

Improving Pedestrian Safety at Unsignalized Crossings

Shawn Turner, P.E.

Texas A&M Transportation Institute





Overview of Presentation

- What are the issues/problems?
- Framework for crossing treatments
 - Marked crosswalk
 - Enhanced crosswalk
 - Active treatment
 - “Red” treatment
 - Full traffic signal

Unsignalized Pedestrian Crossing

- No motor vehicle traffic signal control on main street
- Pedestrian crossing may be at intersecting street or mid-block
- Typically a marked crosswalk, but not necessarily
- More common with larger block size (suburbs)









Problems at Unsignalized Crossings





Problems at Unsignalized Crossings

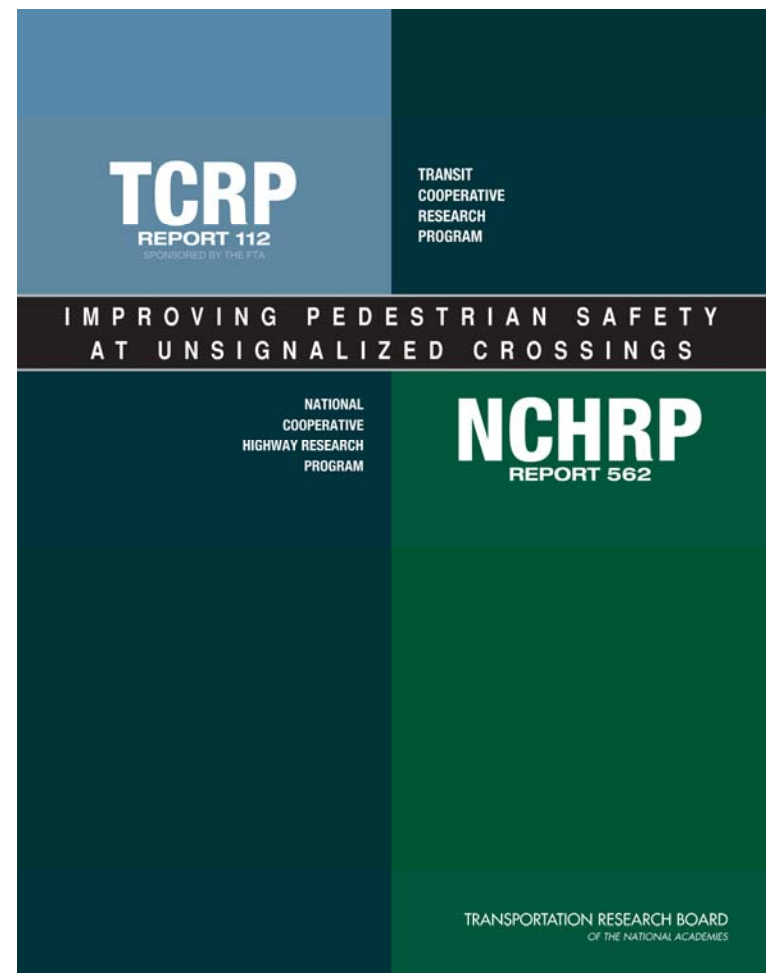
- Confusion about right-of-way
 - Who yields / stops ?
 - Pedestrian must be in crosswalk
- Difficulty judging acceptable gaps
- Excessive delay to pedestrians

Problems × 3

- High-speed arterial streets
- 2 or more lanes in both directions
- Mid-block transit stops
- Limited access control
 - Commercial driveways
 - Center two-way left turn lane
- Low pedestrian volumes (does not satisfy traffic signal warrant)

NCHRP Report 562 / TCRP Report 112

- Recommend treatments for high-speed, high-volume roadways
- Recommend modifications to MUTCD pedestrian traffic signal warrant



FHWA Study on Marked vs. Unmarked Crosswalks



- Depends on:
 - Traffic volume
 - Traffic speed
 - Road width/median
- 1. Marked Crosswalk
- 2. Consider Enhancement to Marking
- 3. Must Add Enhancement to Marking



Safety Benefits of Other Treatments

- Difficult to quantify for each treatment
- Insufficient crash data for experimental treatments
- Lead to use of safety surrogates
 - % motorists yielding to pedestrians
 - Motorist behavior (speed reduction)
 - Pedestrian behavior

What are “treatments”?

- Geometric design
- Traffic calming
- Static warning signs
- Continuous flashing beacons
- Activated beacons

Median Crossing Island



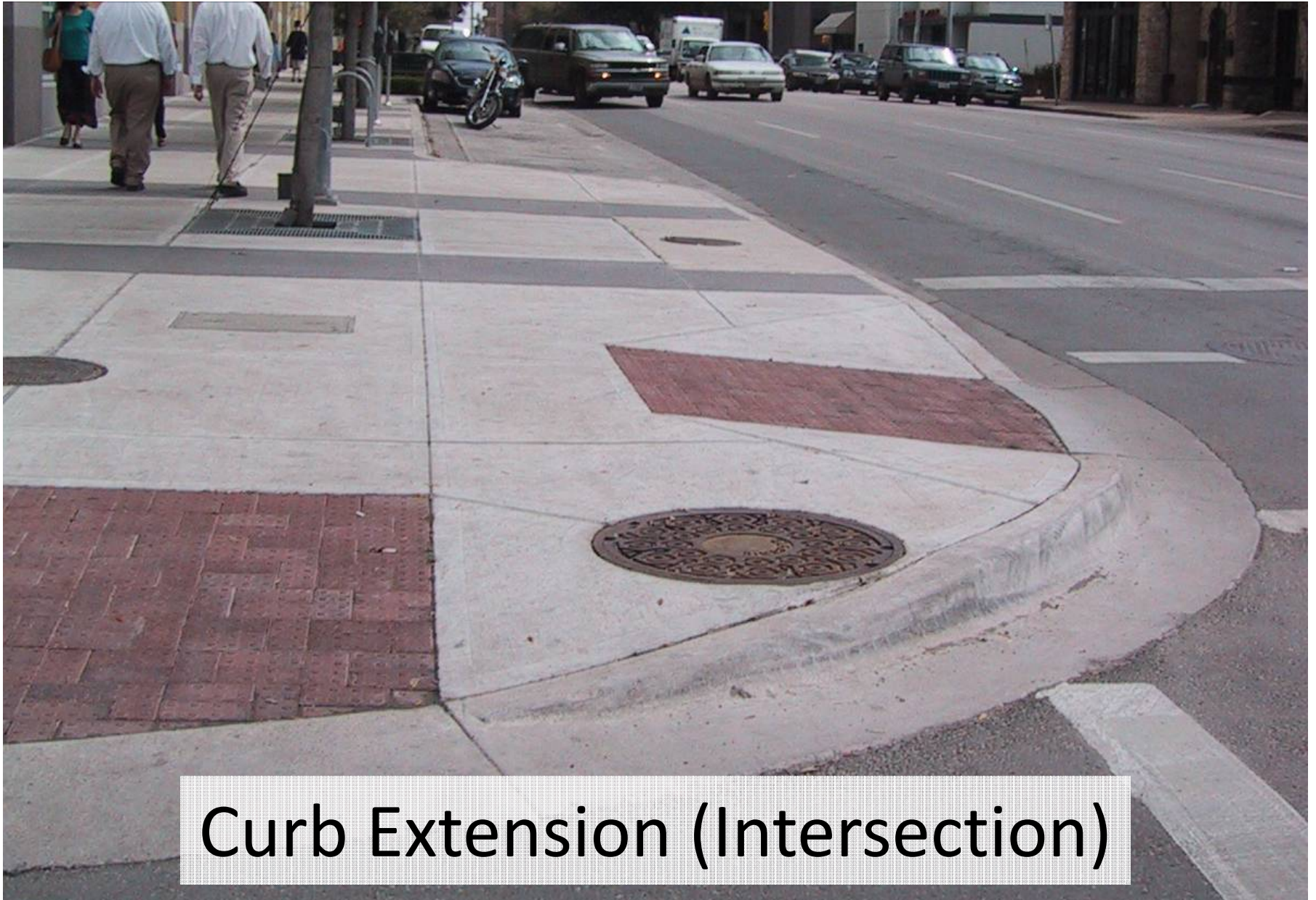
Median Crossing Island





Curb Extension (Mid-Block, Transit Stop)





Curb Extension (Intersection)

Raised Crosswalks



Roadway / Lane Narrowing



Crossing Sign + Markings



In-Street Crossing Signs



High-Visibility Signs / Markings



High-Visibility Signs / Markings





In-Roadway Warning Lights





Overhead Flashing Amber Beacons

Overhead Flashing Amber Beacons



Half Signal



Pedestrian Hybrid Beacon (“HAWK”)



Pedestrian Hybrid Beacon (“HAWK”)



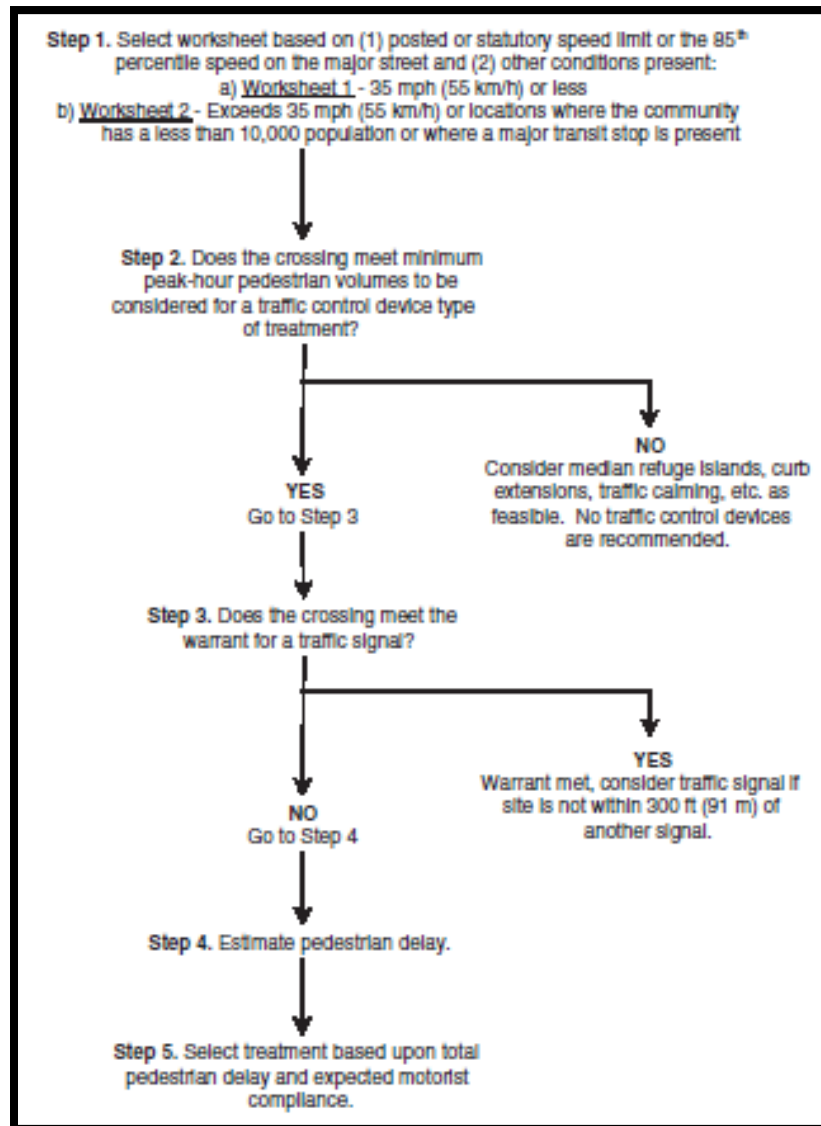
Research Question

- What treatment is most (cost)-effective in different street contexts?

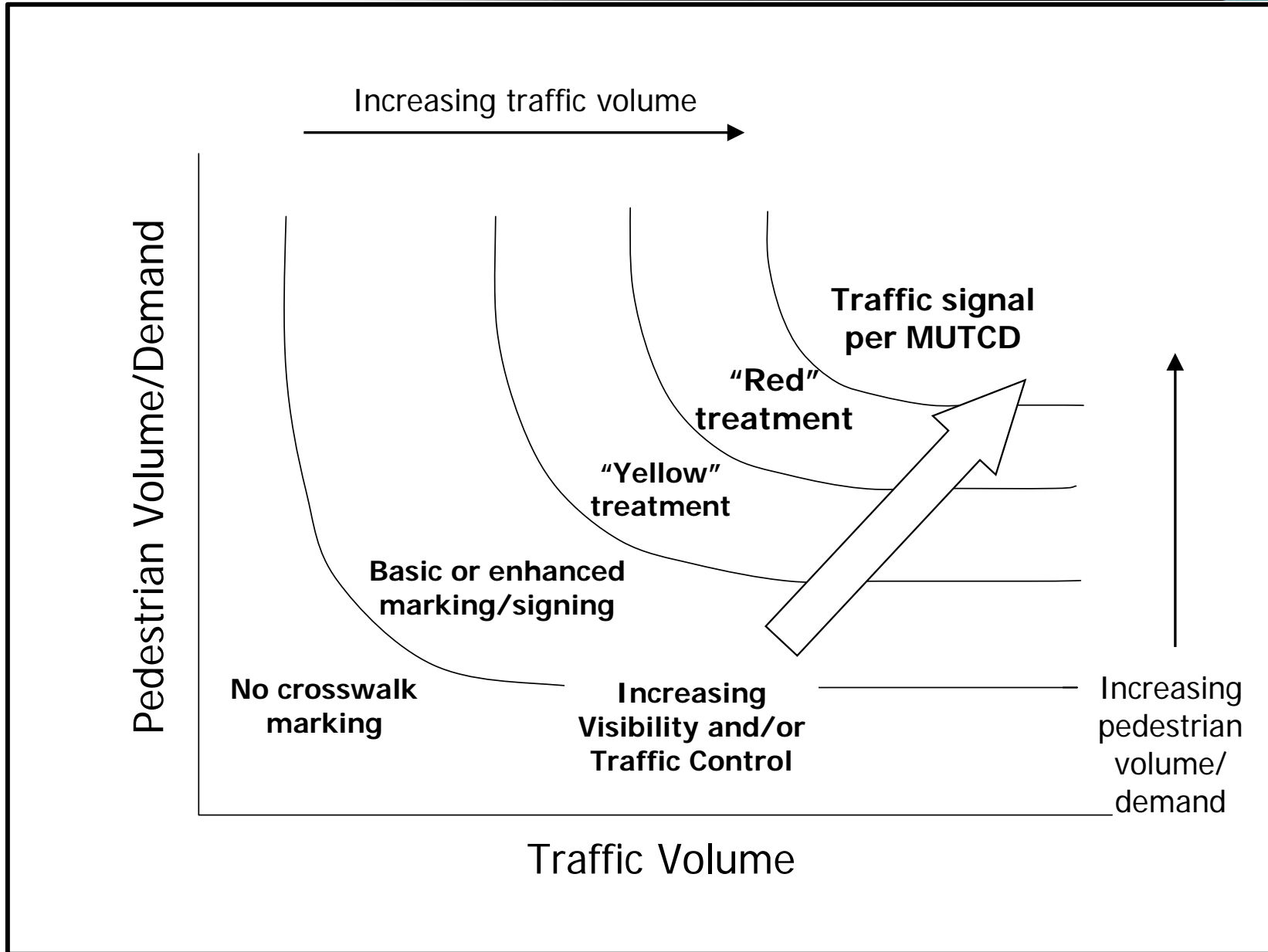
Research Approach

- Evaluate motorist yielding for different treatments in different street contexts
- Higher yielding = less delay, more safe
- Lower yielding = more delay, less safe
- Using Highway Capacity Manual pedestrian delay thresholds, develop algorithm to determine treatment type

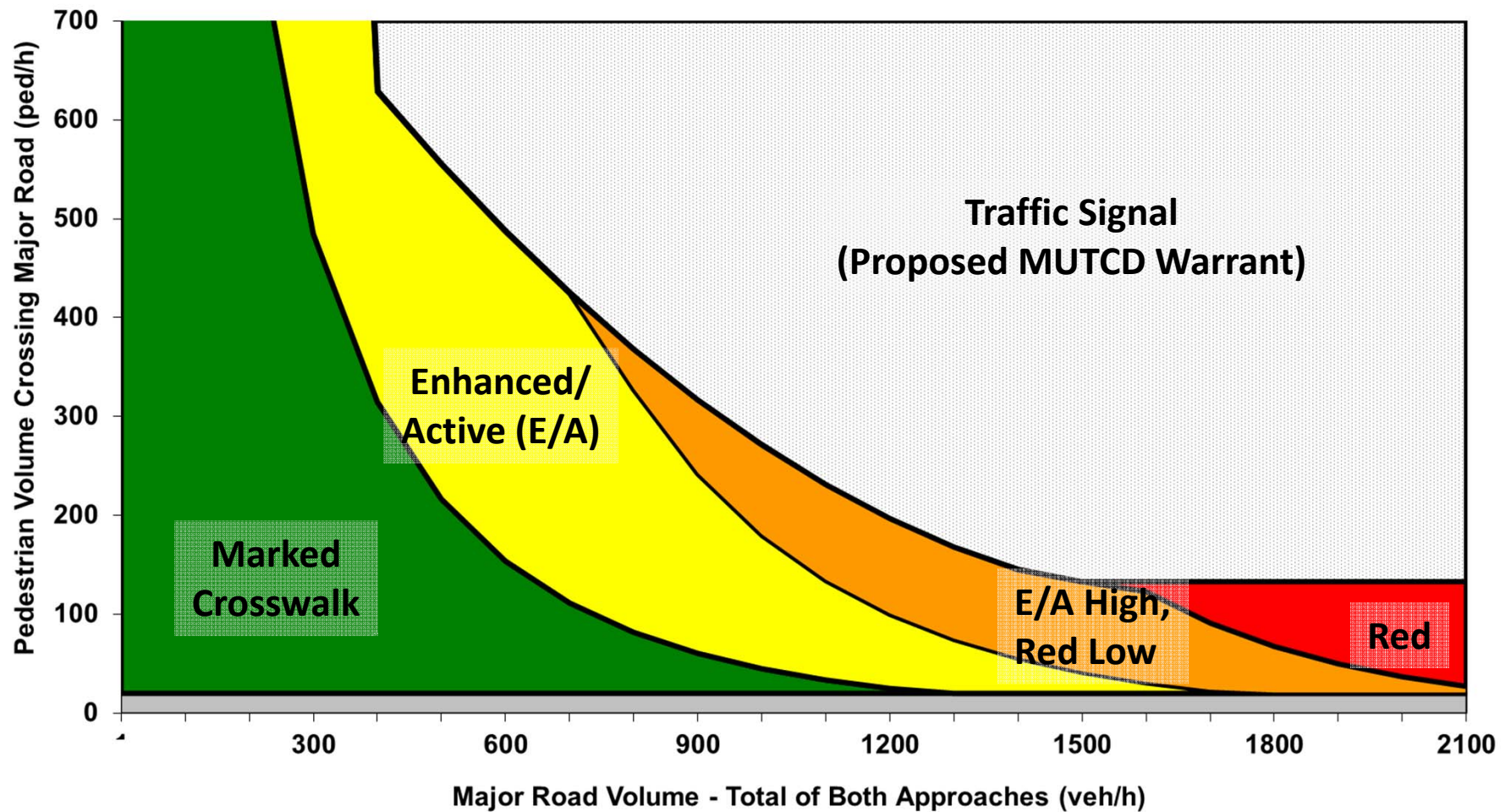
Presto!! Shazam!!



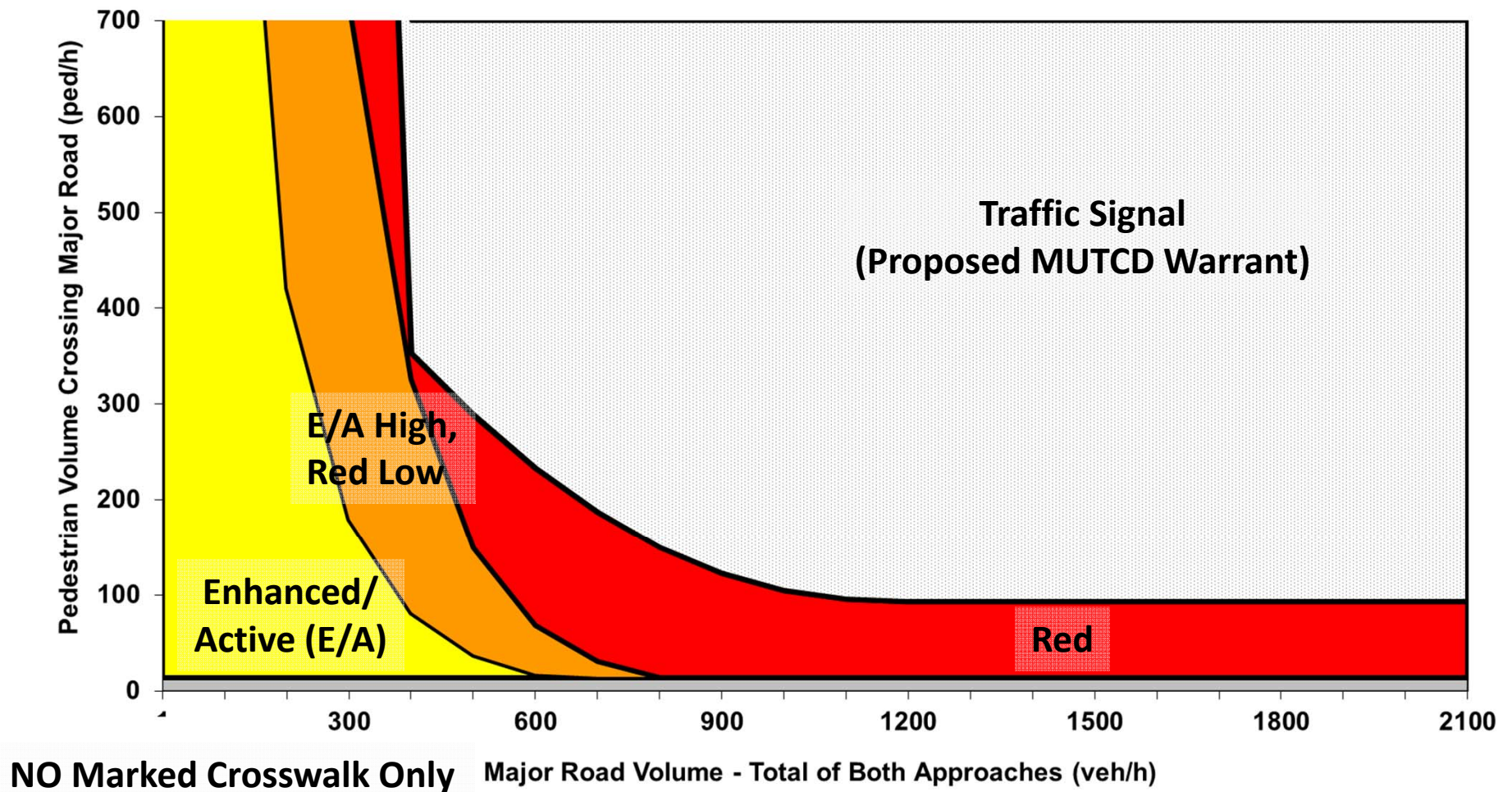
WORKSHEET 1: PEAK-HOUR, 35 MPH (55 KM/H) OR LESS	
Analyst and Site Information	
Analyst:	Major Street:
Analysis Date:	Minor Street or Location:
Data Collection Date:	Peak Hour:
Step 1: Select worksheet (speed reflects posted or statutory speed limit or 85 th percentile speed on the major street):	
a) Worksheet 1 - 35 mph (55 km/h) or less	
b) Worksheet 2 - exceeds 35 mph (55 km/h), communities with less than 10,000, or where major transit stop exists	
Step 2: Does the crossing meet minimum pedestrian volumes to be considered for a TCD type of treatment?	
Peak-hour pedestrian volume (ped/h), V_p	2a
If 2a ≥ 20 ped/h, then go to Step 3.	
If 2a < 20 ped/h, then consider median refuge islands, curb extensions, traffic calming, etc. as feasible.	
Step 3: Does the crossing meet the pedestrian volume warrant for a traffic signal?	
Major road volume, total of both approaches during peak hour (veh/h), V_{maj}	3a
Minimum signal warrant volume for peak hour (use 3a for V_{maj}), SC $SC = (0.00021 V_{maj}^2 - 0.74072 V_{maj} + 734.125)/0.75$ OR $[(0.00021 3a^2 - 0.74072 3a + 734.125)/0.75]$	3b
If 3b < 133 , then enter 133. If 3b ≥ 133 , then enter 3b.	3c
If 15 th percentile crossing speed of pedestrians is less than 3.5 ft/s (1.1 m/s), then reduce 3c by up to 50 percent; otherwise enter 3c.	3d
If 2a $\geq 3d$, then the warrant has been met and a traffic signal should be considered if not within 300 ft (91 m) of another traffic signal. Otherwise, the warrant has not been met. Go to Step 4.	
Step 4: Estimate pedestrian delay.	
Pedestrian crossing distance, curb to curb (ft), L	4a
Pedestrian walking speed (ft/s), S_p	4b
Pedestrian start-up time and end clearance time (s), t_s	4c
Critical gap required for crossing pedestrian (s), $t_c = (L/S_p) + t_s$ OR $[(4a/4b) + 4c]$	4d
Major road volume, total both approaches or approach being crossed if median refuge island is present during peak hour (veh/h), V_{maj}	4e
Major road flow rate (veh/s), $v = V_{maj}/3600$ OR $[4e/3600]$	4f
Average pedestrian delay (s/ped), $d_p = (t_c^2 - v t_c - t_s) / v$ OR $[(t_c^2 - 4f \times 4d - t_s) / 4f]$	4g
Total pedestrian delay (h), $D_p = (d_p \times V_p)/3,600$ OR $[(4g \times 2a)/3600]$ (this is estimated delay for all pedestrians crossing the major roadway without a crossing treatment - assumes 0% compliance). This calculated value can be replaced with the actual total pedestrian delay measured at the site.	4h
Step 5: Select treatment based upon total pedestrian delay and expected motorist compliance.	
Expected motorist compliance at pedestrian crossings in region, Comp = high or low	5a
Total Pedestrian Delay, D_p (from 4h) and Motorist Compliance, Comp (from 5a)	Treatment Category (see Descriptions of Sample Treatments for examples)
$D_p \geq 21.3$ h (Comp = high or low) OR 5.3 h $\leq D_p < 21.3$ h and Comp = low	RED
1.3 h $\leq D_p < 5.3$ h (Comp = high or low) OR 5.3 h $\leq D_p < 21.3$ h and Comp = high	ACTIVE OR ENHANCED
$D_p < 1.3$ h (Comp = high or low)	CROSSWALK



2 Lanes, <55 km/h



6 Lanes, >55 km/h





Questions or Comments?

- Shawn Turner, P.E.
shawn-turner@tamu.edu
<http://tti.tamu.edu>
979-845-8829



Resources / Additional Reading

- *NCHRP Report 562 / TCRP Report 112:*
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf
- *Alternative Treatments for At-Grade Pedestrian Crossings*, ITE 2001 (\$37.50 US)
- *City of Boulder (CO) Pedestrian Crossing Treatment Installation Guidelines*,
http://www.bouldercolorado.gov/index.php?option=com_content&view=article&id=17386&Itemid=5587
- *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations*, FHWA 2005,
<http://www.fhwa.dot.gov/publications/research/safety/04100/04100.pdf>
- *Pedestrian Crossing Control Guide*, TAC 2012 (\$155 CN)