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Improving Pedestrian Safety at Unsignalized Crossings

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CHAPTER 8

Conclusions and Recommendations

This study had two main objectives:

- Recommend selected engineering treatments to improve safety for pedestrians crossing high-volume, high-speed roadways at unsignalized intersections, in particular those served by public transportation; and
- Recommend modifications to the MUTCD pedestrian traffic signal warrant.

The first two sections of this chapter provide conclusions and recommendations for these two main objectives. In accomplishing the two main study objectives, the research team also developed useful supporting information on various aspects of pedestrian safety at unsignalized roadway crossings. This supporting information includes pedestrian characteristics (e.g., walking speed, gap acceptance, and treatment activation behavior), motorist yielding, and traffic engineering and transit agency perspectives. Conclusions and recommendations based on the supporting information are presented in later sections of this chapter.

Guidelines for Pedestrian Crossing Treatments

Summary

The research team developed guidelines for selecting pedestrian crossing treatments for unsignalized intersections and midblock locations (*Guidelines for Pedestrian Crossing Treatments*, included in this report as Appendix A). Quantitative procedures in the guidelines use key input variables (such as, pedestrian volume, street crossing width, and traffic volume) to recommend one of four possible crossing treatment categories:

- Marked crosswalk;
- Enhanced, high-visibility, or "active when present" traffic control device;
- Red signal or beacon device; or
- Conventional traffic control signal.

The guidelines include supporting information for these treatment categories as well as examples and pictures of traffic control devices in each treatment category.

Several traffic engineers tested the guidelines and provided feedback that has been incorporated into the current version. Additionally, the research team tested the guidelines using actual field data from the field study sites as well as other marked crosswalks without treatments. The results of these tests indicated that the guidelines provide appropriate recommendations of pedestrian treatments that substantially agree with engineering judgment.

Recommendation

The research team recommends that the *Guidelines for Pedestrian Crossing Treatments* (included in this report as Appendix A) be widely distributed. The audience and potential users for these guidelines include state, county, and city traffic engineers, transit agencies, roadway designers, and urban planners, as well as consultants for these groups and agencies.

Revisions to the MUTCD Traffic Signal Warrant

Summary

The research team developed and presented recommendations to revise the MUTCD pedestrian warrant for traffic control signals. The proposed revisions were derived from other vehicle-based traffic signal warrants and supplemented with data gathered during the study. The basis for the proposed pedestrian warrant revisions is that the number of pedestrians waiting to cross a street should be no greater than the number of vehicles waiting to cross or enter a street. Once this

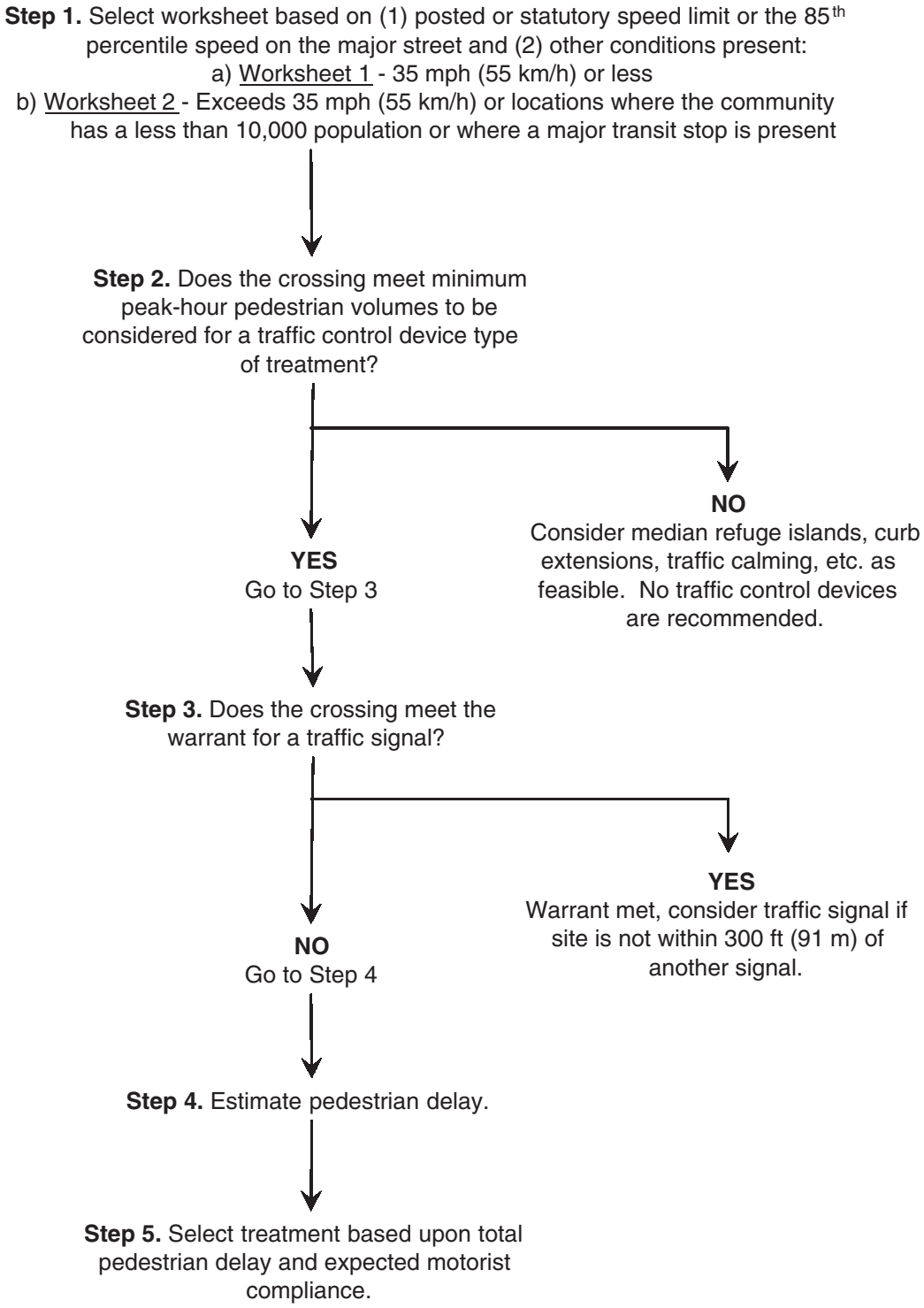

Figure A-1. Flowchart for Guidelines for Pedestrian Crossing Treatments.

WORKSHEET 1: PEAK-HOUR, 35 MPH (55 KM/H) OR LESS

Analyst and Site Information			
Analyst: Analysis Date: Data Collection Date:		Major Street: Minor Street or Location: Peak Hour:	
Step 1: Select worksheet (speed reflects posted or statutory speed limit or 85th 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), $V_{maj\text{-}s}$		*3a*	
Minimum signal warrant volume for peak hour (use *3a* for $V_{maj\text{-}s}$), SC $SC = (0.00021\ V_{maj\text{-}s}^2 - 0.74072\ V_{maj\text{-}s} + 734.125)/0.75$ 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 15th 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* ≥ *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), $V_{maj\text{-}d}$		*4e*	
Major road flow rate (veh/s), $v = V_{maj\text{-}d}/3600$ OR [*4e/3600*]		*4f*	
Average pedestrian delay (s/person), $d_p = (e^{v\ tc} - v\ t_c - 1) / v$ OR $[\ (e^{4f\ x\ 4d} - 4f\ x\ 4d - 1) / 4f\ ]$		*4g*	
Total pedestrian delay (h), $D_p = (d_p \times V_p)/3{,}600$ OR [(*4g*×*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 ≤ D_p < 21.3 h and Comp = low	RED
1.3 h ≤ D_p < 5.3 h (Comp = high or low) OR 5.3 h ≤ D_p < 21.3 h and Comp = high	ACTIVE OR ENHANCED
D_p < 1.3 h (Comp = high or low)	CROSSWALK

Figure A-2. Worksheet 1.