Don’t Stress It: Bikeway Level of Comfort Metrics
DON’T STRESS IT: BIKEWAY LEVEL OF COMFORT

1. Topic Overview
2. Panelists’ Approach to Quantifying Bike Facility Adequacy
3. Group Discussion on Applying LTS to Facility Selection
4. Group Discussion on Bicycle (& Pedestrian) Safety @ Intersections
DON’T STRESS IT: BIKEWAY LEVEL OF COMFORT

Topic Overview
Transportation System Performance: What’s Most Important?
• Mobility?
• Accessibility?
• Safety?
DON’T STRESS IT: BIKEWAY LEVEL OF COMFORT

Topic Overview
Transportation System Performance: What Metrics Matter?
• Comprehensive Planning?
• Development Review?
• Project Planning?
• Design Guidance?
• System Evaluation?
DON’T STRESS IT: BIKEWAY LEVEL OF COMFORT

Panel Discussion:
Panelists’ Approach to Quantifying Bike Facility Adequacy
Existing Requirements

- Adopted in 1997
- Level of Subjectivity
- Established requirement for MMLOS
- Bicycle Standards shown

Figure 3. Bicycle LOS Standards

<table>
<thead>
<tr>
<th>connectivity required for levels of service:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
<tr>
<td>F</td>
</tr>
</tbody>
</table>

minimum LOS

| base city-wide minimum level: | C |
| public school sites: | A |
| recreation sites: | B |
| community/neighborhood commercial centers: | B |
### Existing Requirements

- Different standard by area type

#### Table P-3: Targeted Level of Service by Pedestrian Priority Area

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Directness</th>
<th>Continuity</th>
<th>Street Crossing</th>
<th>Visual Interest and Amenity</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Districts</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Activity Centers and Corridors</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>School Walking Areas</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>Transit Corridors</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>Other Areas Within City</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
</tbody>
</table>
Challenges

- Subjectivity
- Requirements to implement change
- Coordination
- Cost
Proposed Changes

- Revised Process Flowchart
- Pulls in Active Modes Plan
- Links to Vision Zero Action Plan
- Require more analysis in TIS for anything that is not a car
### Table 1. Bicycle Trip Generation Criteria, Peak Hour Bicycle Trip – Draft Proposal

<table>
<thead>
<tr>
<th>Infrastructure Criteria</th>
<th>No approved TDM Plan</th>
<th>With &lt;5 TDM points</th>
<th>With &gt;5 TDM points</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are no existing bicycle facilities connecting to the development</td>
<td>2% of vehicular trips</td>
<td>3% of vehicular trips</td>
<td>5% of vehicular trips</td>
</tr>
<tr>
<td>There are existing but deficient bicycle facilities (do not meet AMP standard), without key destinations within sphere of influence</td>
<td>4% of vehicular trips</td>
<td>6% of vehicular trips</td>
<td>8% of vehicular trips</td>
</tr>
<tr>
<td>There are existing but deficient bike facilities and key destinations within sphere of influence</td>
<td>6% of vehicular trips</td>
<td>8% of vehicular trips</td>
<td>12% of vehicular trips</td>
</tr>
<tr>
<td>There are existing bicycle facilities</td>
<td>8% of vehicular trips</td>
<td>12% of vehicular trips</td>
<td>18% of vehicular trips</td>
</tr>
</tbody>
</table>
## Proposed Changes

### Table 3. Bike Impact Fee Calculation Example – Draft Proposal

<table>
<thead>
<tr>
<th></th>
<th>Desired Bike Flow Rate / hr</th>
<th>Existing Bike Volume / hr</th>
<th>Threshold for bike fee contribution</th>
<th>Existing Bike Lane Capacity Ratio</th>
<th>Site Gen Bike Trip</th>
<th>Total Bike Volume</th>
<th>Proposed Bike Lane Capacity Ratio</th>
<th>Bike Impact Proportion</th>
<th>Cost of Bike Improvement</th>
<th>Length of project</th>
<th>Cost / mile</th>
<th>Segment in bike influence area</th>
<th>Total cost in influence area</th>
<th>Bike Impact Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>150</td>
<td>130</td>
<td>80%</td>
<td>0.87</td>
<td>25</td>
<td>155</td>
<td>1.03</td>
<td>17%</td>
<td>$2,500,000</td>
<td>5</td>
<td>$500,000</td>
<td>0.5</td>
<td>$250,000</td>
<td>$41,666.67</td>
</tr>
</tbody>
</table>

- From Draft AASHTO Bike Guide Table 7.3 and 7.4
- From counts
- Determine by local jurisdiction
- From bike trip generation table
- Difference between existing and proposed ratio
- Random example
- mile
- mile

### Table 2. Bicycle Desired Flow Rate

<table>
<thead>
<tr>
<th>Bike Lane Width (ft)</th>
<th>Peak Hour Directional Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-way PBL</td>
<td></td>
</tr>
<tr>
<td>5.5 - 8.5</td>
<td>150</td>
</tr>
<tr>
<td>8.5 - 10</td>
<td>750</td>
</tr>
<tr>
<td>Two-way PBL</td>
<td></td>
</tr>
<tr>
<td>9 - 12</td>
<td>150</td>
</tr>
<tr>
<td>12 - 16</td>
<td>350</td>
</tr>
</tbody>
</table>
Thank you!
Tyler Stamey, P.E.
tstamey@fcgov.com
970-556-5245
Don’t Stress It: Bikeway Level of Comfort Metrics

Francisco Lovera, P.E., Complete Streets Engineer, MassDOT
MassDOT
Healthy Transportation Policy & Engineering Directive

Policy requires all state transportation projects to increase biking, transit, and walking options.

Healthy Transportation Policy (2013)


Policy Evaluation (2017-2018)


New controlling criteria released to implement policy directive. Focused on pedestrian and bicycle accommodations.

NEW criteria and process to ensure that people of all ages and abilities are afforded the opportunity for safe travel regardless of mode.

Target Speed

- PEDESTRIAN FATALITY & SERIOUS INJURY RISK
  - 18%
  - 50%
  - 77%

- Cone of Vision

Mass.gov/safe-speeds
Pedestrian Facilities Criteria

• Sidewalks on both sides required if...
  • Roadway in an urbanized area, urban cluster, or rural village (where pedestrians are legally allowed)
  • Roadway on or under a bridge where legally allowed
  • Roadways with a High Potential for Everyday Walking

• Minimum width 5’-0”

• Marked crosswalks across all legs of signalized intersections where sidewalks are present or proposed

• Marked crosswalks shall be provided at existing crosswalks
Bicycle Facilities Criteria

• Bicycle facilities required (where bicycles are legally allowed) except for local roads

• Bicycle facilities shall have separation (shared use path, side path, separated bike lane, buffered bike lane) if...
  • Posted speed limit ≥ 40 MPH
  • Vehicular volumes ≥ 10,000 vehicles per day
  • Roadway has more than one travel lane in a single direction
  • Intersection more than one travel lane in a single direction
  • Roadway classified as corridor with a High Potential for Everyday Biking

• Minimum width 5’-0” (single direction), 10’-0” (bi-directional)
  • Does not include curbs, buffers
Potential for Everyday Biking

The Potential for Everyday Biking methodology calculates the likelihood of everyday short trips by bike if safe, comfortable, and convenient bikeways existed. Available for Potential for Walkable Trips too.

https://www.mass.gov/service-details/bicycle-plan
**Design Justification Workbook**

**MassDOT Design Justification Workbook**

**Project:** 60XXX
**Description:** MUNICIPALITY: PROJECT DESCRIPTION

**PEDESTRIAN FACILITIES**

**Facility:** Street Road (Route X)

☐ pedestrians are not legally allowed on the facility, check this box and do not fill out this sheet.

(Fill in information about the proposed Pedestrian Accommodations on this facility.)

For the purposes of this Workbook, the entries for this criterion have been split into several “subcriteria.”

**Type of Pedestrian Accommodation:**

<table>
<thead>
<tr>
<th>Subcriterion: Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum: 5.0 FT</td>
</tr>
<tr>
<td>Existing: FT</td>
</tr>
<tr>
<td>Proposed: 5.0 FT</td>
</tr>
</tbody>
</table>

Source used for minimum: MassDOT Controlling Criteria

Justify the proposed width.

(Attach additional sheets as necessary.)

<table>
<thead>
<tr>
<th>Subcriterion: Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum: 5.0 FT</td>
</tr>
<tr>
<td>Existing: FT</td>
</tr>
<tr>
<td>Proposed: 4.5 FT</td>
</tr>
</tbody>
</table>

Source used for minimum: MassDOT Controlling Criteria

Justify the proposed width.

(Attach additional sheets as necessary.)

<table>
<thead>
<tr>
<th>Subcriterion: Presence</th>
</tr>
</thead>
</table>

Pedestrian facilities exist on

Pedestrian facilities are proposed on

(Complete boxes if any of the following apply.)

☐ The roadway is in an urbanized area, an urban cluster, or a rural village.

☐ The project involves work on or underneath a bridge.

☐ The roadway is identified as having a High Potential of Walkable Trips in the Pedestrian Plan.

Justify the proposed number of sidewalks.

(Attach additional sheets as necessary.)

---

massDOT
Massachusetts Department of Transportation
Vision

All people in Massachusetts will have a safe, comfortable, and convenient option to walk for short trips.

Goal 1

Eliminate pedestrian fatalities and serious injuries.

Increase the percentage of short trips made by walking.

Goal 2

Vision

Biking in Massachusetts will be a safe, comfortable, and convenient option for everyday travel.

Goal 1

Eliminate bicyclist fatalities and serious injuries.

Increase the percentage of everyday trips made by bicycling.

Goal 2
Design Guides

https://www.mass.gov/lists/design-guides-and-manuals
Metric for Infrastructure Projects

• Looking for alternative to motor vehicle Level of Service for evaluating projects.

• Project Development and Design Guide Update
  • Removing LOS references for pedestrian and bicycle modes
  • Focusing on safety rather than level of service

• Infrastructure that work for all, as early as 3-year-old and their caregivers.

• Comfortable for all. A step above safety
Project Example

• Highland Ave
Project Example

• Route 135
Project Example

• Charles River Dam Road
Project Example

• Route 28
Process
Francisco Lovera, P.E.
Francisco.j.lovera@state.ma.us
Don’t Stress It: Bikeway Level of Comfort Metrics

Celeste Gilman, Strategic Policy Administrator, Active Transportation Division
Washington State Department of Transportation

May 15, 2023
Level of Stress and Route Directedness
Level of Traffic Stress - Bicycle

- All riders
- Most riders
- Few riders
- 1% of riders
## Basic LTS

### General Linear LTS (no sidewalk / no marked bike lane / with or without shoulder)

<table>
<thead>
<tr>
<th>Lanes</th>
<th>AADT</th>
<th>&lt;=20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 thru lane per direction (or 1 lane one-way street)</td>
<td>0-750</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>751-1500</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1501-3000</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3000+</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2 thru lanes per direction</td>
<td>0-6000</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&gt;6000</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3+ thru lanes per direction</td>
<td>Any ADT</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

### Conventional Bike Lanes (5' or greater)

<table>
<thead>
<tr>
<th>Lanes</th>
<th>AADT</th>
<th>&lt;=20</th>
<th>25</th>
<th>30</th>
<th>35</th>
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<td>0-750</td>
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<td>2</td>
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<tr>
<td></td>
<td>751-1500</td>
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<td>2</td>
<td>2</td>
<td>4</td>
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<tr>
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<td>1501-3000</td>
<td>1</td>
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<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3000+</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2 thru lanes per direction</td>
<td>0-6000</td>
<td>2</td>
<td>2</td>
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<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
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<tr>
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<td>&gt;6000</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
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<tr>
<td>3+ thru lanes per direction</td>
<td>Any ADT</td>
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<td>3</td>
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<td>4</td>
<td>4</td>
<td>4</td>
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</tr>
</tbody>
</table>
## Basic LTS

### Buffered Bike Lanes (minimum 2’ buffer / greater than or equal to 7 feet total)

<table>
<thead>
<tr>
<th>Lanes</th>
<th>AADT</th>
<th>&lt;=20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
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<tr>
<td></td>
<td>3000+</td>
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<td>3</td>
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<td>4</td>
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<tr>
<td>2 thru lanes per direction</td>
<td>0-6000</td>
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<td>&gt;6000</td>
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<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3+ thru lanes per direction</td>
<td>Any ADT</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
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</tr>
</tbody>
</table>

### Separated Bicycle Lane

<table>
<thead>
<tr>
<th>Lanes</th>
<th>AADT</th>
<th>&lt;=20</th>
<th>25</th>
<th>30</th>
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<th>45</th>
<th>50+</th>
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</thead>
<tbody>
<tr>
<td>1 thru lane per direction (or 1 lane one-way street)</td>
<td>0-750</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td></td>
<td>751-1500</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
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</tr>
<tr>
<td></td>
<td>1501-3000</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3000+</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<td>2 thru lanes per direction</td>
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<tr>
<td>3+ thru lanes per direction</td>
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<td>2</td>
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</tbody>
</table>
### Refined LTS Criteria - DRAFT

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Target / Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating speeds</td>
<td>Lowest acceptable vehicle travel speed (target speed)</td>
</tr>
<tr>
<td>Driveways (especially commercial)</td>
<td>Minimize number of accesses, provide smooth transitions for the PAR</td>
</tr>
<tr>
<td>Turn lanes</td>
<td>Only when necessary, seek alternatives</td>
</tr>
<tr>
<td>Parking lanes</td>
<td>Prioritize roadside parking as an additional buffer</td>
</tr>
<tr>
<td>Crossing distances</td>
<td>Reduce distances using bulbouts and median islands</td>
</tr>
<tr>
<td>Crossing barriers (e.g. median channelization)</td>
<td>Minimize the use of traffic barriers</td>
</tr>
<tr>
<td>Large (e.g. freight) vehicle traffic</td>
<td>Encourage slower travel speeds and turning movements by minimizing curb radii at intersections.</td>
</tr>
<tr>
<td>Minor pinch points (culverts, drain grates, offroad gravel intrusion, etc)</td>
<td>Minimize</td>
</tr>
<tr>
<td>Surface</td>
<td>Smooth and free of abrupt changes in vertical elevation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Target/Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade and cross slope</td>
<td>Minimized grade and linear distance of slope</td>
</tr>
<tr>
<td>Bikeway width</td>
<td>Matched to expected volumes, providing shy space from traffic and obstacles.</td>
</tr>
<tr>
<td>Roadway width</td>
<td>Minimized to reduce crossing distances</td>
</tr>
<tr>
<td>Separation</td>
<td>Maximized by using shoulders, bike lanes, landscaped buffers, parking</td>
</tr>
<tr>
<td>Sight distance</td>
<td>Maximized for drivers and pedestrians by using curb extensions and removing obstructions including parking near intersections</td>
</tr>
<tr>
<td>Traffic conditions</td>
<td>Speeds are managed and lane numbers are minimized</td>
</tr>
<tr>
<td>Intersections/crossings</td>
<td>See intersection guidance</td>
</tr>
<tr>
<td>Conflict points</td>
<td>Eliminated, reduced, or spread out</td>
</tr>
<tr>
<td>Access to adjacent land use</td>
<td>Provide direct path between destinations</td>
</tr>
<tr>
<td>Lighting</td>
<td>Specifically designed to improve bicyclist vision, with other considerations including bicycle conspicuity to drivers and personal security</td>
</tr>
</tbody>
</table>
## Bicycle Facility Selection for LTS2 or Better - DRAFT

### Roadway Context

<table>
<thead>
<tr>
<th>Target Motor Vehicle Speed</th>
<th>Target Motor Vehicle Volume</th>
<th>Motor Vehicle Lanes</th>
<th>All Ages &amp; Abilities Bicycle Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mph (or less)</td>
<td>up to 7000</td>
<td>2 or less E.D.</td>
<td>Bicycle Boulevard, Conventional Bike Lane, Buffered Bike Lane, Separated Bike Lane</td>
</tr>
<tr>
<td></td>
<td>&gt;7000</td>
<td>2 or more lanes E.D.</td>
<td>Buffered Bike Lane, Separated Bike Lane</td>
</tr>
<tr>
<td>Any</td>
<td>3 or more lanes E.D.</td>
<td>Separated Bike Lane</td>
<td></td>
</tr>
<tr>
<td>30 mph</td>
<td>up to 7000</td>
<td>Single lanes</td>
<td>Bicycle Boulevard, Conventional Bike Lane, Buffered Bike Lane, Separated Bike Lane</td>
</tr>
<tr>
<td></td>
<td>2 lanes E.D.</td>
<td>Buffered Bike Lane, Separated Bike Lane</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 7000</td>
<td>2 or more lanes E.D.</td>
<td>Separated Bike Lane</td>
</tr>
<tr>
<td></td>
<td>Any</td>
<td>Any</td>
<td>Separated Bike Lane</td>
</tr>
</tbody>
</table>

### Notes:
- Target Motor Vehicle Speed: 25 mph (or less), 30 mph, > 30 mph
- Target Motor Vehicle Volume: up to 7000, > 7000
- Motor Vehicle Lanes: 2 or less E.D., 2 or more lanes E.D., 3 or more lanes E.D., Single lanes, 2 lanes E.D., Any
Level of Traffic Stress - Pedestrian

- **All people**
  - LTS 1
- **Most people**
  - LTS 2
- **Few people**
  - LTS 3
- **1% of people**
  - LTS 4
Route Directness Index (RDI)

• “How far out of my way do I need to go to cross the highway?”
• WSDOT Multimodal Permeability Pilot
• RDI tied to LTS

Physically high RDI:
Person B must go out of their way to reach a destination due to network design

Functionally high RDI:
Both person A and B must go out of their way to find a reasonable crossing.
What is Route Directness Index?

- straight-line distance “A”
- actual route distance “B”

\[ \text{RDI} = \frac{B}{A} \]
Route Directness Index

RDI Applied - Neighborhood Example

RDI = 5.0

RDI = 1.2

shared-use path
Resources

- WSDOT Active Transportation Plan:
  https://wsdot.wa.gov/construction-planning/statewide-plans/active-transportation-plan
- Multimodal Permeability Pilot:
- WSDOT Complete Streets:
  https://wsdot.wa.gov/construction-planning/complete-streets
- Celeste Gilman presentation on WSDOT Complete Streets for PSU TREC:
  https://trec.pdx.edu/events/professional-development/friday-transportation-seminar-10142022
- NCHRP 1036 - Guidebook for Cross Section Reallocation:
  https://www.trb.org/Publications/Blurbs/182870.aspx
- Celeste Gilman, gilmanc@wsdot.wa.gov, 206.492.0993
Biking is Booming in Chicago

2010
Total Network
193.2 miles
65% population within 1/2 mile
Low-Stress Network
47.2 miles
18% population within 1/2 mile

2014

2018

2022
Total Network
423.4 miles
86% population within 1/2 mile
Low-Stress Network
132.1 miles
51% population within 1/2 mile
Biking is Booming in Chicago

Annual Bikeshare Ridership

- 3.6 Million
- 5.7 Million

2016 - 2022
Belmont Cragin youth victorious after two-year fight brings bike lanes to neighborhood

CHICAGO SUN-TIMES

Chicago to Add Concrete Barriers to All Protected Bike Lanes by 2023
Comfort Looks Like This…

An Equitable Transportation System

- Planning
- Design
- Citywide
- Connected Citywide Network
- Implementation
- Maintenance
- Project
- Low-Stress Options
- Serving Local Trips
- Neighborhood
- Culture of Cycling
- Access to Bikes
DON’T STRESS IT
Low Stress Bikeways Intersection Selection
DEVELOPMENT REVIEW:
A COMPREHENSIVE TRANSPORTATION REVIEW
Transportation System Performance: What’s Most Important?

• Mobility?
• Accessibility?
• Safety?
WHAT INFRASTRUCTURE IS SUFFICIENT TO MAXIMIZE SAFETY FOR CYCLISTS & PEDESTRIANS?

Context Matters!
Urban, Suburban, Rural?
Near a Mobility Hub, School Zone?
What’s the Modal Priority of the Street(s)?
Approach in Year 2004:
Objective: Improve Pedestrian / Cyclist Safety
Create an Intersection Rating System

• Excellent
• Good
• Adequate
• Sub-par
• Poor
PEDESTRIAN RATING: POOR

• Inadequate Signal Timing
• Unwarranted “Hot Right” Lanes
• Sight Distance Problems
PEDESTRIAN RATING: SUB-PAR

- No Pedestrian Walk Signals
- Basic Traffic Infrastructure
PEDESTRIAN RATING: ADEQUATE

“Sub-par” Elements, Plus:

• Pedestrian Walk / Don’t Walk Signals

• Pedestrian Refuge Islands, Where Possible
PEDESTRIAN RATING: GOOD

“Adequate” Elements, Plus:

• “Yield to Pedestrians” Signs
• Turn Restrictions
• Hatched Crosswalks
Pedestrian Rating: Excellent

“Good” Elements, Plus Innovative Treatments, Such as Paddle Signs, etc.
Application:
Off-site Study of Intersection Safety
Define “Adequate” / Requirements
Convey Application to Other Planning Functions

Intersection Ratings:
Excellent
Good
Adequate
Sub-par
Poor
TIME TO UPDATE THE RATING SYSTEM!
CONTACT

Lawrence Marcus, Founder
Forward Progress, LLC

Lmarcus.@forward-progress.com
DON’T STRESS IT
Low Stress Bikeways Intersection Selection
Low Stress Intersection Selection
The Real Reason Ford Is Phasing Out Its Sedans

Lincoln Continental Is Canceled as Brand Shifts to All-SUV Lineup

Dead: Chevy Bolt EV and Bolt EUV
The Bolt EV and Bolt EUV don't have much of a future with the upcoming Blazer EV and Equinox EV.

Trucks And SUVs Are Now Over 80 Percent Of New Car Sales In The U.S.
BIKE SIGNAL / SPLIT PHASE
OFFSET / PROTECTED INTERSECTION
MIXING ZONE
### One Way PBL Intersection Selection Matrix

<table>
<thead>
<tr>
<th>Vehicles per hour turning across PBL</th>
<th>Bike Signal</th>
<th>Offset Intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>Not Recommended</td>
<td>Preferred</td>
</tr>
<tr>
<td>HIGH</td>
<td>Preferred</td>
<td>Not Recommended</td>
</tr>
</tbody>
</table>

DRAFT FOR DISCUSSION PURPOSES
# One Way PBL Intersection Selection Matrix

<table>
<thead>
<tr>
<th>Vehicles per hour turning across PBL</th>
<th>Bike Signal</th>
<th>Offset Intersection</th>
<th>Mixing Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>Not Recommended</td>
<td>Preferred</td>
<td>Not Preferred but possible</td>
</tr>
<tr>
<td>HIGH</td>
<td>Preferred</td>
<td>Not Recommended</td>
<td></td>
</tr>
</tbody>
</table>

- **Area of Ambiguity**

- **CDOT**

DRAFT FOR DISCUSSION PURPOSES
One Way PBL Intersection Selection Matrix

Vehicles per hour turning across PBL

<table>
<thead>
<tr>
<th>LOW</th>
<th>Preferred</th>
<th>Possible</th>
<th>Preferred</th>
<th>Not Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH</td>
<td>Preferred</td>
<td>Possible</td>
<td>Preferred</td>
<td>Not Recommended</td>
</tr>
</tbody>
</table>

Bike Signal

Offset Intersection

Mixing Zone

Not required
## One Way PBL Intersection Selection Matrix

<table>
<thead>
<tr>
<th>Vehicles per hour turning across PBL</th>
<th>Bike Signal</th>
<th>Offset Intersection</th>
<th>Mixing Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>Not Recommended</td>
<td>Preferred</td>
<td></td>
</tr>
<tr>
<td>50 – 100</td>
<td>Possible</td>
<td>Preferred</td>
<td></td>
</tr>
<tr>
<td>101 – 150</td>
<td>Preferred</td>
<td>Possible if necessary</td>
<td></td>
</tr>
<tr>
<td>&gt; 150</td>
<td>Preferred</td>
<td>Not Recommended</td>
<td></td>
</tr>
</tbody>
</table>

Not generally required
### Vehicles per hour turning across PBL

<table>
<thead>
<tr>
<th>50 – 100</th>
<th>Possible if necessary</th>
<th>Preferred</th>
</tr>
</thead>
<tbody>
<tr>
<td>101 – 150</td>
<td>Preferred</td>
<td>Possible if necessary</td>
</tr>
</tbody>
</table>

### Bike Signal

- A: NORTHBOUND STREET (80)
- B: SOUTHBOUND ST (140)
- C: (101)
- D: (90)
- E: (111)
- F: (35)

### Offset Intersection

- G
- H
- I
Where are the three bike signals?
Low Stress Intersection Selection…

Context Matters
Factors can amplify or mitigate the vehicle turning movement numbers
• History / expectation of bikes
• Driver mindset (commuting, local access)
• Cross street lane configuration
• Design vehicle choice
• Speed limit
• Density of pedestrians and use of LPI
• Platooning

Numbers Matter
Break down the counts
• 3600 seconds per hour
• 60 seconds per cycle (50/50 split)
• 100 vph turning across PBL
• 1.6 vehicles per cycle

How many vehicle-bike interactions, what are they, and how are they mitigated/amplified by what’s happening?

DRAFT FOR DISCUSSION PURPOSES
Don’t Stress It: Bikeway Level of Comfort Metrics

Celeste Gilman, Strategic Policy Administrator, Active Transportation Division
Washington State Department of Transportation

May 15, 2023
RDI Example – Walla Walla
Example Facilities
W Main Ave, Spokane

Before

After
W. Sunset Blvd, Spokane

Before

After
SR 99, Seattle

Before

By Michelle Banuchman and Asia Fields
Seattle Times staff reporters

Bergen Fuglestad, a 20-year-old University of Washington student, is an avid runner and hiker. Over the summer, she climbed 14,500-foot Mount Whitney in California and bought a 2000 Dodge camper van to better access Washington’s trailheads.

On Monday evening, she was running on the upper trail around Green Lake near Aurora Avenue North when a driver hopped the curb. The vehicle struck her from behind on the path, sending her 40 feet through the air and leaving her immobile when she landed, her father, Jim Fuglestad, told The Seattle Times.

A statement from the Seattle Police Department said the collision occurred about 5 p.m. on the 6700 block of Aurora Avenue North — close to the path.
Aurora Avenue and N 92\textsuperscript{nd} St

- 92\textsuperscript{nd} 6 crashes (3yrs prior to project). No crashes (16 month after)
- 88\textsuperscript{th}-94\textsuperscript{th} (26% drop in all crashes, 47% drop in injury crashes)
Dexter Ave, Seattle

before

after
15th Ave, Seattle

Before

After
Future Projects
Burlington

**Project:** SR 20 Paving

**Location:**
- AADT 19,000, speed limit 30mph
- Identified as a portion of an overburdened community
- Gaps are identified in WSDOT's Active Transportation Plan
- The City of Burlington is excited for the opportunity to partner with WSDOT to identify improvements needed on and off the highway system to support active transportation and transit
Bellingham

Projects: SR 539/I-5 Fish Passages, Paving, ADA

Located in:
• AADT 51,000, speed limit 35mph, T2 freight route
• Identified as an overburdened community
• Transit route, no pick-ups along this busy corridor
• Gaps identified in WSDOT's Active Transportation Plan
• City of Bellingham ADA and Walking Plans identified needs
• Bicycle route identified off this corridor, this more comfortable route – not fully developed

Lots of activity squeezed into a small space
SeaTac/Tuckwila

Project: SR 99/SR 518 Pedestrian Improvements

Location
- AADT 32,320, speed limit 40mph
- Freight classification T-2
- Posted speed 40 mph
- SR 518 BRT in median with pedestrian bridge connection to light rail and possible southside redevelopment or SR 518 on-ramp
- Metro A Line on SR 99
- Transit oriented development
- Rental car facility
SeaTac/Tuckwila

**Project:** SR 99/SR 518 Pedestrian Improvements

**Location**
- Ramp termini
- Existing light rail station
- Bus Rapid Transit in design
- Overburdened community (Environmental Health Disparity Map rank 10)
- Gaps identified by cities, Sound Transit, and WSDOT
- Strategy identified in SR 518 Corridor Study
Centralia

Projects: SR 507/Skookumchuck River to Thurston Co Line – Pavement Rehabilitation

Characteristics:

• Oakview Elementary School
• AADT 9,400 at Reynolds, 3,800 at City limits
• 35 mph posted speed within City limits
• Designated T-3 Freight Route with significant potential for freight development to the north
• RuralTRANSIT - Route 4 stop to the south
Centralia

Projects: SR 507/Skokumchuck River to Thurston Co Line – Pavement Rehabilitation

Characteristics:
• Significant flooding potential
• Mixture of residential and commercial, more commercial towards W Reynolds Ave
• Little to no sidewalk, unpaved shoulders, one enhanced crossing at W Oak View Ave
• Setback utilities = approx. WSDOT right of way available for improvements
Ritzville

**Project:** I-90/SR 261 EB Bridge Rehab (SR 261 between I-90 ramps)

**Location:**
- AADT 6,300, speed limit 35mph, T-3 freight
- City of Ritzville
- Gaps are identified in WSDOT's Active Transportation Plan
- New mixed-use development will increase demand for active transportation
- WSDOT project will explore what can be implemented within the constrained space under the existing I-90 bridges
- City study will identify additional active transportation strategies for the area, including long-term solution under I-90 for when bridges are replaced
Resources

• WSDOT Active Transportation Plan:
  https://wsdot.wa.gov/construction-planning/statewide-plans/active-transportation-plan
• Multimodal Permeability Pilot:
• WSDOT Complete Streets:
  https://wsdot.wa.gov/construction-planning/complete-streets
• Celeste Gilman presentation on WSDOT Complete Streets for PSU TREC:
  https://trec.pdx.edu/events/professional-development/friday-transportation-seminar-10142022
• NCHRP 1036 - Guidebook for Cross Section Reallocation:
  https://www.trb.org/Publications/Blurbs/182870.aspx
• Celeste Gilman, gilmanc@wsdot.wa.gov, 206.492.0993
Don’t Stress It: Bikeway Level of Comfort Metrics

Francisco Lovera, P.E., Complete Streets Engineer, MassDOT
Bicycle Facilities Criteria

• Bicycle facilities required (where bicycles are legally allowed) except for local roads

• Bicycle facilities shall have separation (shared use path, side path, separated bike lane, buffered bike lane) if...
  • Posted speed limit ≥ 40 MPH
  • Vehicular volumes ≥ 10,000 vehicles per day
  • Roadway has more than one travel lane in a single direction
  • Intersection more than one travel lane in a single direction
  • Roadway classified as corridor with a High Potential for Everyday Biking

• Minimum width 5’-0” (single direction), 10’-0” (bi-directional)
  • Does not include curbs, buffers
Potential for Everyday Biking

The Potential for Everyday Biking methodology calculates the likelihood of everyday short trips by bike if safe, comfortable, and convenient bikeways existed. Available for Potential for Walkable Trips too.

https://www.mass.gov/service-details/bicycle-plan
**Vision**
All people in Massachusetts will have a safe, comfortable, and convenient option to walk for short trips.

**Goal 1**
*Eliminate* pedestrian fatalities and serious injuries.

**Goal 2**
*Increase* the percentage of short trips made by walking.

**Vision**
Biking in Massachusetts will be a safe, comfortable, and convenient option for everyday travel.

**Goal 1**
*Eliminate* bicyclist fatalities and serious injuries.

**Goal 2**
*Increase* the percentage of everyday trips made by bicycling.
Design Guides

https://www.mass.gov/lists/design-guides-and-manuals
Metric for Infrastructure Projects

• Looking for alternative to motor vehicle Level of Service for evaluating projects.

• Project Development and Design Guide Update
  • Removing LOS references for pedestrian and bicycle modes
  • Focusing on safety rather than level of service

• Infrastructure that work for all, as early as 3-year-old and their caregivers.

• Comfortable for all. A step above safety
• Adopted in 1997
• Level of Subjectivity
• Established requirement for MMLOS
• Bicycle Standards shown
### Existing Requirements

- **Different standard by area type**

<table>
<thead>
<tr>
<th>Directness</th>
<th>Continuity</th>
<th>Street Crossing</th>
<th>Visual Interest and Amenity</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Districts</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Activity Centers and Corridors</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>School Walking Areas</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Transit Corridors</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Other Areas Within City</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
</tbody>
</table>
Challenges

- Subjectivity
- Requirements to implement change
- Coordination
- Cost
Proposed Changes

• Revised Process Flowchart
• Pulls in Active Modes Plan
• Links to Vision Zero Action Plan
• Require more analysis in TIS for anything that is not a car
## Table 1. Bicycle Trip Generation Criteria, Peak Hour Bicycle Trip – Draft Proposal

<table>
<thead>
<tr>
<th>Infrastructure Criteria</th>
<th>No approved TDM Plan</th>
<th>With &lt;5 TDM points</th>
<th>With &gt;5 TDM points</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are no existing bicycle facilities connecting to the development</td>
<td>2% of vehicular trips</td>
<td>3% of vehicular trips</td>
<td>5% of vehicular trips</td>
</tr>
<tr>
<td>There are existing but deficient bicycle facilities (do not meet AMP standard), without key destinations within sphere of influence</td>
<td>4% of vehicular trips</td>
<td>6% of vehicular trips</td>
<td>8% of vehicular trips</td>
</tr>
<tr>
<td>There are existing but deficient bike facilities and key destinations within sphere of influence</td>
<td>6% of vehicular trips</td>
<td>8% of vehicular trips</td>
<td>12% of vehicular trips</td>
</tr>
<tr>
<td>There are existing bicycle facilities</td>
<td>8% of vehicular trips</td>
<td>12% of vehicular trips</td>
<td>18% of vehicular trips</td>
</tr>
</tbody>
</table>
### Table 2. Bicycle Desired Flow Rate

<table>
<thead>
<tr>
<th>Bike Lane Width (ft)</th>
<th>Peak Hour Directional Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-way PBL</td>
<td></td>
</tr>
<tr>
<td>5.5 - 8.5</td>
<td>150</td>
</tr>
<tr>
<td>8.5 - 10</td>
<td>750</td>
</tr>
<tr>
<td>Two-way PBL</td>
<td></td>
</tr>
<tr>
<td>9 - 12</td>
<td>150</td>
</tr>
<tr>
<td>12 - 16</td>
<td>350</td>
</tr>
</tbody>
</table>

### Table 3. Bike Impact Fee Calculation Example – Draft Proposal

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Source/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired Bike Flow Rate / hr</td>
<td>150</td>
<td>From Draft AASHTO Bike Guide Table 7.3 and 7.4</td>
</tr>
<tr>
<td>Existing Bike Volume / hr</td>
<td>130</td>
<td>From counts</td>
</tr>
<tr>
<td>Threshold for bike fee contribution</td>
<td>80%</td>
<td>Determine by local jurisdiction</td>
</tr>
<tr>
<td>Existing Bike Lane Capacity Ratio</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>Site Gen Bike Trip</td>
<td>25</td>
<td>From bike trip generation table</td>
</tr>
<tr>
<td>Total Bike Volume</td>
<td>155</td>
<td></td>
</tr>
<tr>
<td>Proposed Bike Lane Capacity Ratio</td>
<td>1.03</td>
<td></td>
</tr>
<tr>
<td>Bike Impact Proportion</td>
<td>17%</td>
<td>Difference between existing and proposed ratio</td>
</tr>
<tr>
<td>Cost of Bike Improvement</td>
<td>$2,500,000</td>
<td>Random example</td>
</tr>
<tr>
<td>Length of project</td>
<td>5</td>
<td>mile</td>
</tr>
<tr>
<td>Cost / mile</td>
<td>$500,000</td>
<td></td>
</tr>
<tr>
<td>Segment in bike influence area</td>
<td>0.5</td>
<td>mile</td>
</tr>
<tr>
<td>Total cost in influence area</td>
<td>$250,000</td>
<td></td>
</tr>
<tr>
<td>Bike Impact Fee</td>
<td>$41,666.67</td>
<td></td>
</tr>
</tbody>
</table>
Thank you!
Tyler Stamey, P.E.
tstamey@fcgov.com
970-556-5245
Don’t Stress It: Bikeway Level of Comfort Metrics