Countermeasure Strategies for Pedestrian Safety

Pedestrian Safety at Roundabouts

Hillary Isebrands

Federal Highway Administration

January 6, 2016

Today's Presentation

- **Introduction and housekeeping**
- **Audio issues?**
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Transit and Pedestrian Safety

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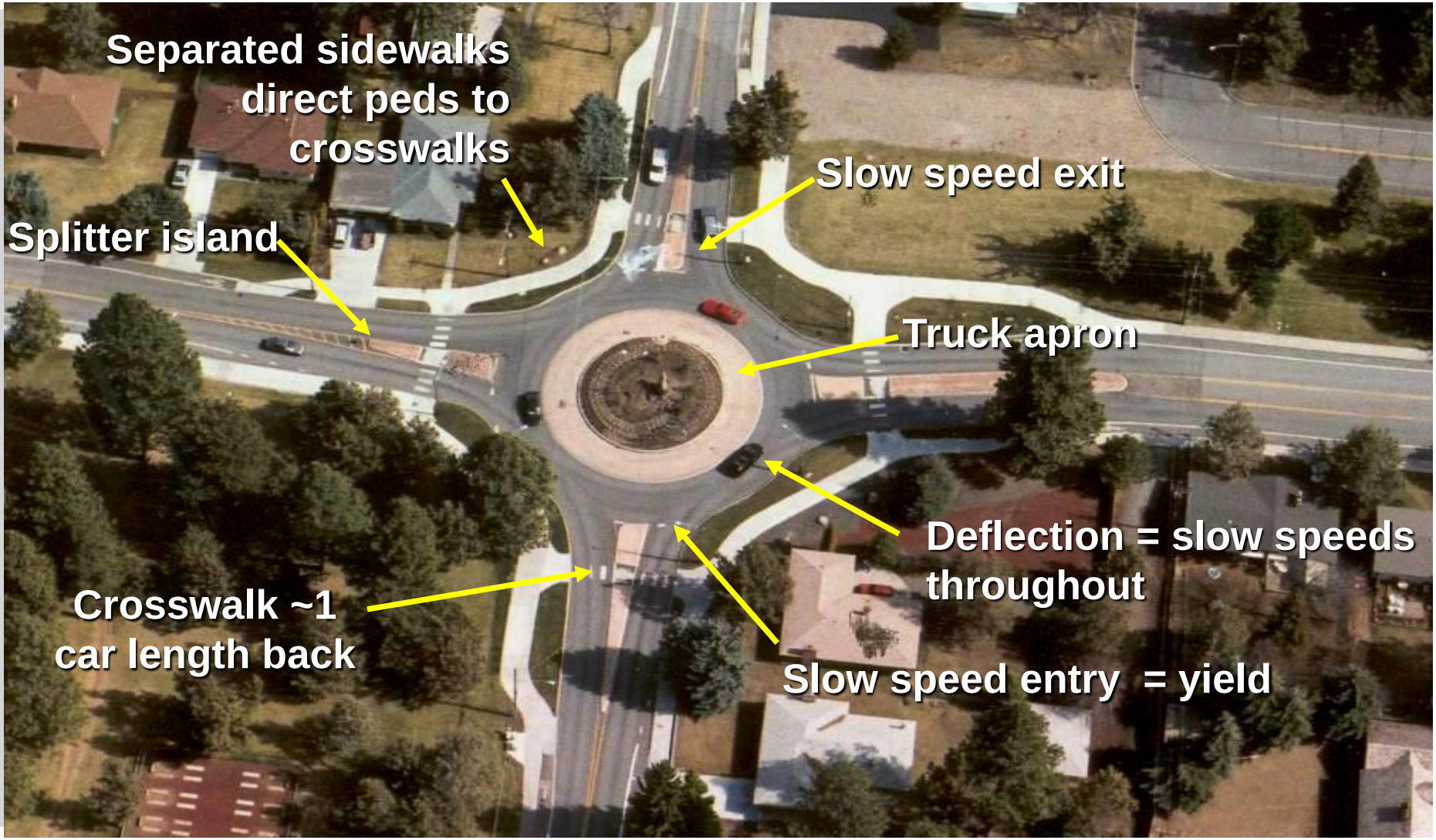
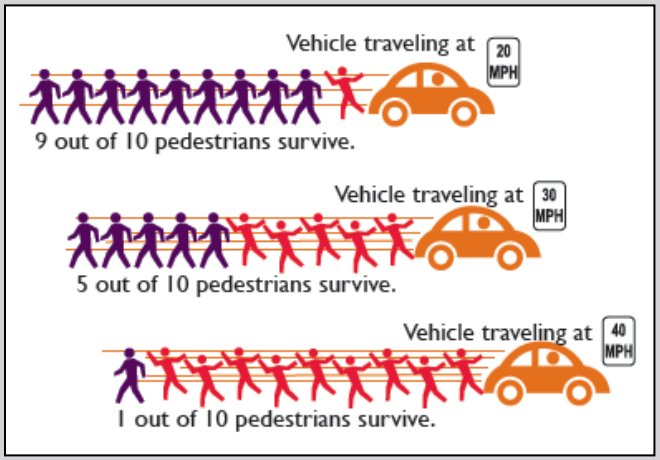
WHY WELL DESIGNED ROUNDABOUTS WORK FOR PEDESTRIANS



PEDESTRIAN ROUNDABOUT EXPERIENCE

- Low speeds (15-25mph)
- Fewer conflict points (16 to 8 ped-veh)
- Shorter crossing distances
- Cross only one direction of travel at a time



Source of Images: Seattle DOT

Photo credits: Butzek

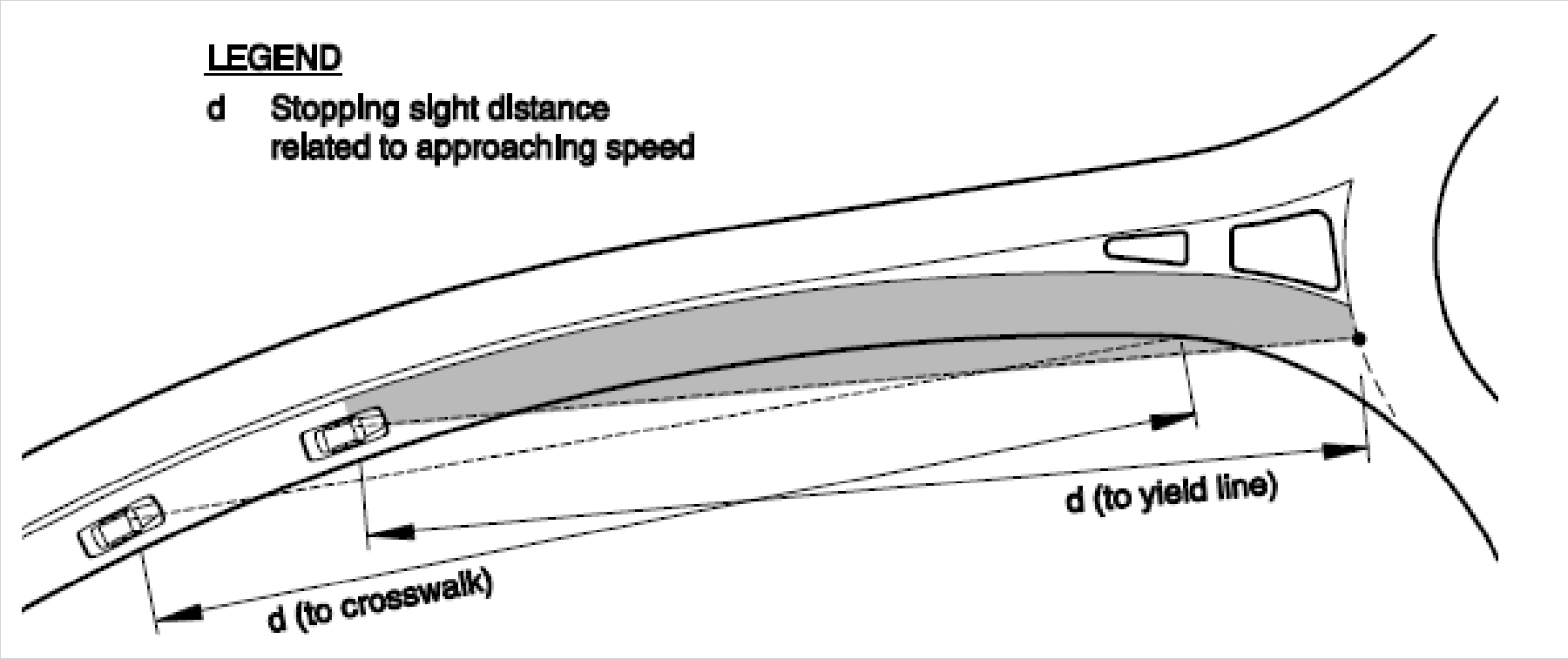
PEDESTRIAN SAFETY

- Belgium study*
  - Converting an unsignalized intersection to a roundabout associated with 27% decrease in pedestrian crashes
- US experience
  - No existing comprehensive “before” and “after” crash data analyses
  - Surrogate safety metrics such as vehicle speed and yielding compliance can also be used
  - Multilane crossings still present a multiple threat challenge for pedestrians
  - Audible cues needed to assess gaps and judge vehicle yielding behavior are different as compared to orthogonal intersections

*De Brabander, B., & Vereeck, L. (2007). Safety Effects of Roundabouts in Flanders: Signal type, speed limits and vulnerable road users. *Accident Analysis & Prevention*, *39*(3), 591-599.

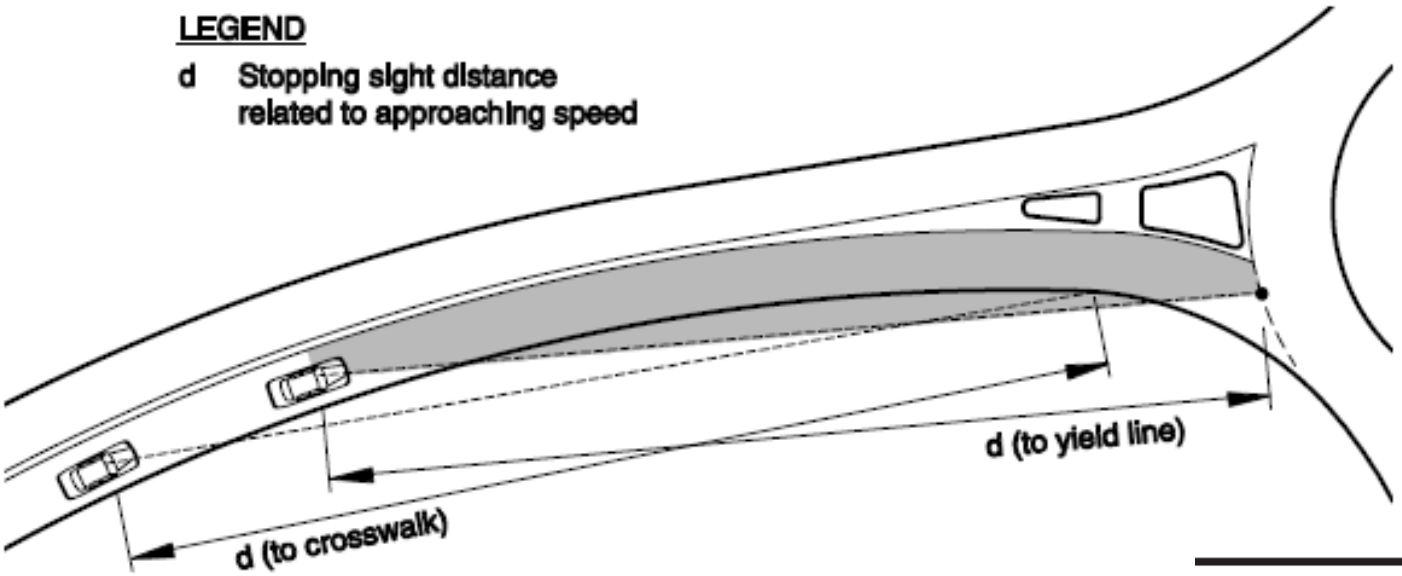
SIGHT DISTANCE SPLITTER ISLAND CROSSWALKS

STOPPING SIGHT DISTANCE



Source: NCHRP 672, Roundabouts: An Informational Guide, 2nd Edition

STOPPING SIGHT DISTANCE



$$d = (1.468)(t)(V) + 1.087\frac{V^2}{a}$$

where

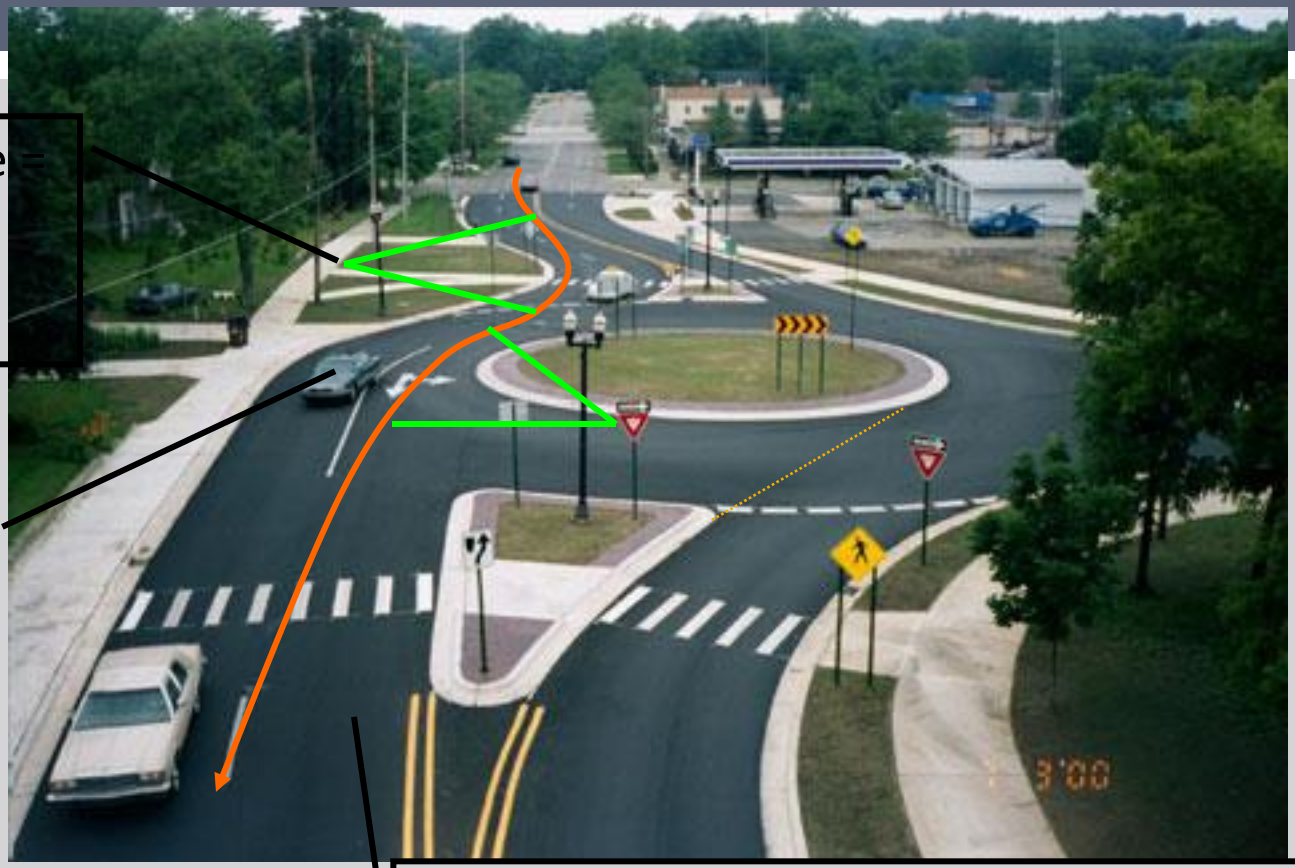
d = stopping sight distance, ft;
t = perception–brake reaction time, assumed to be 2.5 s;
V = initial speed, mph; and
a = driver deceleration, assumed to be 11.2 ft/s^2.

Speed (mph)	Computed Distance* (ft)
10	46.4
15	77.0
20	112.4
25	152.7
30	197.8
35	247.8
40	302.7
45	362.5
50	427.2
55	496.7

SPEEDS AT CROSSWALK

Entry Curvature = Slow entry R1

Slow circulating R2

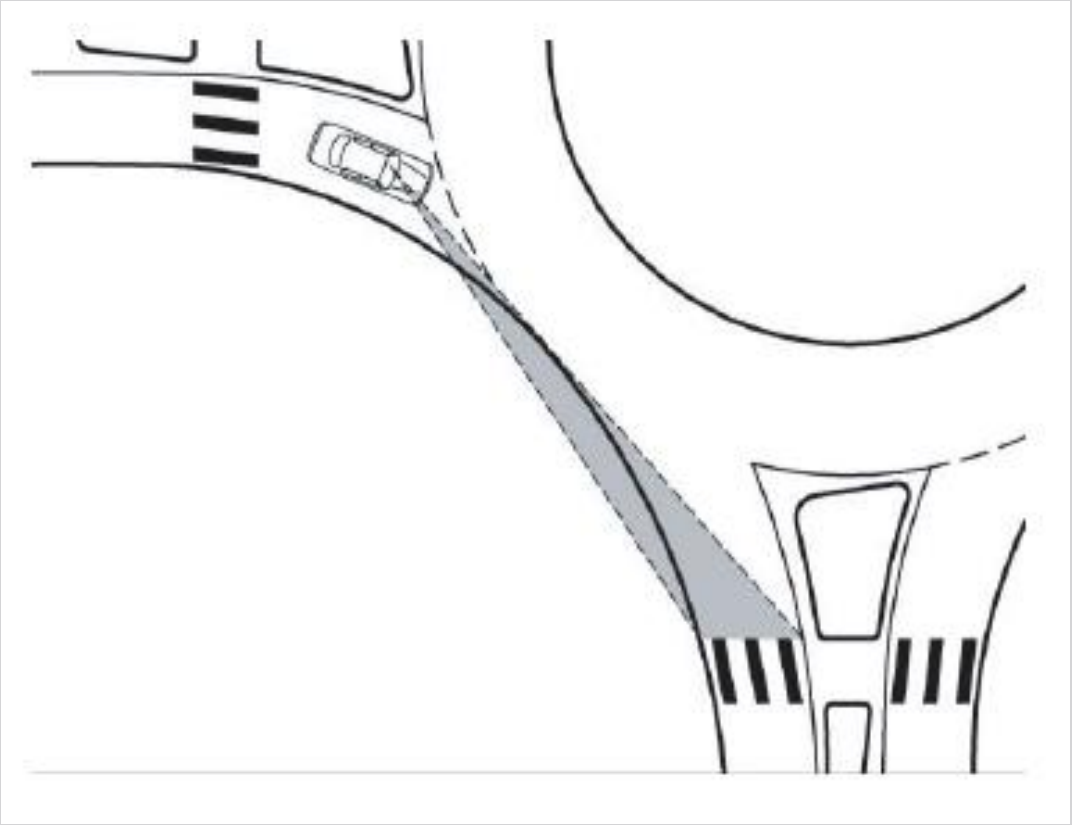


Average vehicular speeds at ped crossing dictated by geometry acceleration rate of 4-7 ft/sec*sec and dist to crossings ….18 mph

Source: MTJ Engineering

SIGHT LINE TO EXIT CROSSWALK

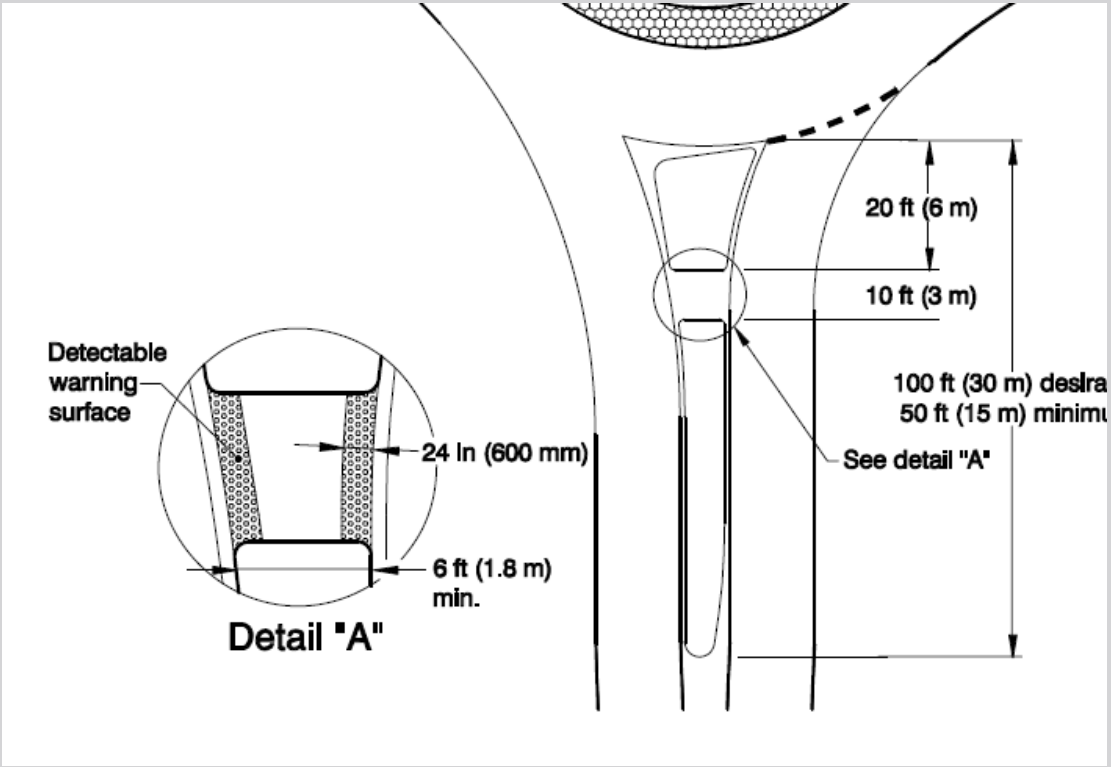
Landscape consideration: **DO NOT** block sight line



Source: NCHRP 672, Roundabouts: An Informational Guide, 2nd Edition

SPLITTER ISLAND DESIGN GUIDANCE

- Typically raised
- Width – minimum* of 6 ft at the crosswalk
- Typical crosswalk setback of 20 ft
  - Approx one vehicle length behind yield line
  - Lengths may vary between entrance and exit



* Minimum if a two-stage crossing

Source: NCHRP 672, Roundabouts: An Informational Guide, 2nd Edition

PEDESTRIAN DESIGN DIMENSIONS

Table 9-31 Key Design Dimensions to Accommodate Nonmotorized Users

User	Characteristic	Dimension	Affected Roundabout Features
Bicyclist	Length	1.8 m [6.0 ft]	Splitter island width at crosswalk
	Minimum operating width	1.2 m [4.0 ft]	Bike lane width on approach roadways; shared use path width
Pedestrian	Width	0.5 m [1.6 ft]	Sidewalk width, crosswalk width
Wheelchair user	Minimum width	0.75 m [2.5 ft]	Sidewalk width, crosswalk width
	Operating width	0.9 m [3.0 ft]	Sidewalk width; crosswalk width
Person pushing stroller	Length	1.7 m [5.6 ft]	Splitter island width at crosswalk
Skaters	Typical operating width	1.8 m [6.0 ft]	Sidewalk width

Source: 2011 AASHTO Green Book

CROSSWALK OPTIONS

CROSSWALK OPTIONS

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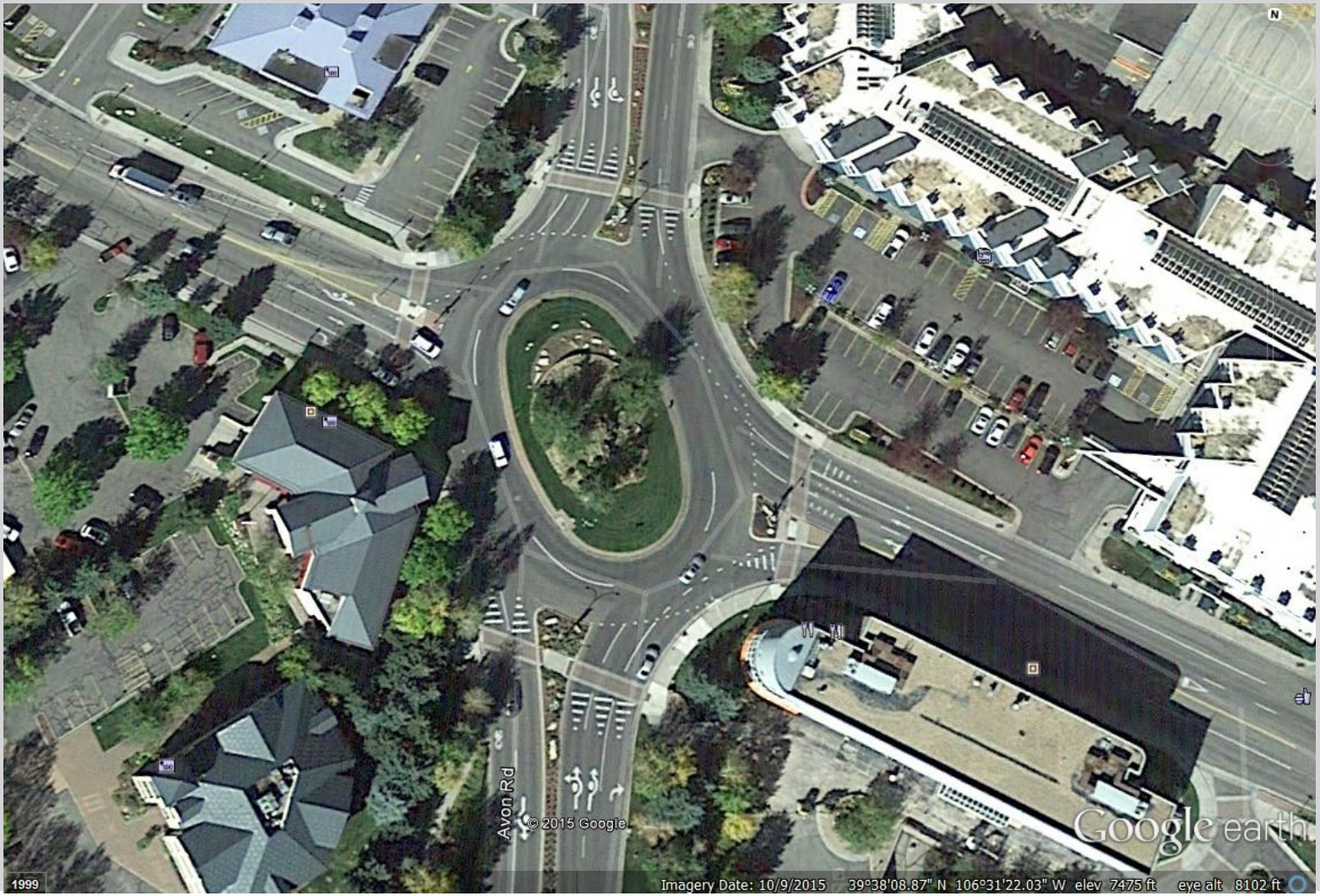


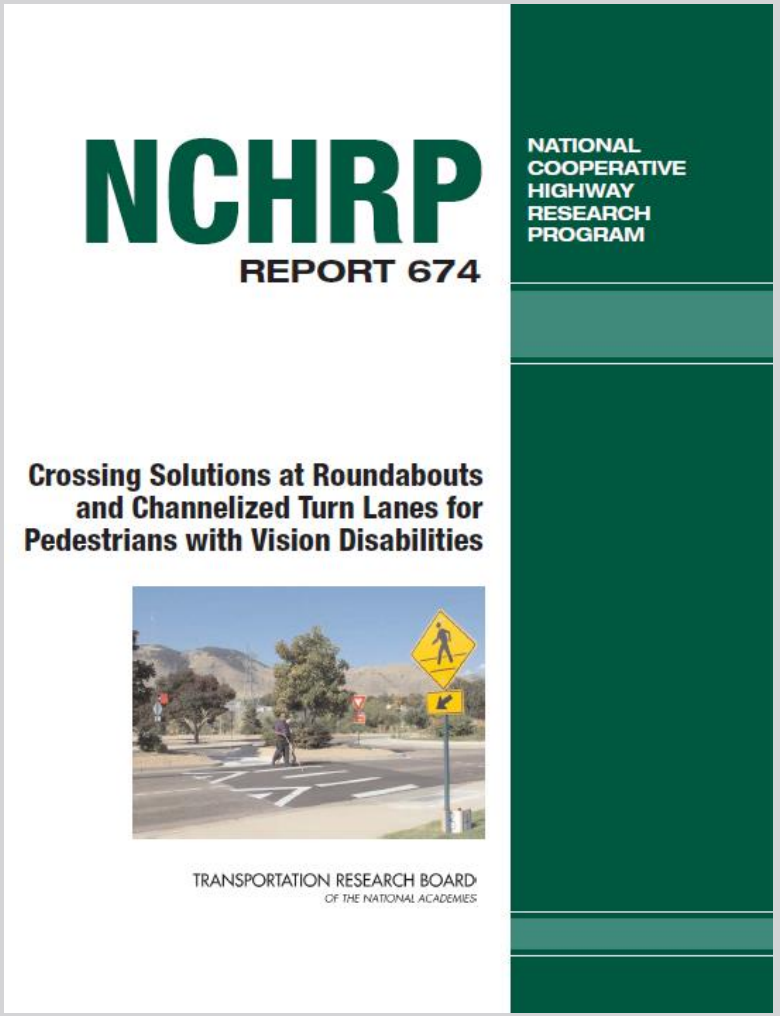
ACCESSIBILITY AT ROUNDABOUTS IN THE UNITED STATES

EAGLE COUNTY, CO

ACCESSIBILITY RESEARCH AT ROUNDABOUTS

Blind pedestrians must master four principal tasks for crossing a street:

1. *Finding the crosswalk &* identifying the intended crossing location
2. *Aligning to cross*
3. *Deciding when to cross*
4. *Maintaining alignment while crossing* multiple lanes until the far side is reached



RAISED CROSSWALK IN GOLDEN, CO

Photo Source: City of Golden, CO

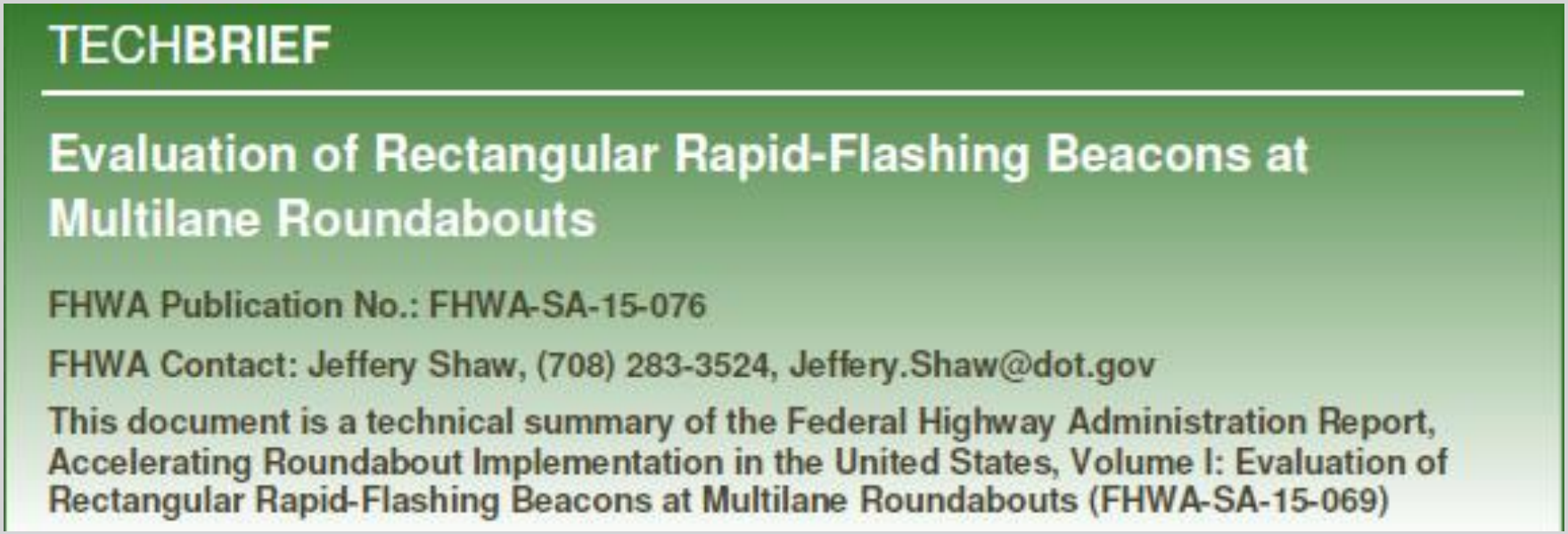
PEDESTRIAN HYBRID BEACONS IN GOLDEN, CO

Photo Source: Isebrands

PEDESTRIAN HYBRID BEACON
PECOS/I-70 RAMP, DENVER, CO

Photo Source: Isebrands

FHWA EVALUATION OF RECTANGULAR RAPID FLASHING BEACONS AT MLR



TECHBRIEF

Evaluation of Rectangular Rapid-Flashing Beacons at Multilane Roundabouts

FHWA Publication No.: FHWA-SA-15-076

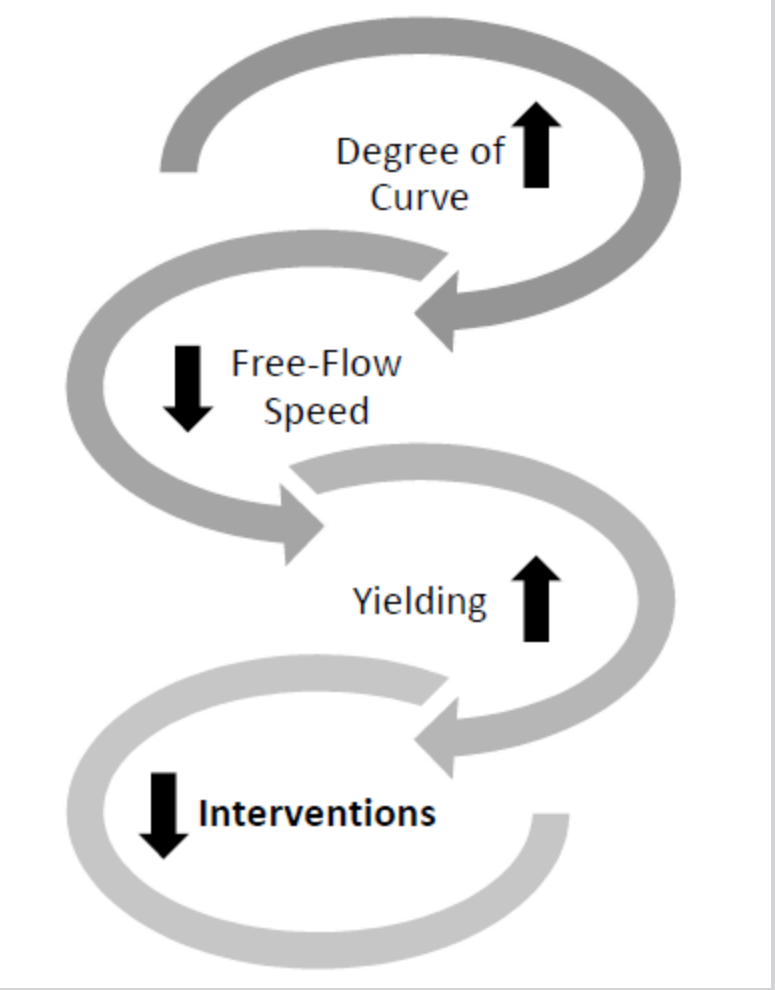
FHWA Contact: Jeffery Shaw, (708) 283-3524, Jeffery.Shaw@dot.gov

This document is a technical summary of the Federal Highway Administration Report, Accelerating Roundabout Implementation in the United States, Volume I: Evaluation of Rectangular Rapid-Flashing Beacons at Multilane Roundabouts (FHWA-SA-15-069)

- The objective of this effort was to conduct field studies at multilane roundabouts with the goal of defining the region of feasibility for RRFBs at multilane roundabouts to provide guidance and data for practitioners(1) and the U.S. Access Board(2).

FHWA RRFB EVALUATION PERFORMANCE MEASURES – ACCESSIBILITY AUDIT

- Percent Intervention
- Pedestrian Delay
- Free Flow Speed at Crosswalk
- Driver Yielding Rate at Crosswalk



Conceptual relationship between interventions and other factors

FHWA RRFB CONFIGURATION RESULTS AT ROUNDABOUTS

Based on this research, RRFB installations should

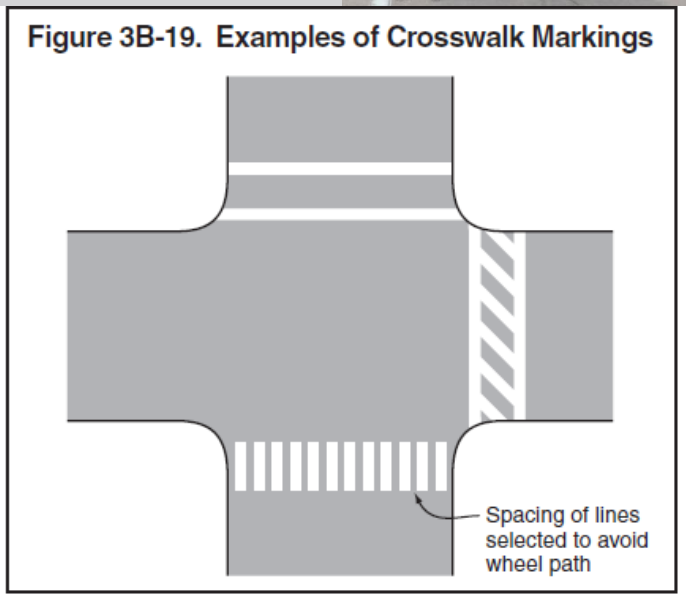
- … be installed as a two-stage crossing with separate devices for crosswalks on the roundabout's entry and exit legs
- … be installed on both ends of the crosswalk; both at the curb and at the splitter island
- … be installed to be as visible as possible to drivers, and the design should consider the brightness and orientation of the devices
- … need to be outfitted with audible devices with both a pushbutton locator tone and a speech message indicating when the yellow lights are flashing

RRFB IN AVON, CO

SIGNING & MARKING

VISIBILITY OF THE CROSSWALKS

- Proper signing is important
  - YIELD
  - Pedestrian Warning
  - Lane Use
- High visibility crosswalks are preferred



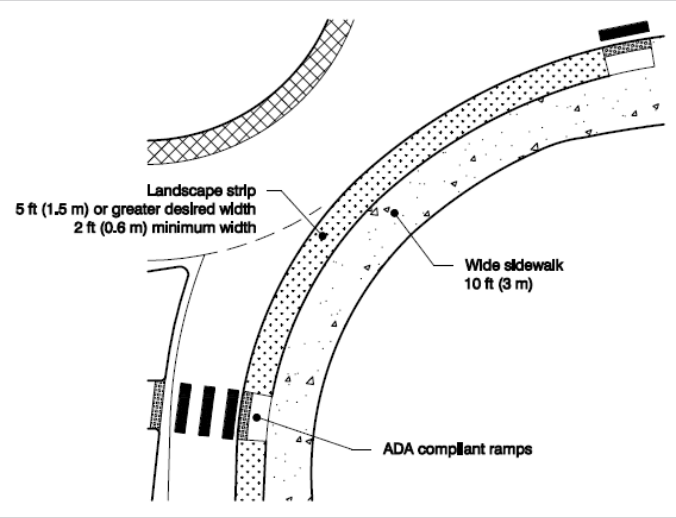
PEDESTRIAN SIGNS SHOULD STAND OUT

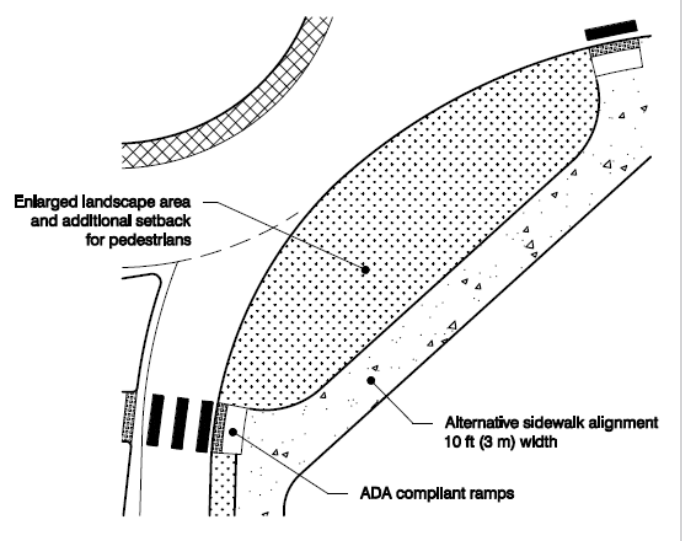
LANDSCAPING

SIDEWALK BUFFERS

- Wherever possible, sidewalks should be set back from the edge of the circulatory roadway with a landscape strip
  - Discourages pedestrians from crossing to the central island or cutting across the circulatory roadway of the roundabout
  - Helps guide pedestrians with vision impairments to the designated crosswalks
- Landscape strips provide
  - Increased offset from traffic
  - Room for signs, street furniture and snow storage
  - Buffer to allow for the overhang of large vehicles as they navigate the roundabout

SIDEWALK BUFFERS





Overland Park, Kansas

SPLITTER ISLAND & APPROACH LANDSCAPING

- Avoid landscaping in the line of sight of crosswalks
  - Within critical visibility areas limit height to 2 ft

SPLITTER ISLAND & APPROACH LANDSCAPING

- Hardscape treatments , patterned concrete or paver surface, may be used on splitter islands in lieu of landscaping

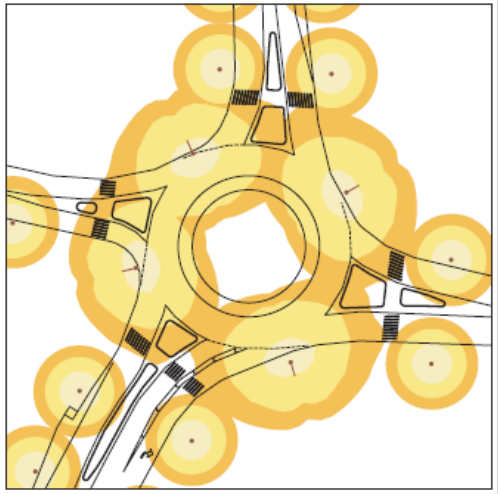
LIGHTING

PERIMETER LIGHTING

- Pedestrians illuminated
- Signs illuminated

Study Source: Hasson and Lutkevich

PERIMETER ILLUMINATION



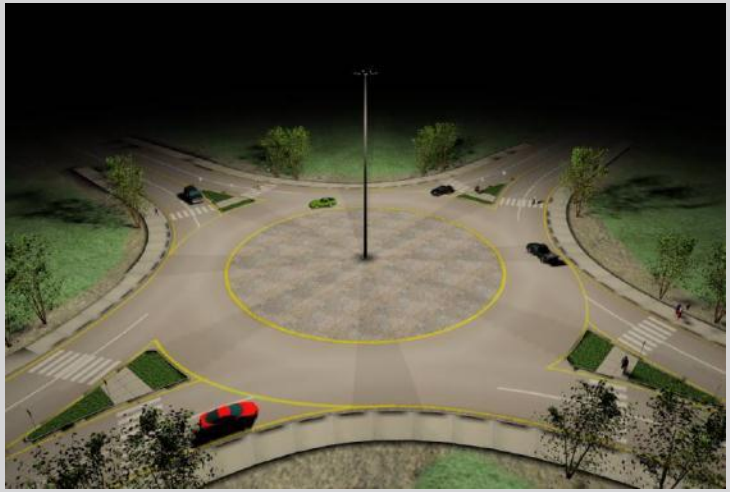
Perimeter Illumination Design

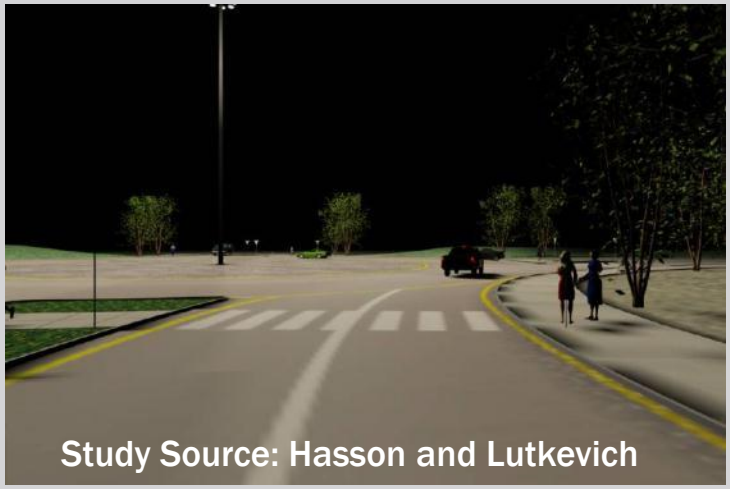
Advantages	Disadvantages
• Illumination can be strongest around critical bicycle and pedestrian areas. • Continuity of poles and luminaires is maintained for the illumination of the lanes, as well as good visual guidance on the circulatory roadway. • Approach signs typically appear in positive contrast and thus are clearly visible. • Maintenance of luminaires is easier due to curbside location.	• Illumination is weakest in central island, which may limit visibility of roundabout from a distance. • More poles are required to achieve the same illumination level. • Poles may need to be located in critical conflict areas to achieve illumination levels and uniformity.

Source: NCHRP 672, Roundabouts: An Informational Guide, 2nd Edition

CENTRAL ILLUMINATION

- Pedestrians visible only as silhouettes
- Signs not visible





Study Source: Hasson and Lutkevich

ECOLUMINANCE STUDY – NY STATE/RPI

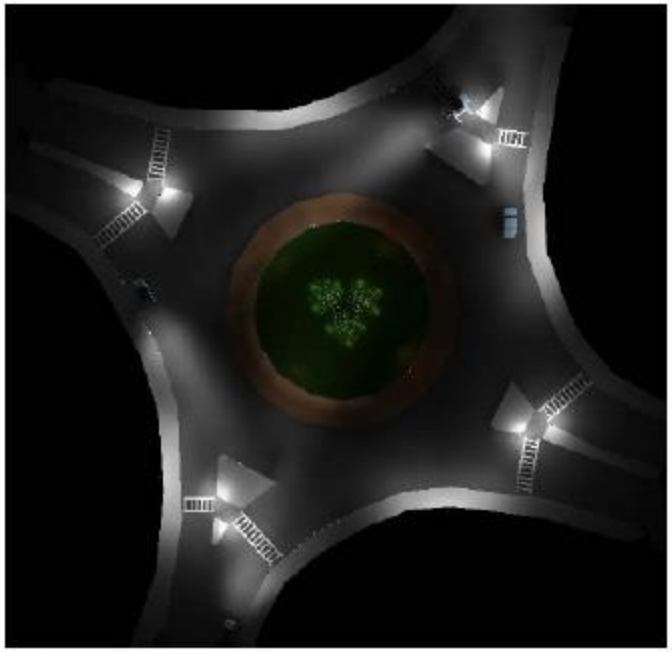


Figure 25. Plan view of the lighting layout.

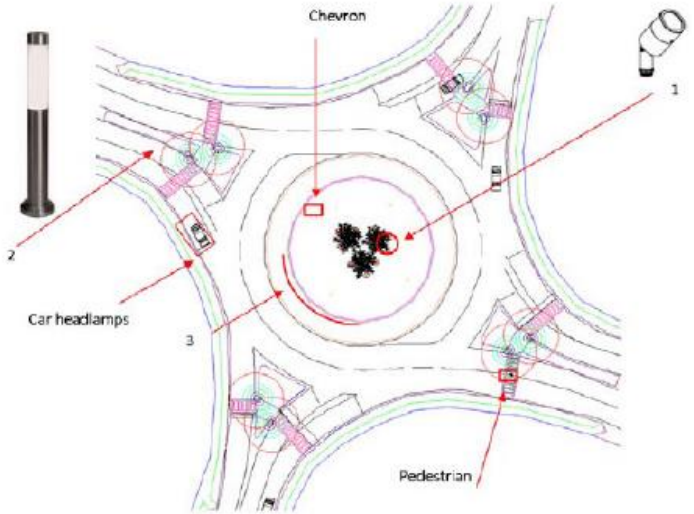


Figure 21. Lighting elements that are used in the final lighting system.

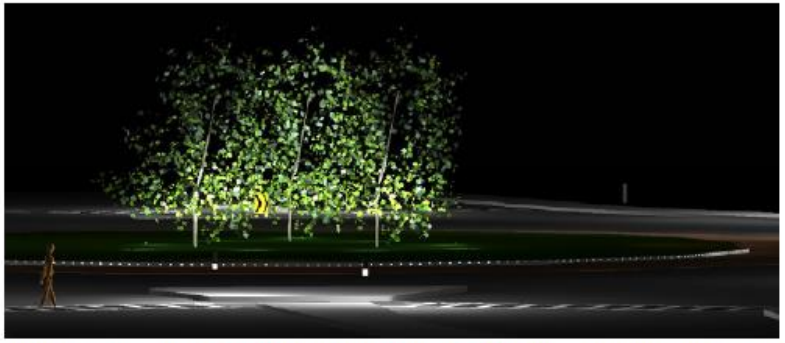


Figure 22. Isometric view of the roundabout showing the lighting on the crosswalks, the landscape

IESNA LIGHTING LEVELS

Table 1. Illuminance Levels at Roundabouts and Other Intersections

Recommended Illuminance for Intersections				
Roadway Classification (Street A/Street B)	Average Maintained Illuminance at Pavement[1]			Uniformity Ratio (E_{avg}/E_{min})[2]
	Pedestrian/Area Classification			
	High lux (fc)	Medium lux (fc)	Low lux (fc)	
Major/Major	34.0 (3.2)	26.0 (2.4)	18.0 (1.7)	3.0
Major/Collector	29.0 (2.7)	22.0 (2.1)	15.0 (1.4)	3.0
Major/Local	26.0 (2.4)	20.0 (1.9)	13.0 (1.2)	3.0
Collector/Collector	24.0 (2.2)	18.0 (1.7)	12.0 (1.1)	4.0
Collector/Local	21.0 (2.0)	16.0 (1.5)	10.0 (0.9)	4.0
Local/Local	18.0 (1.7)	14.0 (1.3)	8.0 (0.7)	6.0

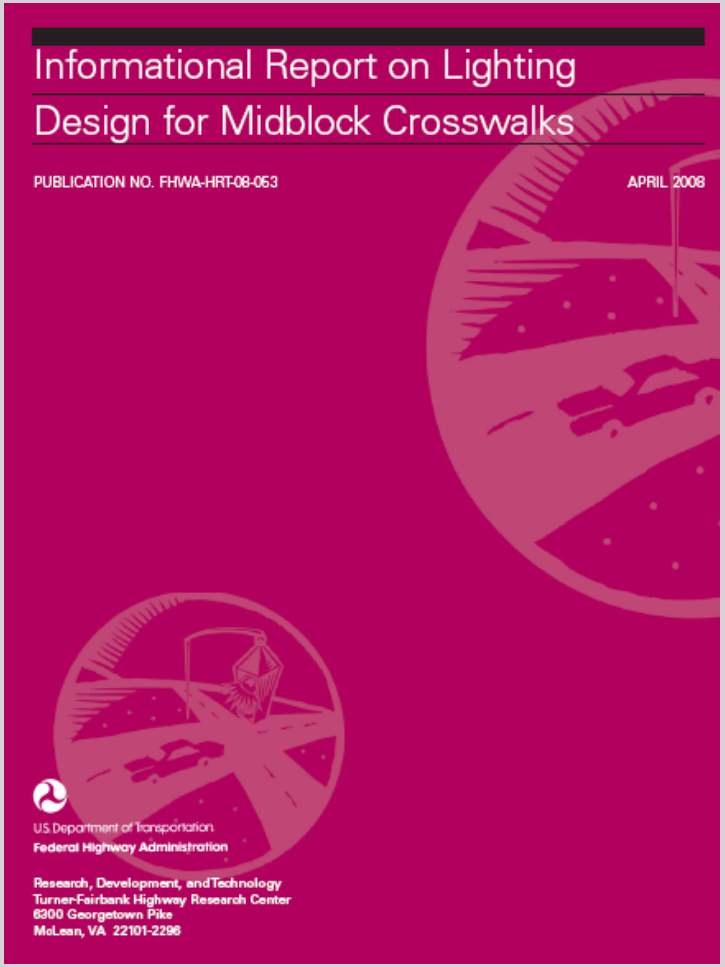
[1] fc = foot candles (conversion factor from lux to foot candles is 10.67.)
fc has been rounded to the nearest tenth

[2] E_{avg} = Horizontal Illuminance, E_{min} = Vertical Illuminance

Source: ANSI / IESNA RP-8-00 Table 9

INFORMATIONAL REPORT ON LIGHTING DESIGN FOR MIDBLOCK CROSSWALKS

- FHWA-HRT-08-053
  - April 2008
  - Available at http://www.tfhrc.gov/safety/pubs/08053/08053.pdf



SAMPLE ILLUSTRATIONS FROM FHWA REPORT

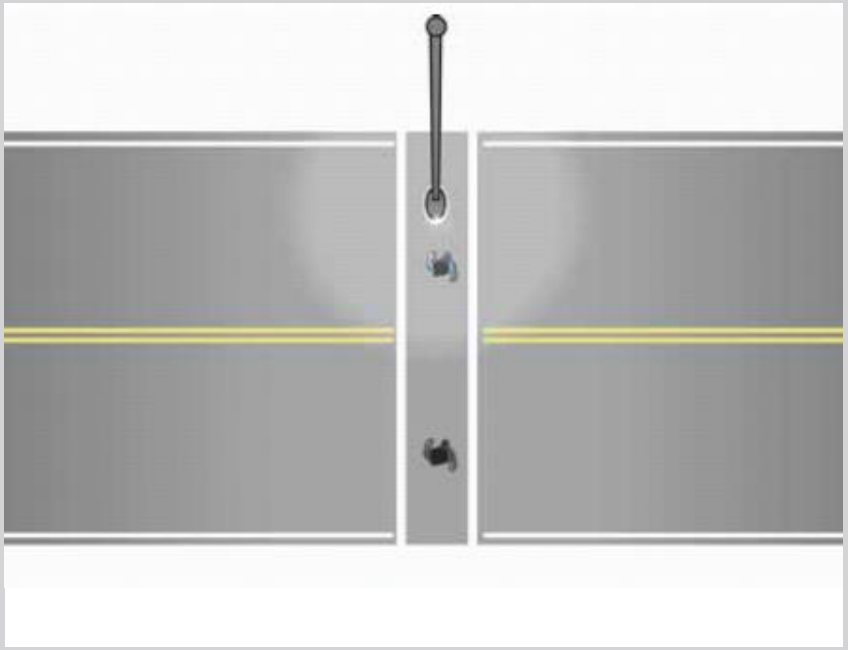


Fig 11. Traditional midblock crosswalk lighting layout

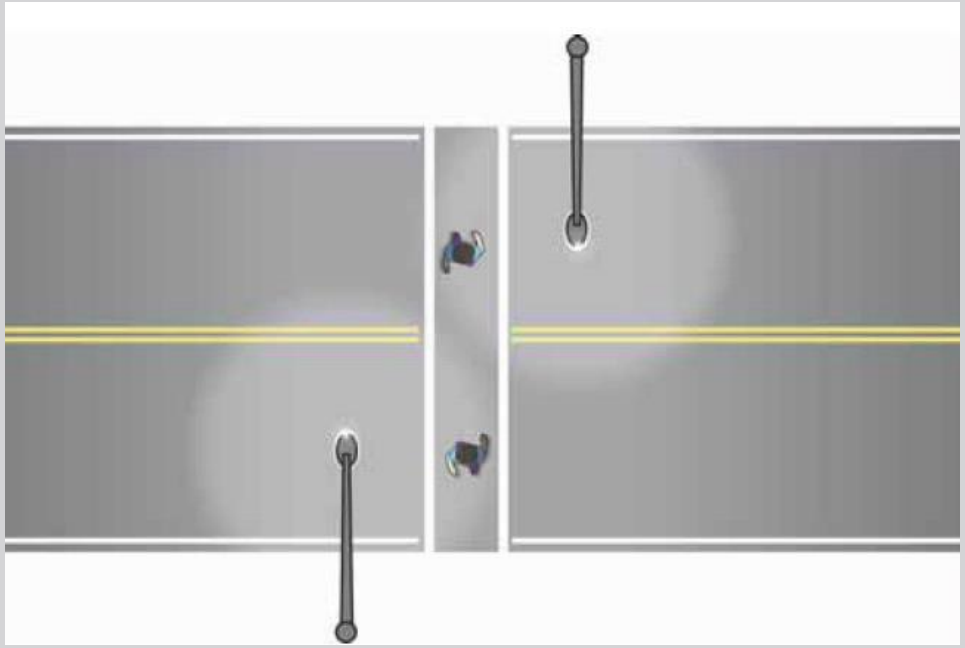


Fig 12. New design for midblock crosswalk lighting layout

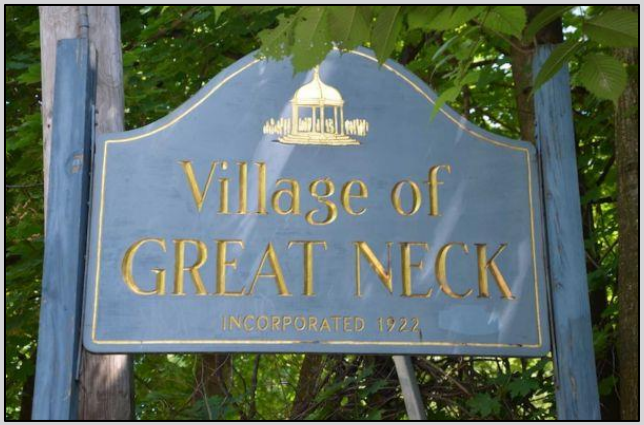
Recommended lighting level: 20 lux at 5’ above pavement

CASE STUDY

CASE STUDY: ROUNDABOUTS (GREAT NECK PLAZA, NY)

Problem/Background

- Small, dense, suburban community on Long Island
- High pedestrian activity & older population
  - Busy central business district
  - High-use train station
- Excessive vehicle speeds



CASE STUDY: ROUNDABOUTS (GREAT NECK PLAZA, NY)

Solution

- City received traffic calming grant from state DOT
  - Goal: calm traffic, enhance visibility of pedestrians, & improve crosswalk safety
- 4-way STOP replaced by roundabout
  - Contrasting pavement color, curb extensions, fencing, and islands used to direct traffic
- Other locations: illuminated pedestrian crossings and speed awareness devices installed
- Cost: $365,000 for the roundabout, $275,000 for the other improvements

Before

After

CASE STUDY: ROUNDABOUTS (GREAT NECK PLAZA, NY)

Results

- Pedestrian collisions reduced near the roundabout after installation
- Users indicate a safer pedestrian environment
- Vehicle flow improved
- Effect of pedestrian crossing signs & speed warning devices not as good
- Officials and residents consider project a success

Speed awareness device installed at same time as roundabout

BICYCLISTS

BICYCLIST ROUNDABOUT EXPERIENCE

- Low speeds (15-25mph)
- Fewer conflict points
- Bicyclists can take the lane OR use bike ramp to exit to multi-use path and cross with pedestrians

BICYCLISTS AT ROUNDABOUTS

Photo credits: Isebrands

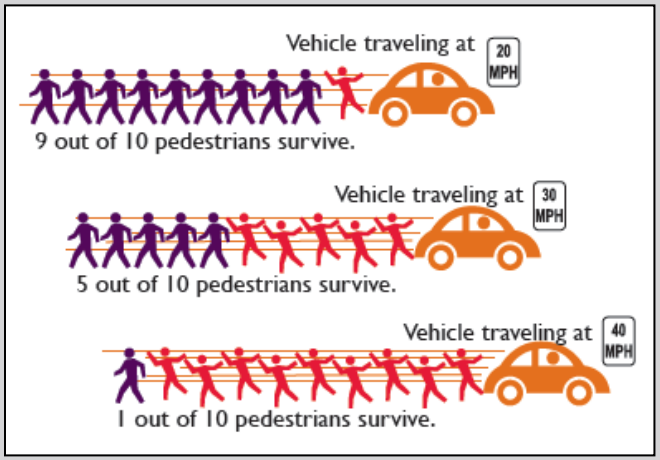
BIKE & PED PATH RINGS IN NETHERLANDS

https://bicycledutch.wordpress.com/2013/05/09/a-modern-amsterdam-roundabout/

SUMMARY & QUESTIONS

SUMMARY

- Low speeds (15-25mph)
- Fewer conflict points (16 to 8 ped-veh)
- Shorter crossing distances
- Cross only one direction of travel at a time



Source of Images: Seattle DOT

Thank You!

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  - Downloadable/streaming recording and presentation slides
- **Questions?**
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