Pedestrian Level of Traffic Stress

Robert J. Schneider, PhD, UW-Milwaukee Department of Urban Planning

Authors: Sydney Swift, Robert J. Schneider, Kyle Nelson – November 2024

Pedestrian Level of Traffic Stress

- A simple representation of pedestrians' perceptions of traffic safety in the roadway environment
- Uses a small set of factors to assign LTS 1-4

Pedestrian Level of Traffic Stress

- Origins
- Components
- Examples
- Next steps

Origins

- Bicycle Level of Traffic Stress
- Mineta Transportation Institute
  Mekuria, Furth & Nixon (2012)

Bike lanes and shoulders not adjacent to a parking lane

Number of lanes	Bike lane width	Prevailing Speed ≤ 25 mph	30 mph	35 mph	40 mph	45 mph	50+ mph
1 thru lane per direction, or unlaned	6+ ft	LTS 1	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	4 or 5 ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 4
2 thru lanes per direction	6+ ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	4 or 5 ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 4
3+ lanes per direction	any width	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4

Notes
1. If bike lane / shoulder is frequently blocked, use mixed traffic criteria.
2. Qualifying bike lane / shoulder should extend at least 4 ft from a curb and at least 3.5 ft from a pavement edge or discontinuous gutter pan seam
3. Bike lane width includes any marked buffer next to the bike lane.

Source: Furth, P.G. "Level of Traffic Stress Criteria for Road Segments, Version 2.0," http://www.northeastern.edu/peter.furth/criteria-for-level-of-traffic-stress/, June 2017.

Origins: Pedestrian Planning Practice

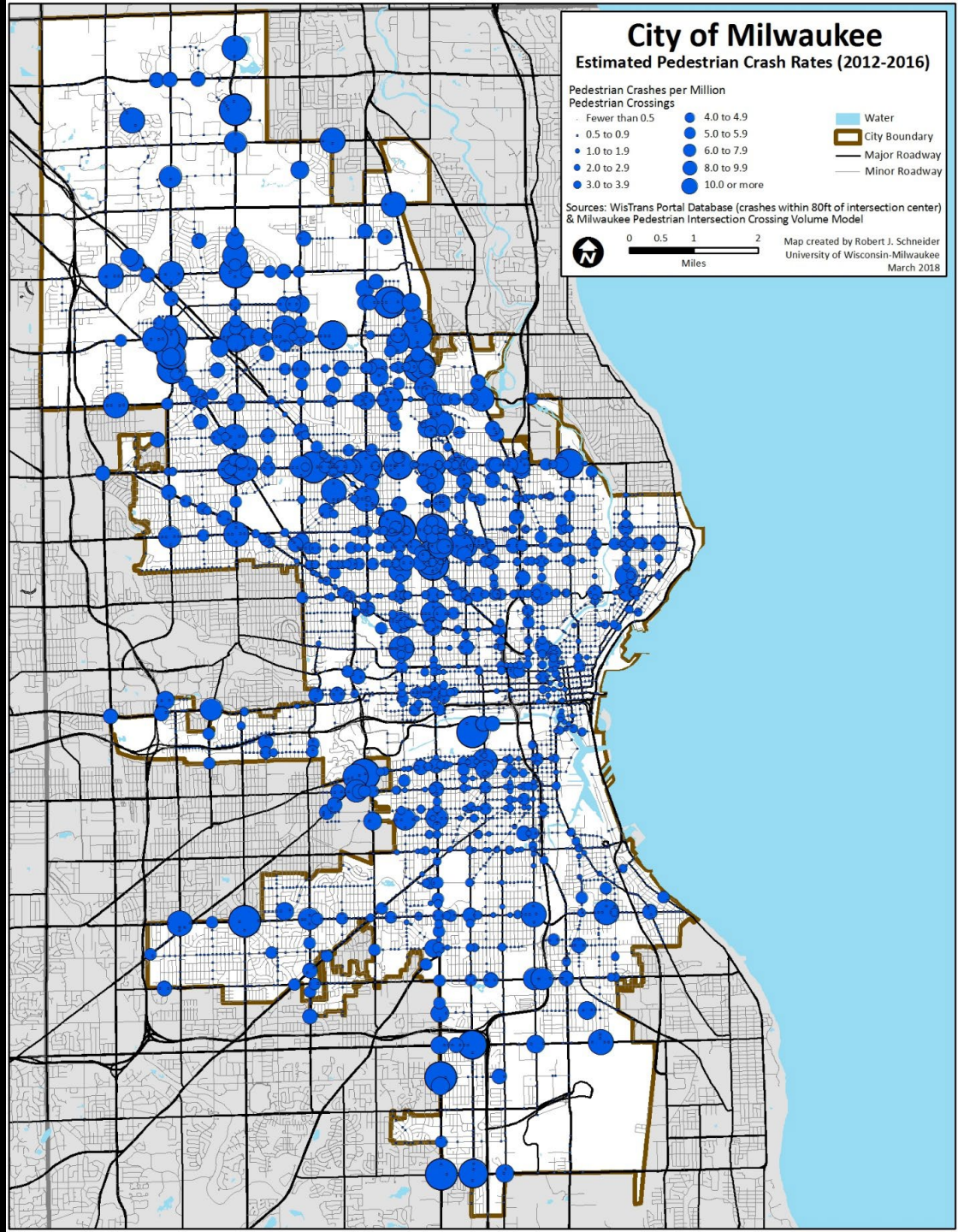
- Oregon DOT
  Pedestrian Level of Traffic Stress (2020)
- Washington State DOT
  Pedestrian Level of Traffic Stress (2020)
- Montgomery County, MD
  Pedestrian Level of Comfort (2020)

Origins: Pedestrian Suitability Literature

Table 3. Summary of Pedestrian Suitability Literature Reviews

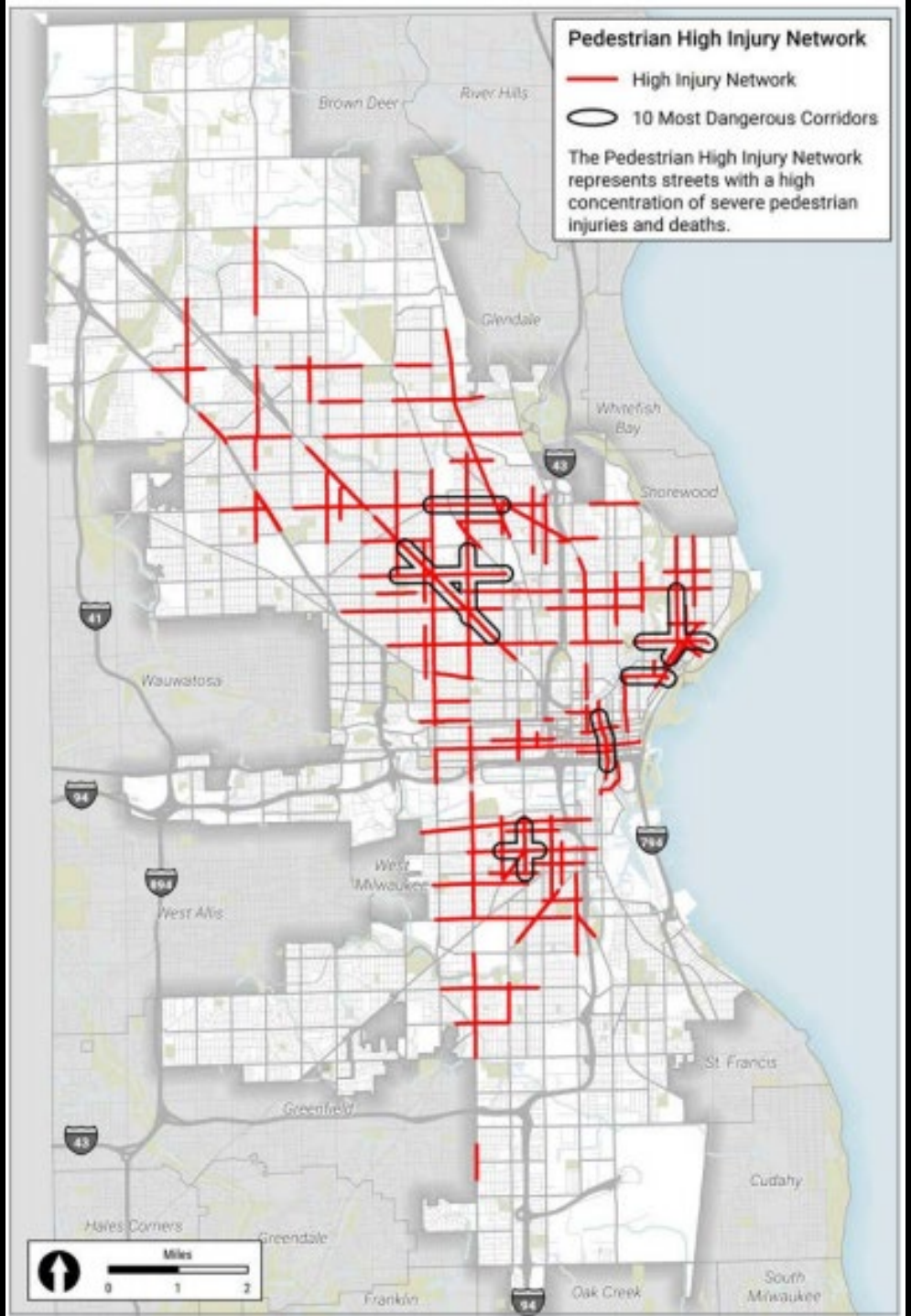
General information		Methods		Common Variables or Factors Identified in Literature				Notes
Study Location(s)	Author(s)	Number of Studies Reviewed	Lit review approach	Land Use & Built Environment	Traffic Characteristics	Pathway Conditions	Other	Additional Details
Methodologies from the US	Phillips & Guttenplan (2003)		Summarize types of quality of service and methodologies	• Lateral separation	• Ease of street crossing • Pedestrian signals •Traffic speeds	• Surface Condition	• Facility type	• Assessed multimodal quality of service including bicycle and public transit • Examined supply side assessments • Most studies fail to consider surrounding paths and trails
Field Tests in Beijing, Washington, Delhi and others	Krambeck (2006)	24 pedestrian audit and index methodologies	Analyze each methodology to develop a Global Walkability Index	• Surrounding Land Use Characteristics	• Traffic Speed • Crossing Safety	• Cleanliness	• Funding and resources • Perception of safety • Pedestrian Density	• Used to form conclusions on a broader area, not a specific segment • Requires field work and survey collection to grade the level of service (LOS)
Eight varying sidewalks in Alabama, US	Sisiopiku, Byrd & Chittoor (2007)	5 methods of evaluating level of service	Review and compare existing methods for establishing the quality of pedestrian sidewalks in an urban setting	• Sidewalk Space • Crossing opportunities • Buffer	• Traffic Speed	• Personal security •Pedestrian volume •Mix of Users	• Surface quality	• The same sidewalk may result in multiple LOS ratings • No method can capture all sidewalk factors in sufficient detail
Indices analyzing areas or Segments largely from the US	Maghelal & Capp (2011)	25 pedestrian suitability indices	Identify variables across studies and categorize each as objective, subjective, or distinctive as they apply to measuring in GIS	• Sidewalk Width • Location of Sidewalk • Length of Crosswalk	• Traffic Speed • Traffic Volume • Availability of Signals		• Population Density • Convenience	• Did not address the validity of indices, only compiled a list of variables. • Focused on aerial approaches and specifically in the lens of GIS applications.
Studies from around the world including a majority from the US	Raad & Burke (2018)	58 pedestrian level of service studies	Preferred Reporting Items for Systematic Review Recommendations (PRISMA) protocol	• Footpath width • Shoulder or buffer width • Lighting	• Traffic speed • Traffic Volume	• Footpath Condition	• User Characteristics	• Looked at studies for mixed use areas, footpaths, intersections, and mid-block crossings • Used a mix of quantitative and qualitative studies • Acknowledged little research for pedestrians with disabilities

Origins: Pedestrian Safety Analysis



Source: City of Milwaukee Pedestrian Plan, 2019

Origins: Pedestrian Safety Analysis



Source: City of Milwaukee Pedestrian Plan, 2019

Origins: Pedestrian Safety Guidance

Table 1. Application of pedestrian crash countermeasures by roadway feature.

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	● 2 4 5 6	● 5 6 7 9	○ 5 6 ● 9	● 4 5 6	● 5 6 7 9	○ 5 6 ● 9	● 4 5 6 7 9	○ 5 6 7 9	○ 5 6 9
3 lanes with raised median (1 lane in each direction)	● 2 3 4 5	● ○ 5 7 9	○ ○ 5 ● 9	○ 3 4 5 7 9	○ ○ 5 ● 9	○ ○ 5 ● 9	○ ○ 4 5 7 9	○ ○ 5 ● 9	○ ○ 5 9
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	● 2 3 4 5 6 7 9	● ○ 5 6 7 9	○ ○ 5 6 9	○ 3 4 5 6 7 9	○ ○ 5 6 ● 9	○ ○ 5 6 9	○ ○ 4 5 6 7 9	○ ○ 5 6 9	○ ○ 5 6 9
4+ lanes with raised median (2 or more lanes in each direction)	● ○ 5 7 8 9	● ○ 5 7 8 9	○ ○ 5 8 ●	○ ○ 5 7 8 9	○ ○ 5 ● 8 9	○ ○ 5 8 ●	○ ○ 5 ● 8 9	○ ○ 5 8 ●	○ ○ 5 8 ●
4+ lanes w/o raised median (2 or more lanes in each direction)	● ○ 5 6 7 8 9	○ ○ 5 ● 7 8 9	○ ○ 5 ● 8 9	○ ○ 5 ● 7 8 9	○ ○ 5 ● 8 9	○ ○ 5 ● 8 9	○ ○ 5 ● 8 9	○ ○ 5 ● 8 9	○ ○ 5 ● 8 9

Given the set of conditions in a cell,

- # Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- ● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- ○ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
2 Raised crosswalk
3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
4 In-Street Pedestrian Crossing sign
5 Curb extension
6 Pedestrian refuge island
7 Rectangular Rapid-Flashing Beacon (RRFB)**
8 Road Diet
9 Pedestrian Hybrid Beacon (PHB)**

*Refer to Chapter 4, 'Using Table 1 and Table 2 to Select Countermeasures,' for more information about using multiple countermeasures.
**It should be noted that the PHB and RRFB are not both installed at the same crossing location.

Source: Federal Highway Administration. Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, Authors: L. Blackburn, C. Zegeer, and K. Brookshire, FHWA-SA-17-072, Updated, 2018.

PLTS Stress Levels

- Four categories
  - **PLTS 1: Little to no stress**; requires little attention to the traffic situation
  - **PLTS 2: Little stress**; requires moderate attention to the traffic situation
  - **PLTS 3: Moderate stress**; requires sustained attention to the traffic situation
  - **PLTS 4: High stress**; requires sustained attention to the traffic situation and special ability to navigate safely

PLTS Variables: Road Segments

- Factors for traveling along road segments:
  - Traffic speed on adjacent roadway
  - Motor vehicle traffic volume of adjacent roadway
  - Sidewalk width
  - Paved shoulder width
  - Buffer width between motor vehicle travel lane and pedestrian space

PLTS: Roadway Segment Tables

Table 1. ROADWAY SEGMENTS		
No Sidewalk		
Speed[1]	Shoulder (≥8ft)	No Shoulder
≤ 15mph	1	2
16-25mph	3	3
> 25mph	4	4

Table 2a. ROADWAY SEGMENTS: Low Traffic Volume (< 2500 AADT)					
		Buffer Width			
Speed[14]	**Sidewalk Width**	> 10ft	5ft to 9ft	1ft to 4ft	None
≤ 20mph	> 10ft	1	1	1	1
	8ft to 10ft	1	1	1	1
	5ft to 7ft	1	1	2	2
	<5ft	2	2	2	3
21-25mph	> 10ft	1	1	1	2
	8ft to 10ft	1	1	2	2
	5ft to 7ft	1	2	2	3
	<5ft	2	3	3	4
26-30mph	> 10ft	1	1	2	2
	8ft to 10ft	1	2	2	3
	5ft to 7ft	1	2	2	3
	<5ft	2	3	3	4
31-35mph	> 10ft	1	1	2	2
	8ft to 10ft	1	2	2	3
	5ft to 7ft	2	3	3	4
	<5ft	3	3	4	4
> 35mph	> 10ft	1	2	3	3
	8ft to 10ft	2	2	3	3
	5ft to 7ft	3	3	4	4
	<5ft	4	4	4	4

PLTS: Roadway Segment Tables

Table 1. ROADWAY SEGMENTS		
No Sidewalk		
Speed[1]	Shoulder (≥8ft)	No Shoulder
≤ 15mph	1	2
16-25mph	3	3
> 25mph	4	4

Table 2c. ROADWAY SEGMENTS: High Traffic Volume (> 7500 AADT)					
		Buffer Width			
Speed	**Sidewalk Width**	> 10ft	5ft to 9ft	1ft to 4ft	None
≤ 20 mph	> 10ft	1	1	2	2
	8ft to 10ft	1	2	2	3
	5ft to 7ft	2	2	3	4
	<5ft	3	3	4	4
21-25mph	> 10ft	1	1	2	2
	8ft to 10ft	1	2	3	3
	5ft to 7ft	2	3	3	4
	<5ft	3	4	4	4
26-30mph	> 10ft	1	1	2	3
	8ft to 10ft	1	2	2	3
	5ft to 7ft	2	3	3	4
	<5ft	3	4	4	4
31-35mph	> 10ft	1	2	3	3
	8ft to 10ft	2	3	3	4
	5ft to 7ft	3	3	4	4
	<5ft	4	4	4	4
> 35mph	> 10ft	2	2	3	3
	8ft to 10ft	2	3	3	4
	5ft to 7ft	3	4	4	4
	<5ft	4	4	4	4

PLTS Variables: Roadway Crossings

- Factors for crossing roads:
  - Traffic speed on roadway being crossed
  - Number of lanes being crossed
  - Presence of traffic signal/PHB
  - Presence of stop sign
  - Presence of raised refuge island
  - Presence of curb extension(s)
  - Presence of high visibility crosswalk marking/RFB at the crossing

Source: Google Maps

PLTS: Roadway Crossing Tables (controlled)

Table 10. Pedestrian LTS for Controlled Roadway Crossings: High Traffic Volume (> 7,500 AADT)

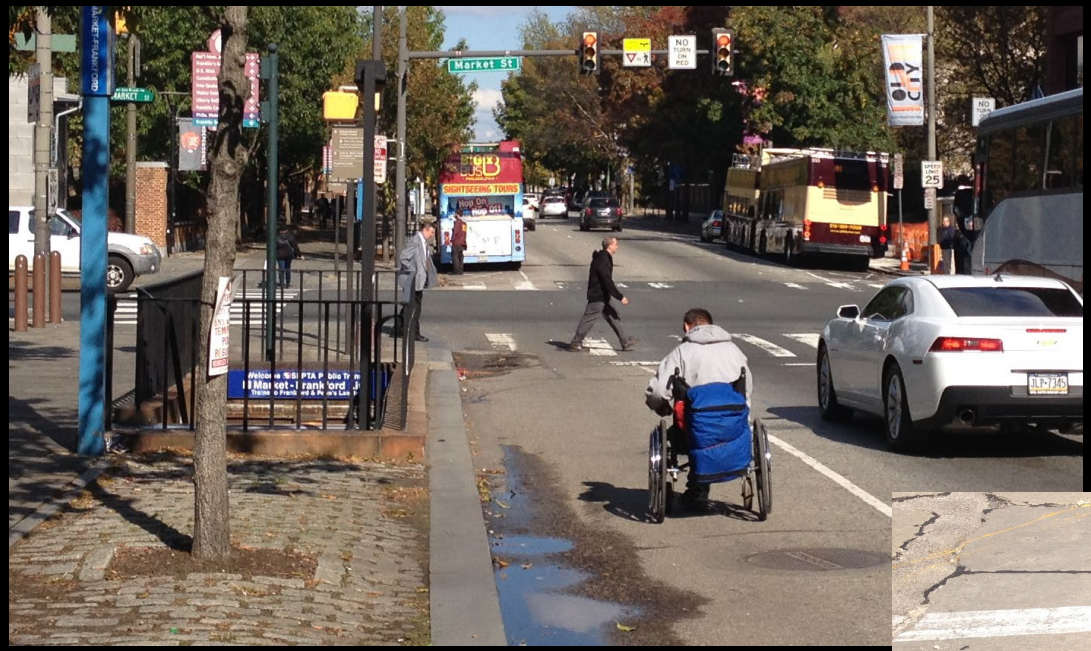
		Crossing Treatments			
Traffic Control	**Crossing Width**	Raised Refuge Island AND Curb Extension(s)	Raised Refuge Island only	Curb Extension only	None
Traffic Signal	1-2 lanes	1	1	2	2
	3 lanes	1	2	2	2
	4 lanes	2	3	3	3
	5+ lanes	3	3	4	4
Stop Sign	1-2 lanes	1	1	2	2
	3 lanes	2	2	3	3
	4+ lanes	2	3	4	4
Pedestrian Hybrid Beacon	1-2 lanes	1	2	2	2
	3 lanes	2	3	3	3
	4+ lanes	3	3	4	4

PLTS: Roadway Crossing Tables (uncontrolled)

Table 13. Pedestrian LTS for Uncontrolled Roadway Crossings: High Traffic Volume (< 7,500 AADT)

Traffic Control	Traffic Speed	Crossing Width	Crossing Treatment			
			Raised Refuge Island AND Curb Extension(s)	Raised Refuge Island OR Curb Extension(s) only	High Visibility Crosswalk Marking Only	None
Rapid Flashing Beacons	≤ 25mph	1-2 lanes	1	2	2	2
		3 lanes	2	2	3	3
		4+ lanes	2	3	3	4
	26-30mph	1-2 lanes	2	2	2	3
		3 lanes	2	3	3	3
		4+ lanes	3	3	4	4
	> 30mph	1-2 lanes	2	2	3	3
		3 lanes	3	3	3	4
		4+ lanes	3	4	4	4
No Traffic Control	≤ 25mph	1-2 lanes	2	2	2	3
		3 lanes	2	2	3	3
		4+ lanes	3	3	3	4
	26-30mph	1-2 lanes	2	2	2	3
		3 lanes	2	3	3	3
		4+ lanes	3	4	4	4
	> 30mph	1-2 lanes	2	3	3	3
		3 lanes	3	3	4	4
		4+ lanes	4	4	4	4

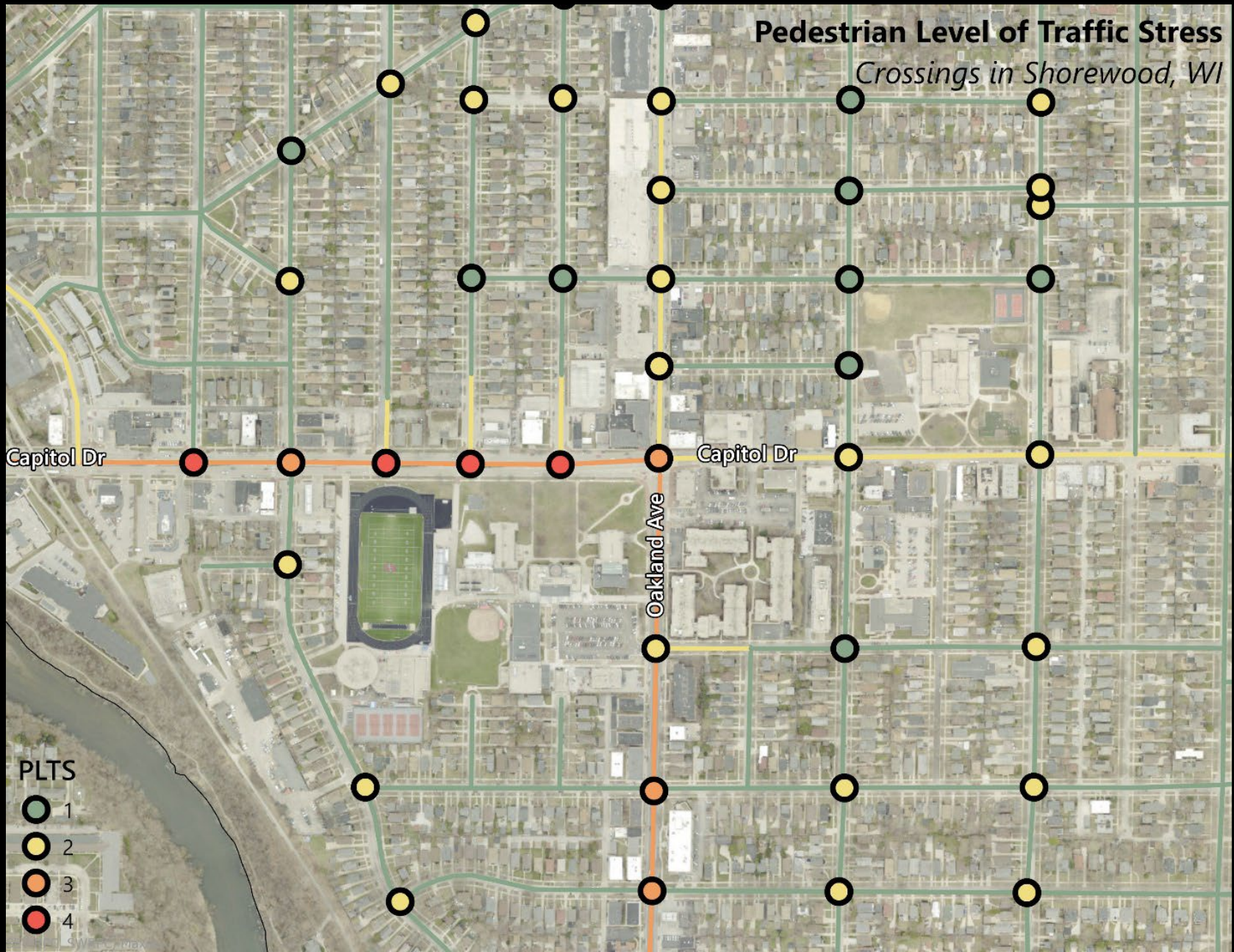
Inaccessible Curb Ramps
→ Crossing PLTS automatically = 3 or 4



PLTS Examples

PLTS: Existing

PLTS: Existing



Segment PLTS: Before & After

Source: Google Maps. (2024). Streetview, https://www.google.com/maps.

Figure 8. Highway G with no sidewalk in 2013

2013

Source: Google Maps. (2024). Streetview, https://www.google.com/maps.

Figure 9. Highway G with sidewalk in 2023

2023

Egg Harbor, WI

Segment PLTS: Before & After

Source: Google Maps. (2024). Streetview, https://www.google.com/maps.

Figure 8. Highway G with no sidewalk in 2013

Source: Google Maps. (2024). Streetview, https://www.google.com/maps.

Figure 9. Highway G with sidewalk in 2023

2013

2023

Table 2c. ROADWAY SEGMENTS: High Traffic Volume (> 7500 AADT)					
		Buffer Width			
Speed	Sidewalk Width	> 10ft	5ft to 9ft	1ft to 4ft	None
≤ 20 mph	> 10ft	1	1	2	2
	8ft to 10ft	1	2	2	3
	5ft to 7ft	2	2	3	4
	<5ft	3	3	4	4
21-25mph	> 10ft	1	1	2	2
	8ft to 10ft	1	2	3	3
	5ft to 7ft	2	3	3	4
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	8ft to 10ft	1	2	2	3
	5ft to 7ft	2	3	3	4
	<5ft	3	4	4	4
31-35mph	> 10ft	1	2	3	3
	8ft to 10ft	2	3	3	4
	5ft to 7ft	3	3	4	4
	<5ft	4	4	4	4
> 35mph	> 10ft	2	2	3	3
	8ft to 10ft	2	3	3	4
	5ft to 7ft	3	4	4	4
	<5ft	4	4	4	4

PLTS 4

PLTS 3

Egg Harbor, WI

Table 2c. ROADWAY SEGMENTS: High Traffic Volume (> 7500 AADT)					
		Buffer Width			
Speed	Sidewalk Width	> 10ft	5ft to 9ft	1ft to 4ft	None
≤ 20 mph	> 10ft	1	1	2	2
	8ft to 10ft	1	2	2	3
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	8ft to 10ft	2	3	3	4
	5ft to 7ft	3	3	4	4
	<5ft	4	4	4	4
> 35mph	> 10ft	2	2	3	3
	8ft to 10ft	2	3	3	4
	5ft to 7ft	3	4	4	4
	<5ft	4	4	4	4

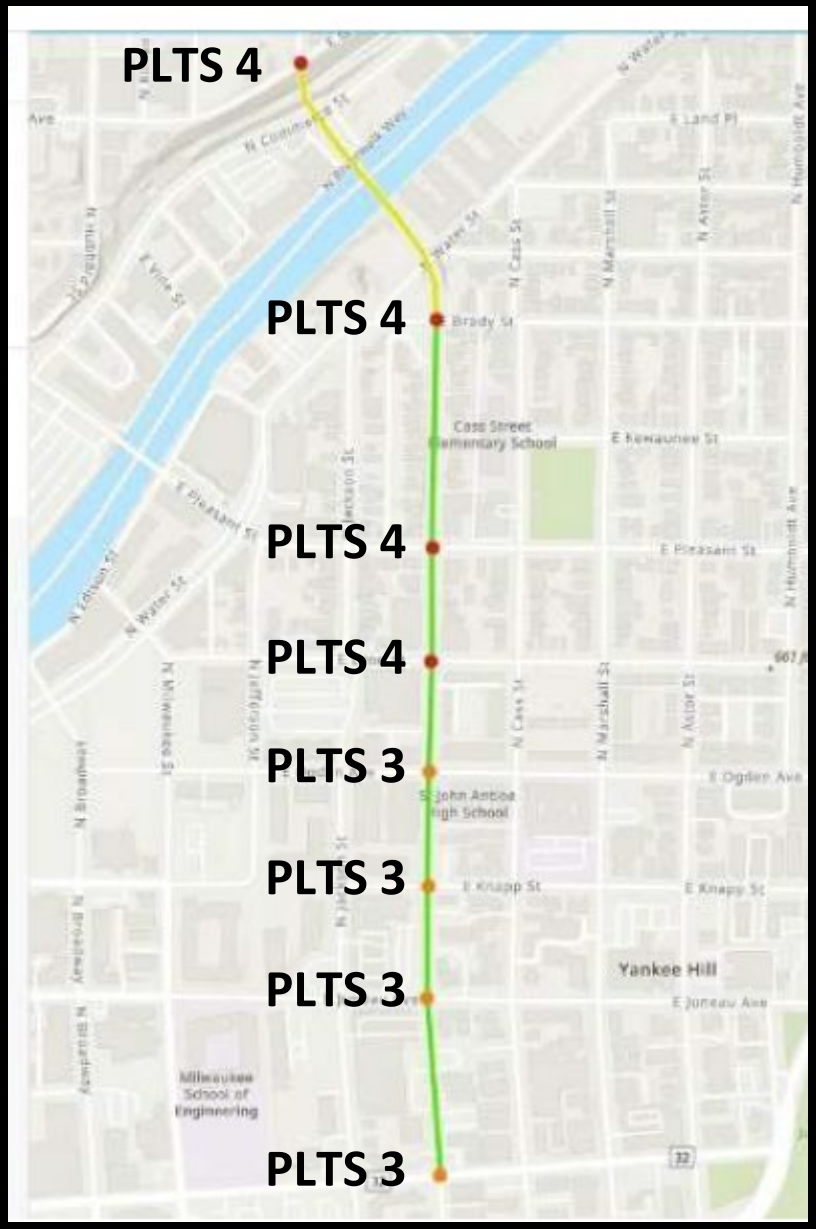
PLTS: Before & After

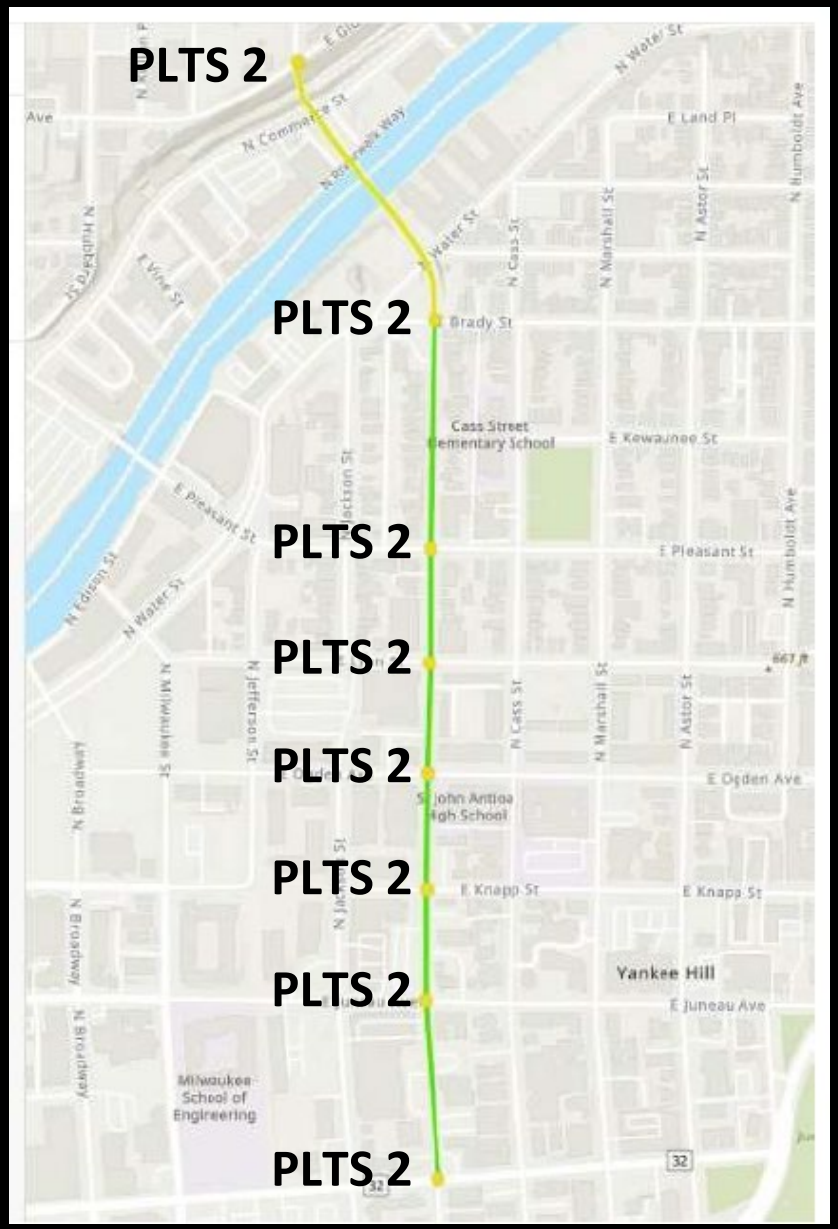
Source: City of Milwaukee (2024). Van Buren Street Transformation Project, https://engage.milwaukee.gov/download_file/186/546.

Figure 4. Rendering of N. Van Buren Street after redesign project

Milwaukee, WI

Crossing PLTS: Before & After





2022 Milwaukee, WI 2024

PLTS Considerations

- Pedestrian LTS is necessarily simple.
  It should be complemented by:
  - Americans with Disabilities Act (ADA) Accessibility Assessment
  - Pedestrian Crash Analysis
  - Pedestrian Demand Analysis
  - Social and Economic Environment Assessment
  - Public Engagement

Characteristics not included

Pedestrian volumes

Characteristics not included

Signal timing, RTOR restrictions, turning radii

Characteristics not included

Landscaping, facility condition, noise, aesthetics

Characteristics not included

Roadway lighting

Next Steps

- Apply in San Diego, Albuquerque, Milwaukee
- Validation through surveys, interviews
- Relationship to pedestrian crash risk?

PLTS Validation Options

- Practitioner review of maps & tables
- Public ratings of specific locations in the field
- Public ratings of pictures & descriptions in an online survey

3. Thinking about **street traffic**, how safe do you think it is to travel in **YOUR NEIGHBORHOOD** by...

	Very Unsafe	Unsafe	Neutral	Safe	Very Safe
WALKING?	○	○	○	○	○
BICYCLING?	○	○	○	○	○
RIDING THE BUS?	○	○	○	○	○
DRIVING A CAR (driver)?	○	○	○	○	○
RIDING IN A CAR (passenger)?	○	○	○	○	○
OTHER? (list:_____)	○	○	○	○	○

4. Please write one or two comments about **traffic safety** on streets in **YOUR NEIGHBORHOOD**.

5. Thinking about **crime and personal security**, how safe do you think it is to travel in **YOUR NEIGHBORHOOD** by...

	Very Unsafe	Unsafe	Neutral	Safe	Very Safe
WALKING?	○	○	○	○	○
BICYCLING?	○	○	○	○	○
RIDING THE BUS?	○	○	○	○	○
DRIVING A CAR (driver)?	○	○	○	○	○
RIDING IN A CAR (passenger)?	○	○	○	○	○
OTHER? (list:_____)	○	○	○	○	○

6. Please write one or two comments about **crime and security** on streets in **YOUR NEIGHBORHOOD**.

Questions & Discussion

Robert Schneider, PhD, Professor
University of Wisconsin-Milwaukee
Department of Urban Planning
E-mail: rjschnei@uwm.edu
Twitter: **@pedbikebob**