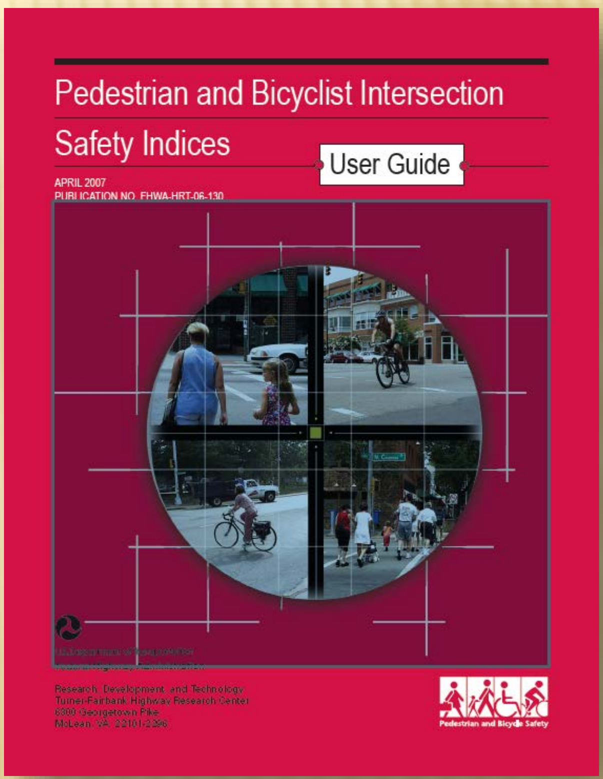
Calculate Index Values

Prioritize Sites

BICYCLIST INTERSECTION SAFETY INDICES

Inputs:

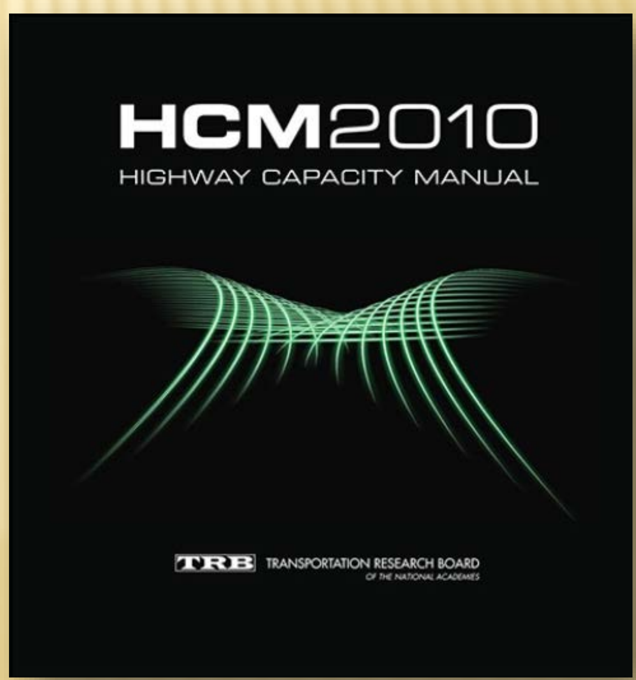
- ADT on main and cross streets.
- Number of through vehicle lanes on cross street.
- Number, type, and configuration of traffic lanes on main street approach.
- Speed limit on main street.
- Presence of on-street parking on main street approach.
- Type of traffic control on approach of interest (signal or no signal).



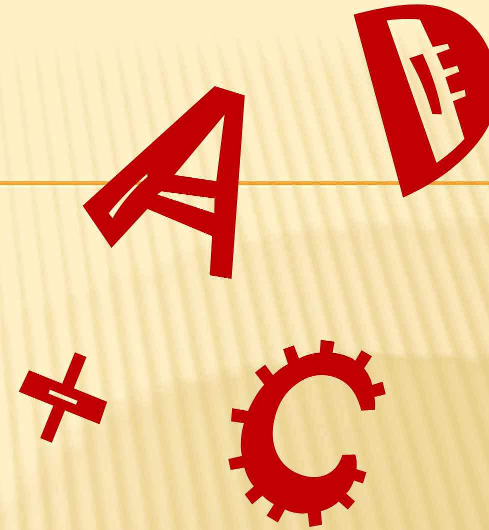
BICYCLE LEVEL-OF-SERVICE

Interrupted flow:

- LOS reported separately for each mode
  - Purpose, length, and expectation differs
- Travel speed
- Intersection delay
- Bicyclist perception



BICYCLE LEVEL-OF-SERVICE



Factors in bicycle LOS score:
Interrupted flow

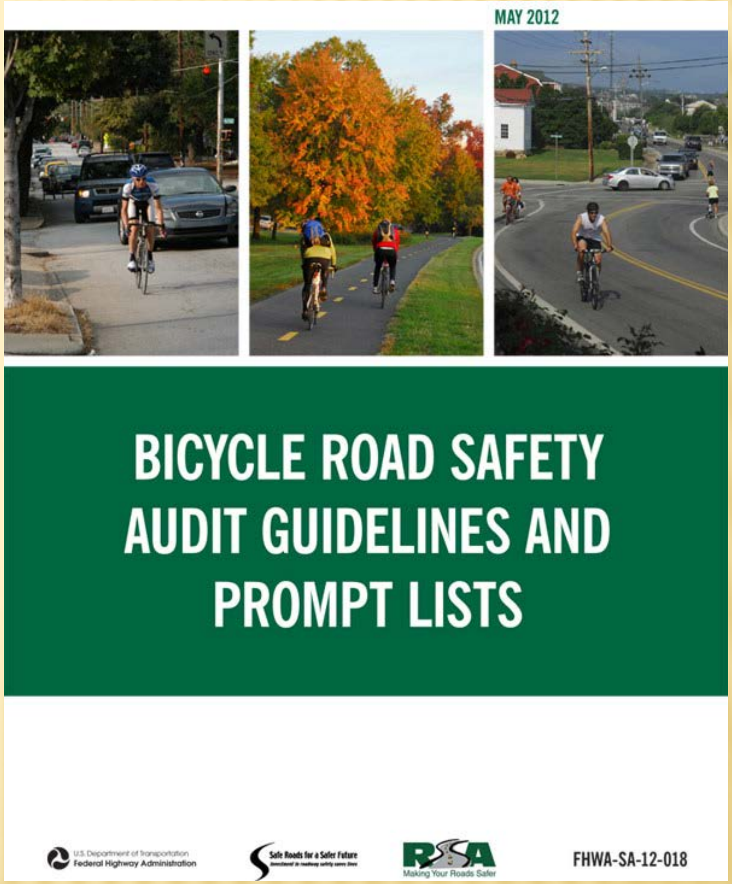
- Motorized vehicle volume
- % heavy vehicles
- % occupied parking
- # lanes
- Outside lane width
- Median
- Curb
- Access
- Pavement condition
- Motorized vehicle speed

LEVELS OF TRAFFIC STRESS (LTS)

Levels of Traffic Stress			
LTS 1	LTS 2	LTS 3	LTS 4
• Physically separated from traffic or low-volume, mixed-flow traffic at 25 mph or less • Bike lanes 6 ft wide or more • Intersections easy to approach and cross • Comfortable for children	• Bike lanes 5.5 ft wide or less, next to 30 mph auto traffic • Unsignalized crossings of up to 5 lanes at 30 mph • Comfortable for most adults • Typical of bicycle facilities in Netherlands	• Bicycle lanes next to 35 mph auto traffic, or mixed-flow traffic at 30 mph or less • Comfortable for most current U.S. riders • Typical of bicycle facilities in U.S.	• No dedicated bicycle facilities • Traffic speeds 40 mph or more • Comfortable for “strong and fearless” riders (vehicular cyclists)

ROAD SAFETY AUDIT

- Formal safety examination conducted by an independent, experienced, multidisciplinary team
- RSA Prompt List
- Bikeability checklist



RSA PROMPT LIST

D.8: Are the intersection/transition and paths leading to the transition adequately lit (see C.8)?

D.9: Is the visibility of cyclists as they make the transition from one facility or roadway geometry to another adequate from the perspective of all road users?

The transition, whether along a roadway or at an intersection, should allow drivers to see cyclists and understand their path and intent, and vice versa. The following should be investigated:

- Obstructions caused by roadside features (e.g., fences and vegetation).
- Adequacy of warning signs.
- Location of the transition with respect to roadway geometry (e.g., shoulder drop and turn lanes) (see also A.9 and C.9).

The picture to the left depicts a bike lane that hooks right through a major intersection and transitions to a protected bikeway. Chevrons on the pavement help guide cyclists and show motorists the path provided for cyclists through the intersection (note that the chevron pavement markings do not conform to the MUTCD).

D.10 and D.11: Are signs and markings at transition areas appropriate?

Transitions and termini should be appropriately signed and marked to warn cyclists of conditions ahead, particularly at locations at which cyclists do not expect transitions or termini. Likewise, motorized vehicles should have adequate warning when off-road bicycle facilities transition to on-road facilities. The intended paths of all road users should also be appropriately signed and marked at the point of transition. Additional attention may be given to locations with high volumes of unfamiliar users or tourists.

BIKEABILITY CHECKLIST

Go for a ride and use this checklist to rate your neighborhood's bikeability.

How bikeable is your community?

Location of bike ride (be specific):

Rating Scale: 1 awful, 2 many problems, 3 some problems, 4 good, 5 very good, 6 excellent

1. Did you have a place to bicycle safely?

a) On the road, sharing the road with motor vehicles?

- ☐ Yes
- ☐ Some problems (please note locations):
  - ☐ No space for bicyclists to ride
  - ☐ Bicycle lane or paved shoulder disappeared
  - ☐ Heavy and/or fast-moving traffic
  - ☐ Too many trucks or buses
  - ☐ No space for bicyclists on bridges or in tunnels
  - ☐ Poorly lighted roadways
  - Other problems: ________________________

b) On an off-road path or trail, where motor vehicles were not allowed?

- ☐ Yes
- ☐ Some problems:
  - ☐ Path ended abruptly
  - ☐ Path didn't go where I wanted to go
  - ☐ Path intersected with roads that were difficult to cross
  - ☐ Path was crowded
  - ☐ Path was unsafe because of sharp turns or dangerous downhills
  - ☐ Path was uncomfortable because of too many hills
  - ☐ Path was poorly lighted
  - Other problems: ________________________

2. How was the surface that you rode on?

- ☐ Good
- ☐ Some problems, the road or path had:
  - ☐ Potholes
  - ☐ Cracked or broken pavement
  - ☐ Debris (e.g. broken glass, sand, gravel, etc.)
  - ☐ Dangerous drain grates, utility covers, or metal plates
  - ☐ Uneven surface or gaps
  - ☐ Slippery surfaces when wet (e.g. bridge decks, construction plates, road markings)
  - ☐ Bumpy or angled railroad tracks
  - ☐ Rumble strips
  - Other problems: ________________________

Overall Surface Rating: (circle one)
1 2 3 4 5 6

3. How were the intersections you rode through?

- ☐ Good
- ☐ Some problems:
  - ☐ Had to wait too long to cross intersection
  - ☐ Couldn't see crossing traffic
  - ☐ Signal didn't give me enough time to cross the road
  - ☐ Signal didn't change for a bicycle
  - ☐ Unsure where or how to ride through intersection
  - Other problems: ________________________

Designing for Bicyclist Safety

SELECTING COUNTERMEASURES

DESIGN GUIDELINES

FHWA Memorandum – August 20, 2013
"Bicycle and Pedestrian Facility Design Flexibility"

Guide for the Development of Bicycle Facilities (AASHTO)
Designing Urban Walkable Thoroughfares (ITE)
Urban Bikeway Design Guide (NACTO)

New 2015
Separated Bike Lanes Planning & Design Guide (FHWA)

New 2016
Achieving Multimodal Networks: Applying Flexibility and Reducing Conflicts (FHWA)

New 2017
Small Town and Rural Multimodal Networks (FHWA)

BIKESAFE

The **Bicycle Safety Guide and Countermeasure Selection System** is intended to provide practitioners with the latest information available for improving the safety and mobility of those who bike. The online tools provide the user with a list of possible engineering, education, or enforcement treatments to improve bicycle safety and/or mobility based on user input about a specific location.

GUIDE

Background

Understand what is needed to create a viable bicycle network.

Analysis

How crash typing can lead to the most appropriate countermeasures.

Statistics

Learn about the factors related to thebicycle crash problem.

Implementation

Needed components for treatments.

COUNTERMEASURES

Selection Tool

Find countermeasures based on desired objectives.

Countermeasure List

A comprehensive list of all countermeasures.

Selection Matrices

Find countermeasures based on crash types and performance objectives.

CASE STUDIES

RESOURCES & GUIDELINES

Designing for Bicyclist Safety

SUMMARY THOUGHTS

KEY SAFETY FACTORS

- Speed
- Number of lanes
- Visibility
- Traffic volume & composition
- Conflict points
- Proximity
- Bike control
- Connectivity