U.S. Department of Transportation
Federal Highway Administration

Pedestrian and Bicycle Information Center

Designing for Pedestrian Safety

Intersection Geometry

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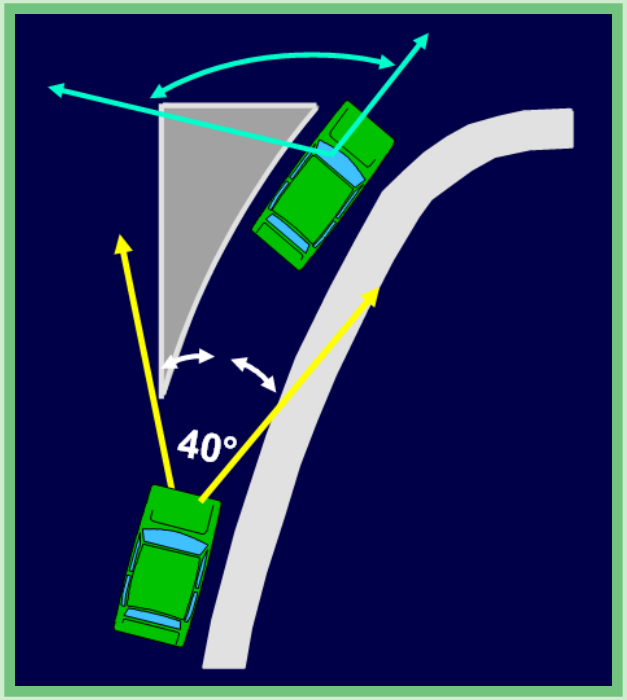


Learning Outcomes

At the end of this module, you will be able to:

- ⇨ **Explain why tight/right angle intersections are best**
- ⇨ **Describe why pedestrians need access to all corners**
- ⇨ **Assess good crosswalk placement: where peds want to cross & where drivers can see them**
- ⇨ **Explain how islands can break up complex intersections**

Intersection Crashes
Some basic facts:

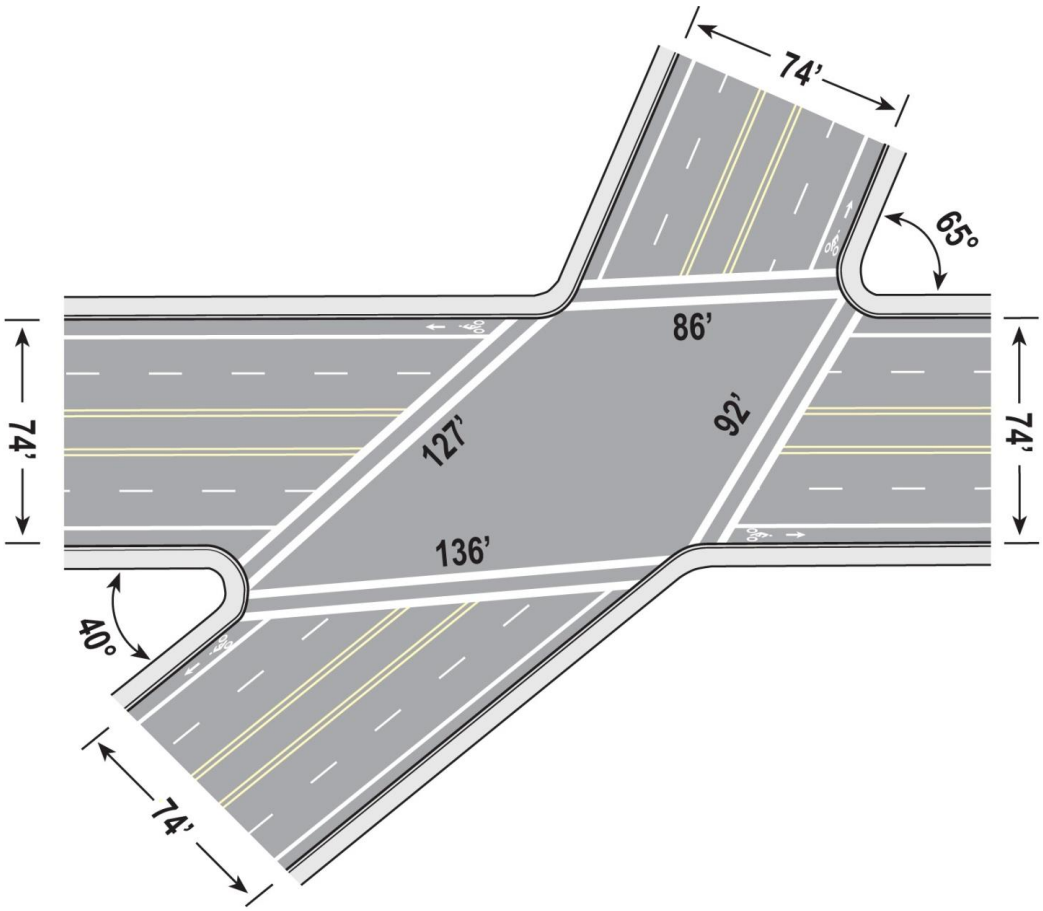
1. Most (urban) crashes occur at intersections
2. Most occur at signalized intersections
3. Most are associated with turning movements
4. Geometry matters: keeping intersections tight, simple & slow speed make them safer for everyone

Small, tight intersections best for pedestrians…

Simple, few conflicts, slow speeds

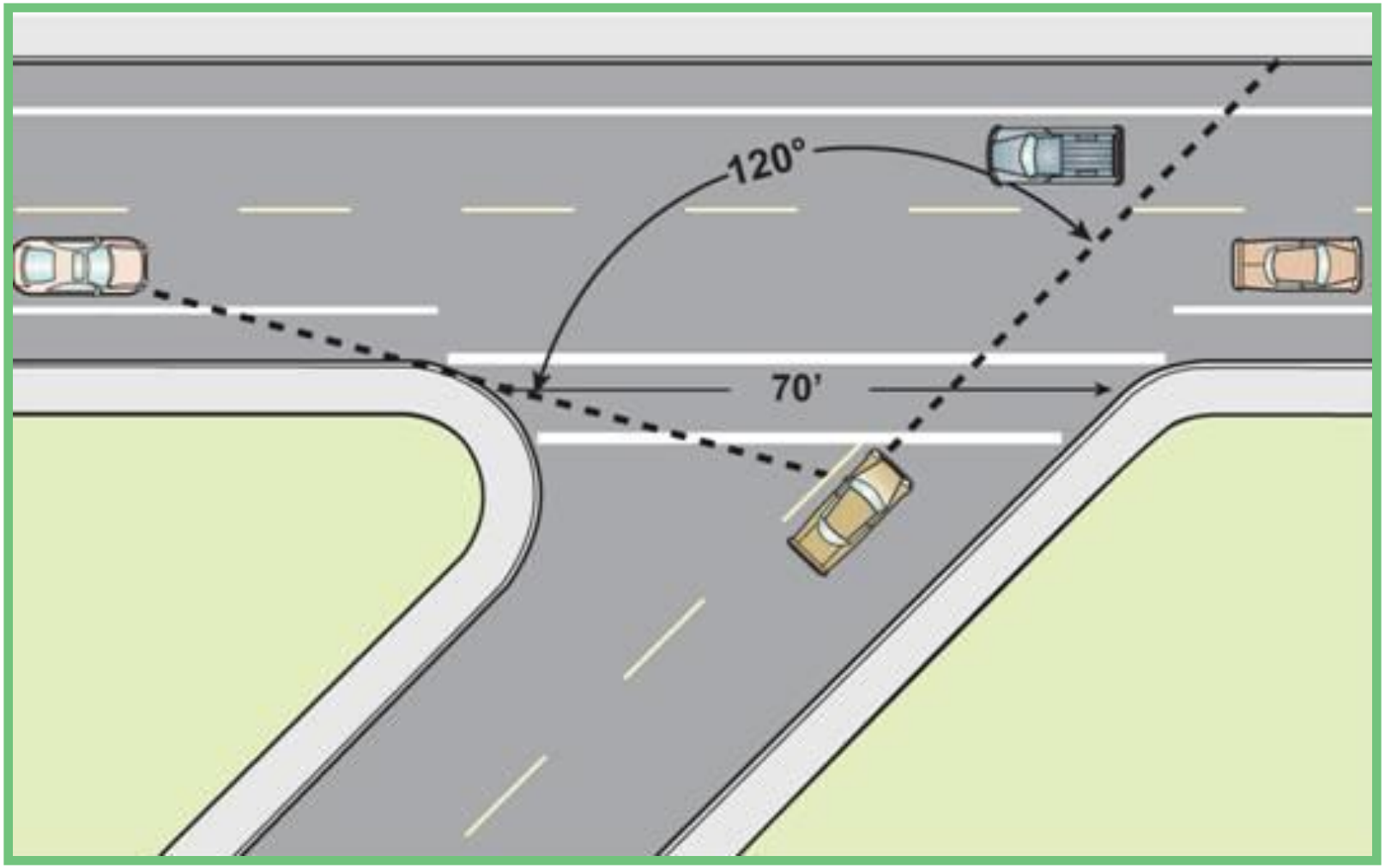
Large intersections can work for pedestrians – with mitigation

Skewed intersections

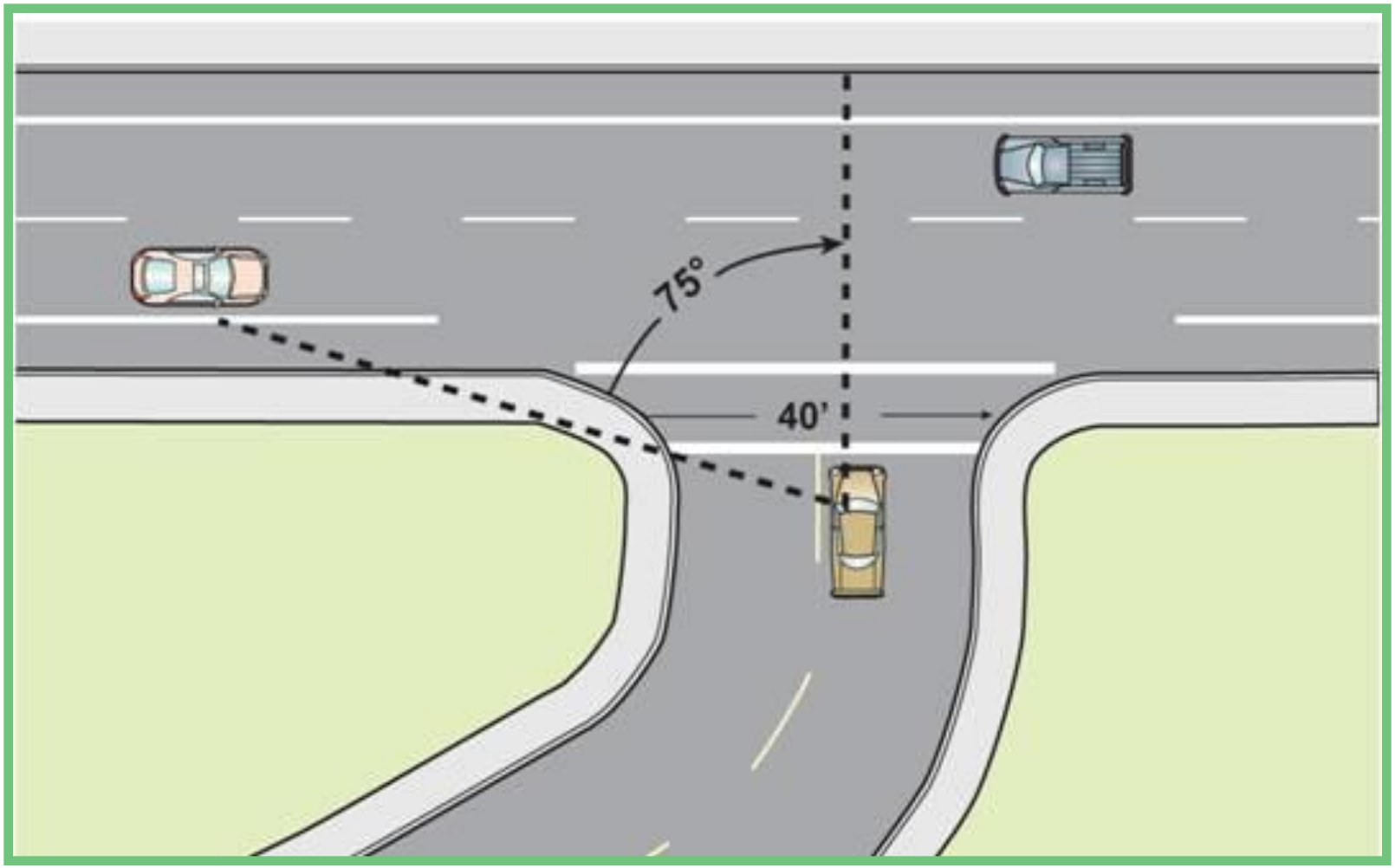


Skew increases crossing distance & speed of turning cars

Cars can turn at high speed

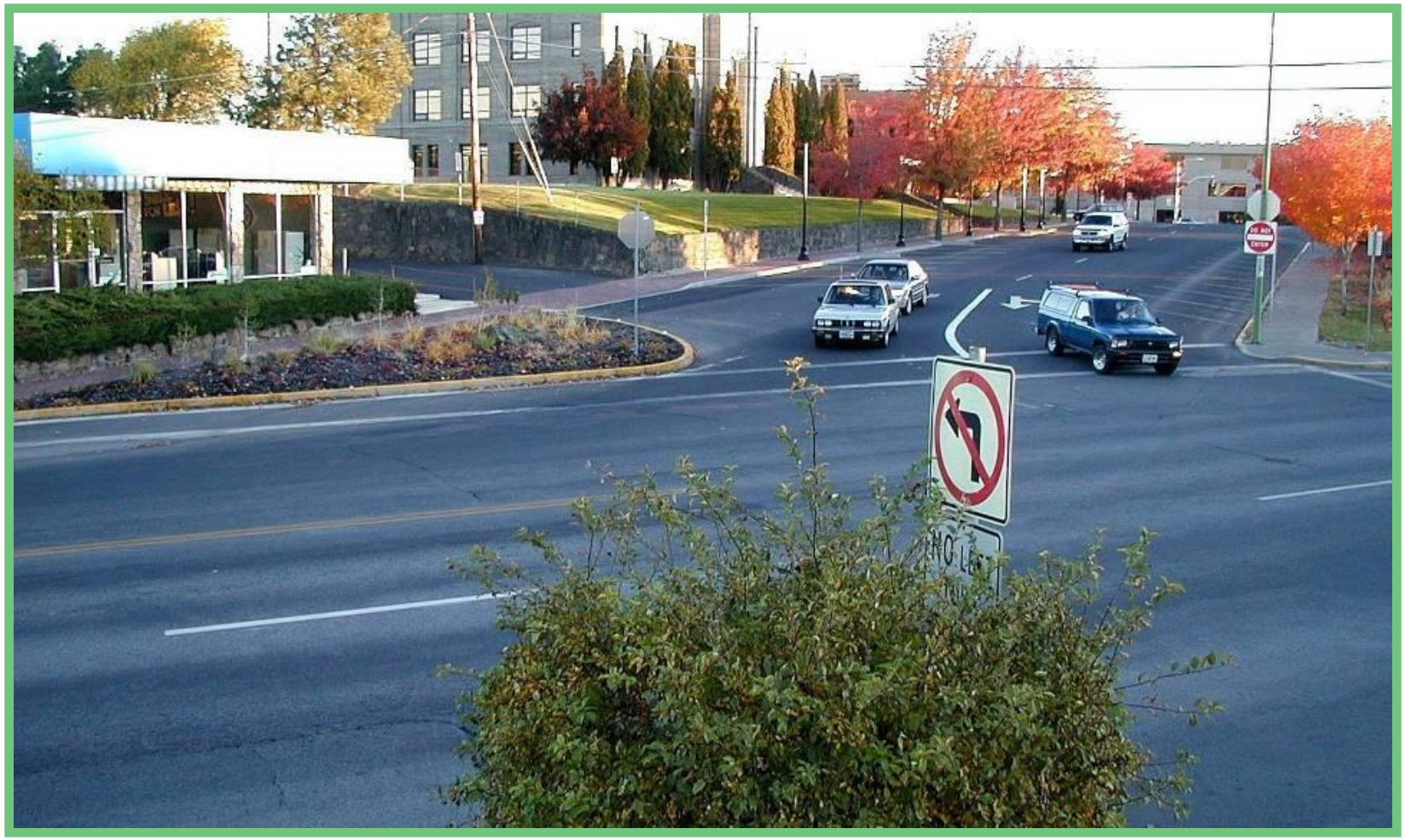


Skew increases crosswalk length, decreases visibility



Right angle decreases crosswalk length, increases visibility

Skewed intersection reduces visibility
Driver looks left, doesn't see pedestrian on right



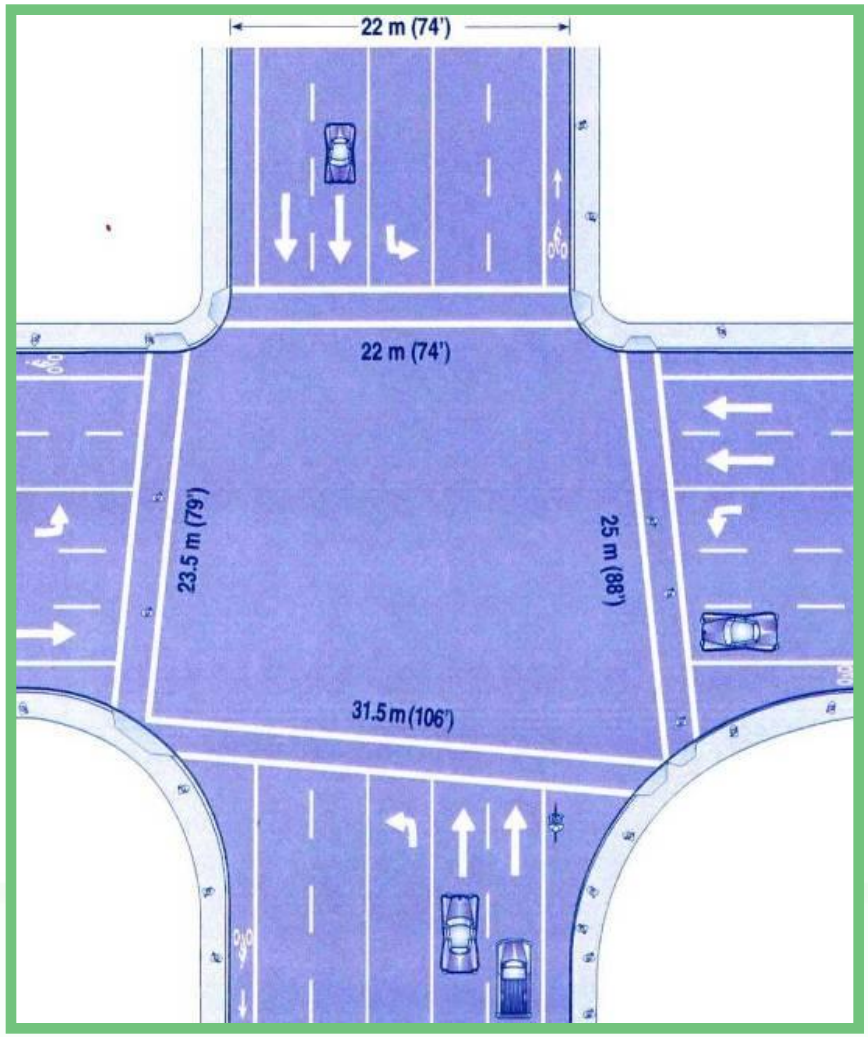
Adjust skew by bringing out curb

Result: driver behavior change

Curb radius – small radii are safer for pedestrians

Large radii:

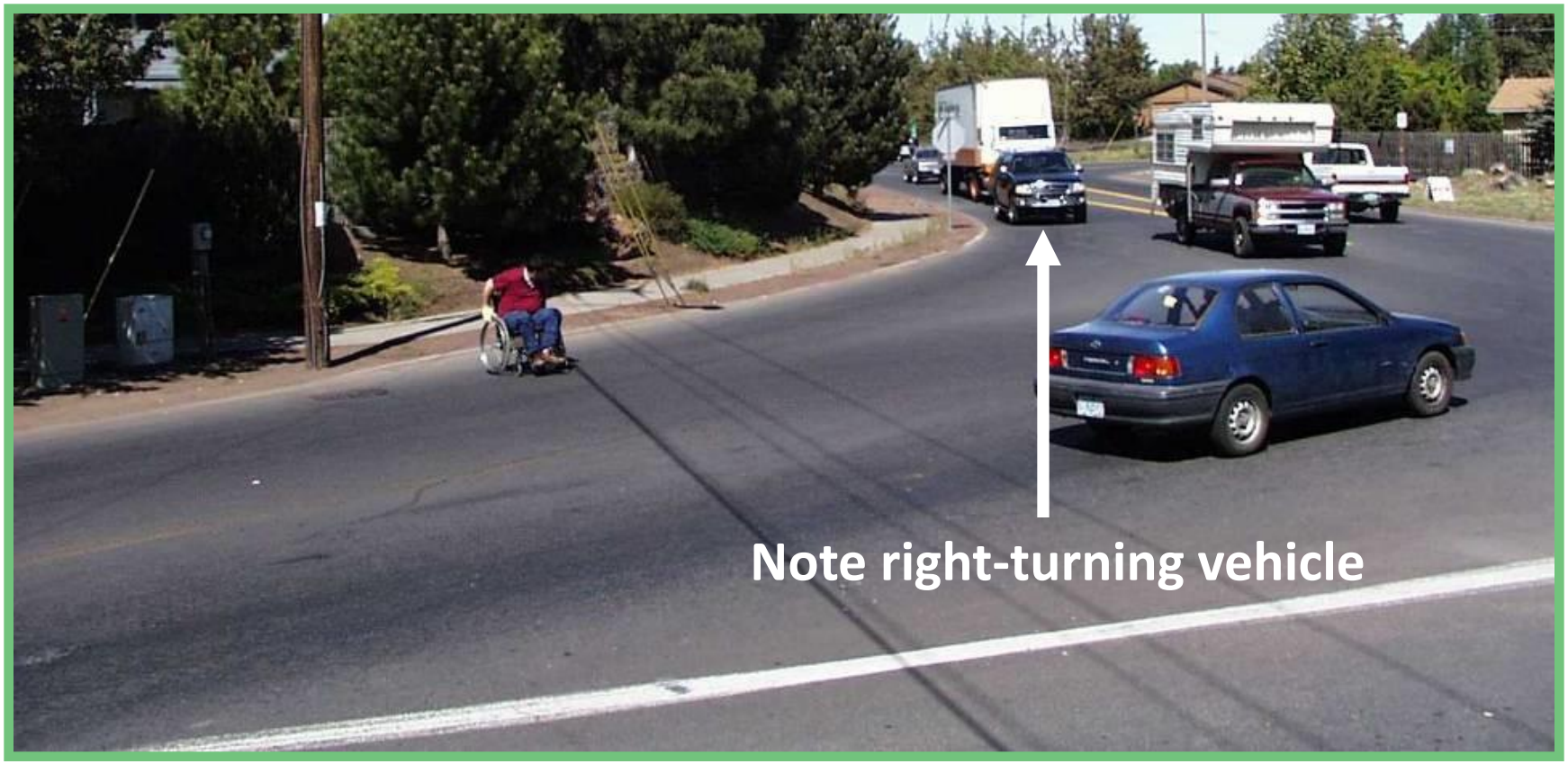
1. **Increase crossing distance and**
2. **Make crosswalk & ramp placement more difficult**



Effect of large radius on crosswalk:

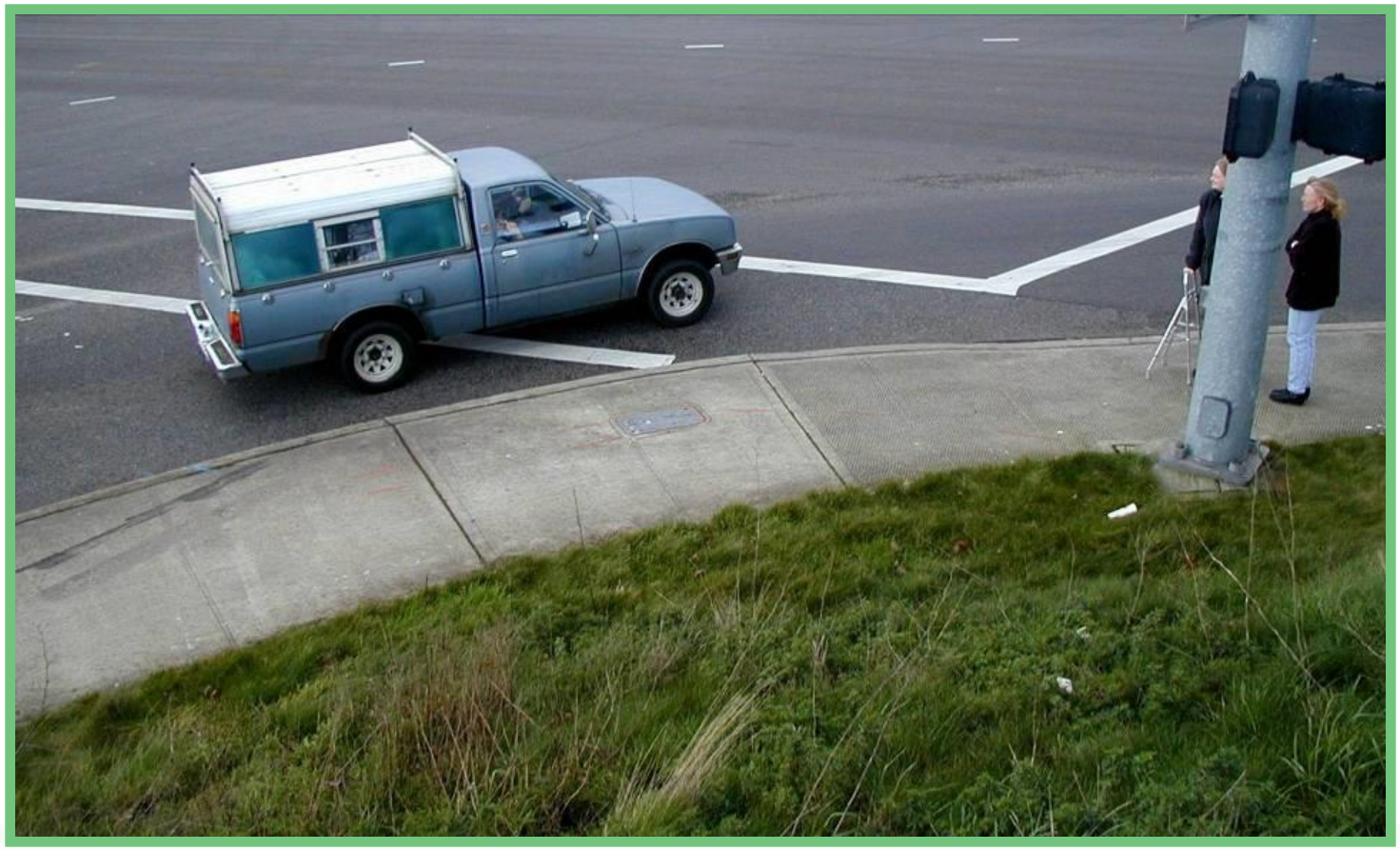
It adds to crossing distance…

Effect of large radius on crosswalk:



…and makes it hard to figure out where to cross

Effect of large radius on drivers



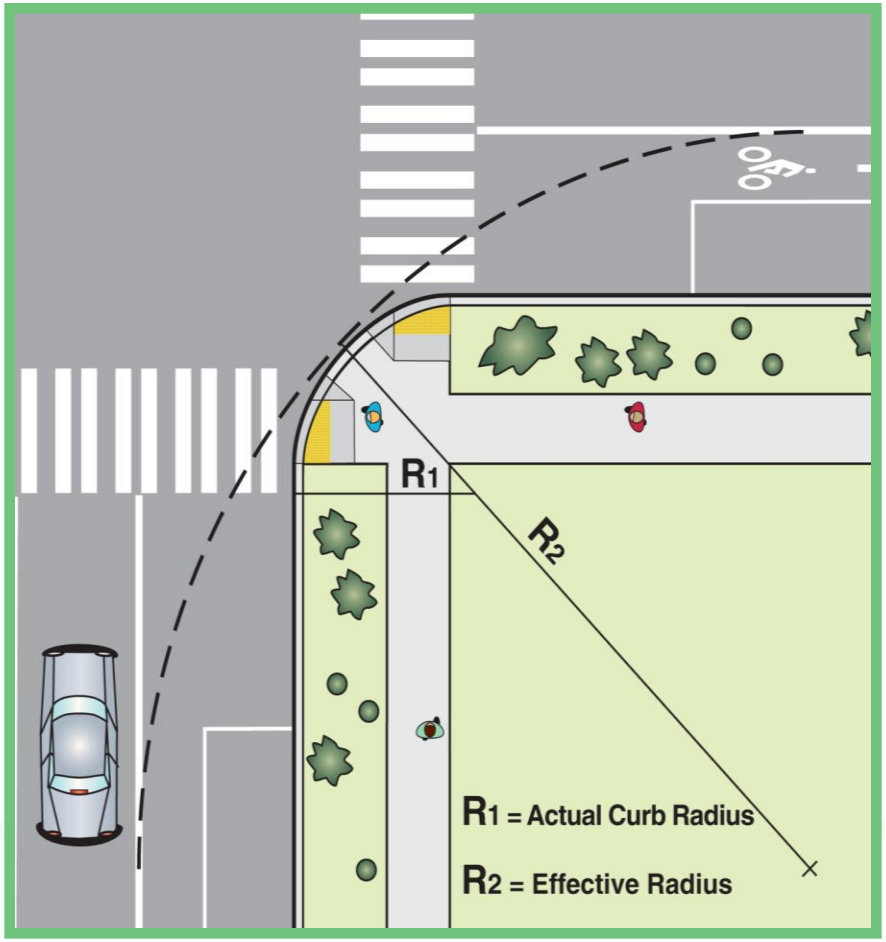
They drive fast…

Effect of large radius on drivers

…ignoring pedestrians

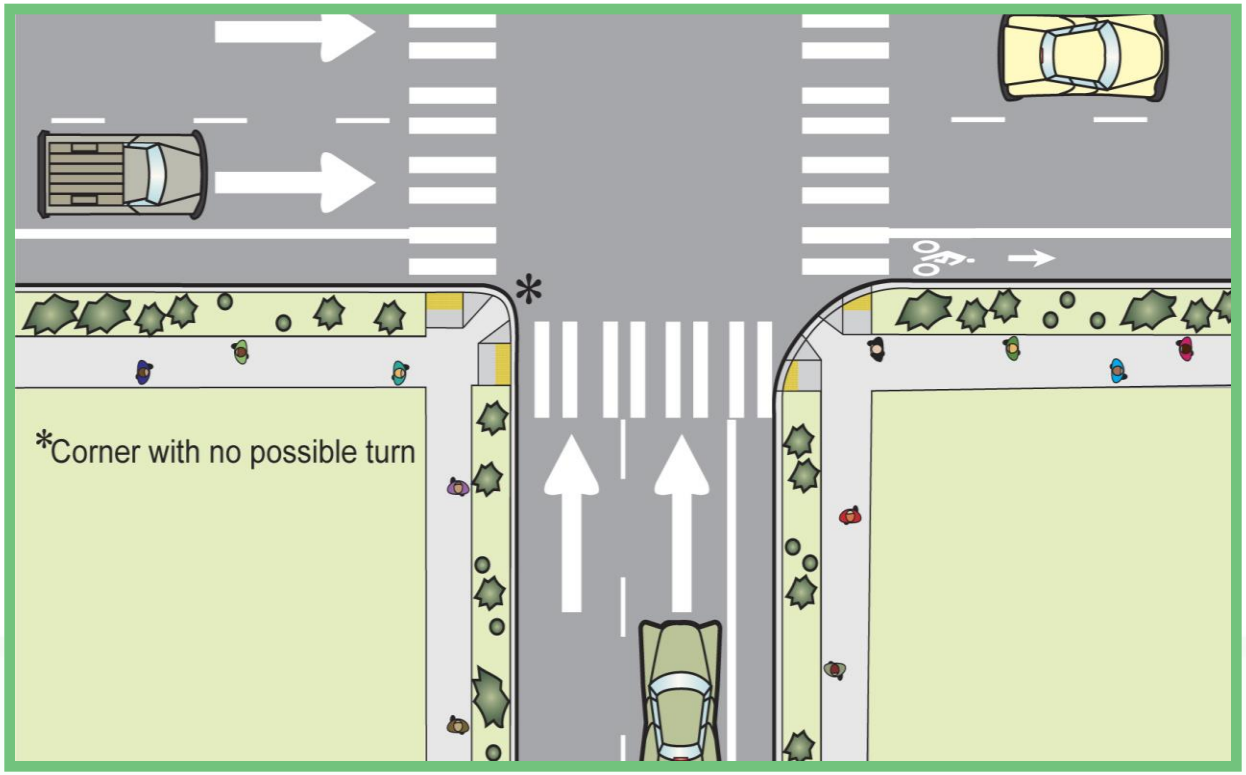
Minimize curb radius

1. **Calculate effective radius: Larger than built radius if travel lanes offset from curb with parking and/or bike lane**



Minimize curb radius

2. **At one-way streets, corner with no turns can have tight radius**



Minimize curb radius

3. **Don't choose larger design vehicle than necessary**

   (Bus makes turn several times an hour)

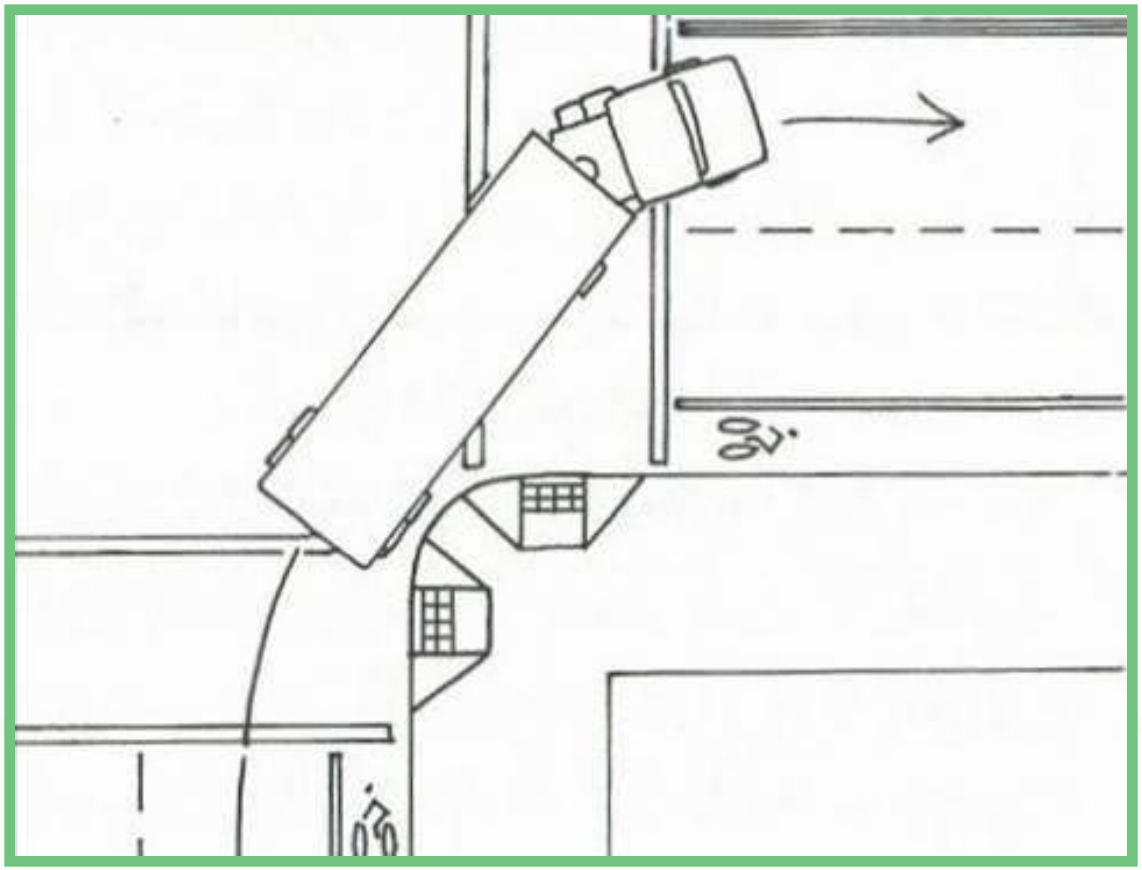
Minimize curb radius

4. **Don't choose larger design vehicle than necessary**

   (Moving van, once or twice a year; peds cross every day)

Minimize curb radius

5. **Where appropriate, let trucks use 2nd lane**

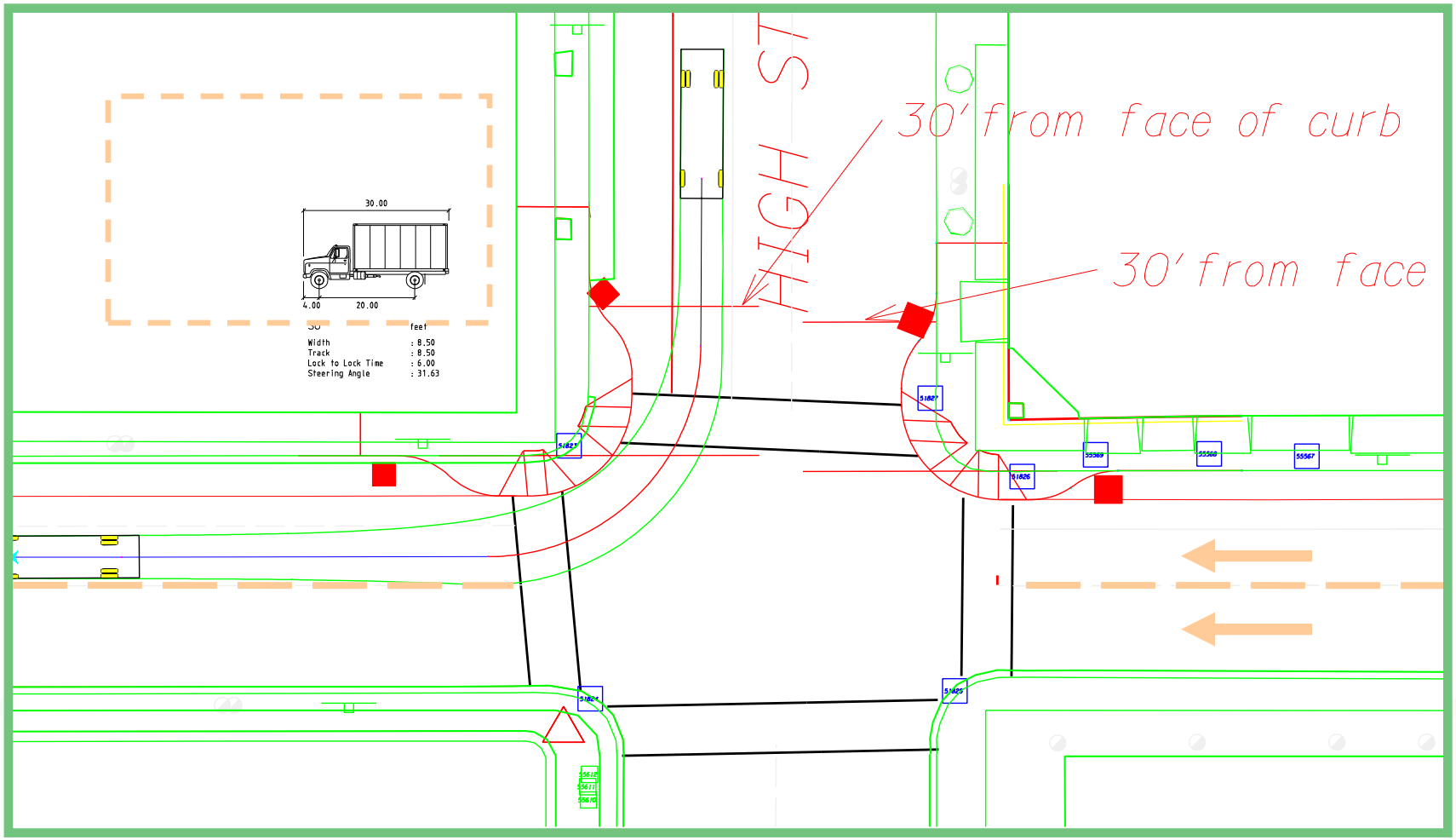


Minimize curb radius

6. **Trucks can make very tight turns at slow speeds**

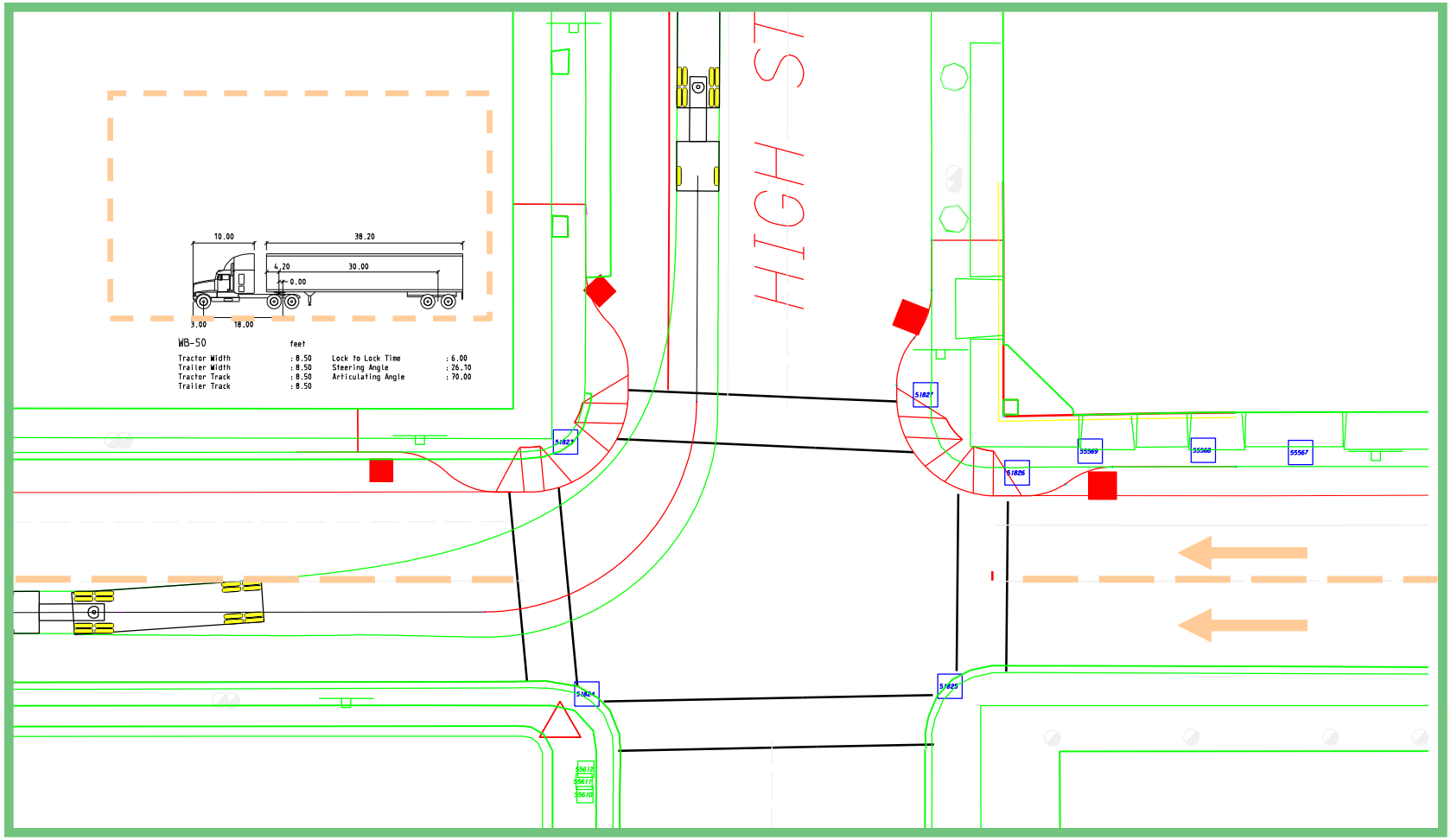
Minimize curb radius

7. Turn common Single Unit truck (SU-30) into near lane



Minimize curb radius

7. Turn less common Semi (WB-50) into 2nd lane



CRF for curb radii: not yet known

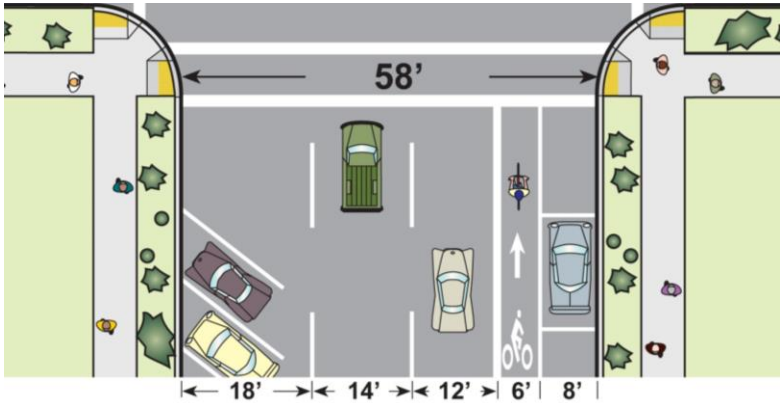
Although an exact number has not been determined, a study conducted by Zegeer et al. in Florida showed a correlation between large radii and higher pedestrian crash rates with right turning vehicles

Discussion:

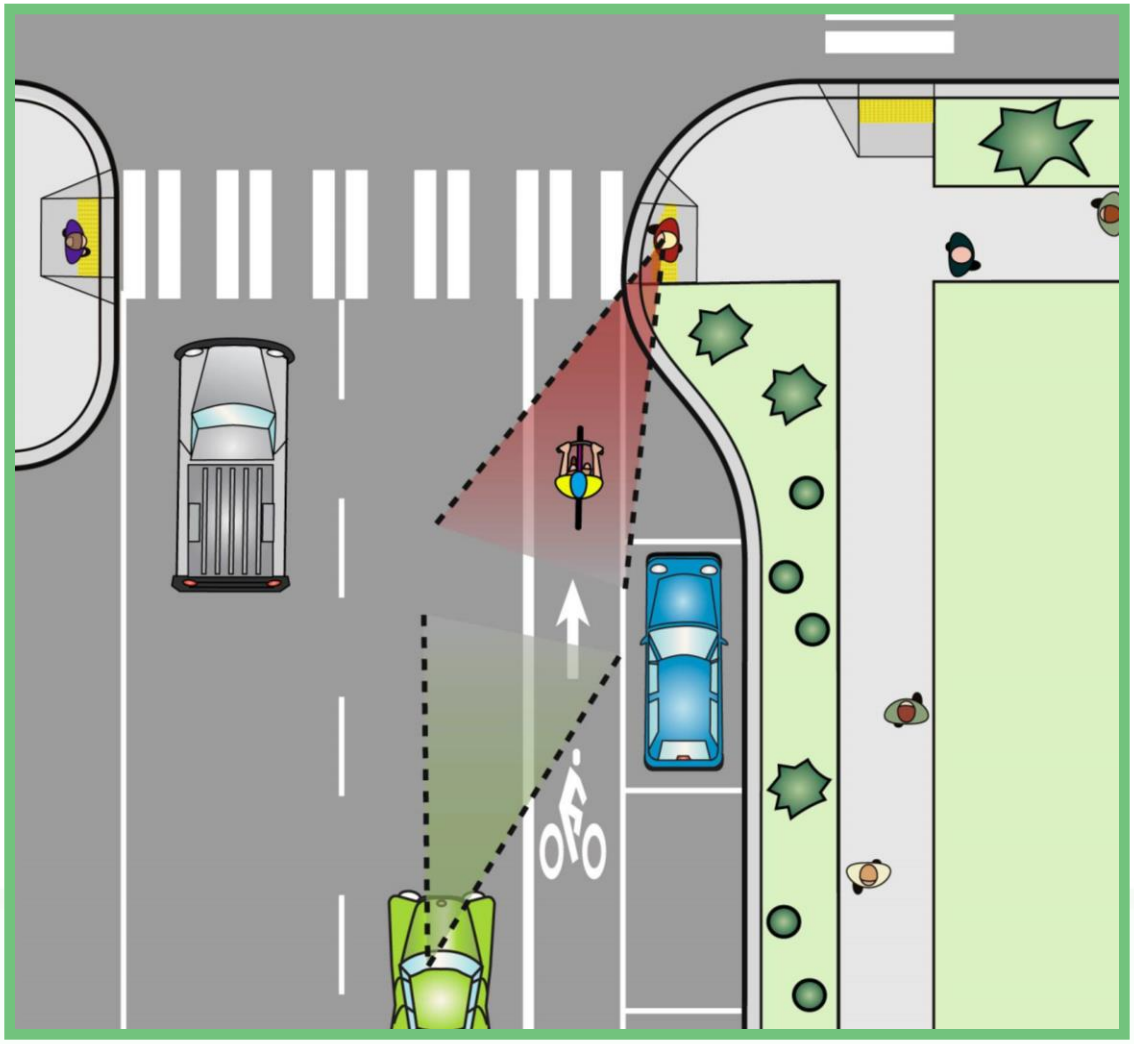
- What are your policies & practices regarding corner radii?

Curb extensions

- Most focus is on reduced crossing distance
- Other advantages:
  - Better visibility between peds and motorists
  - Traffic calming
  - Room for street furniture
- Curb extensions should be the width of the parking lane and not encroach on bike lanes or travel lanes



Better Visibility



Pedestrians wait where they can see, in front of parked cars

Curb ext. places pedestrian where he can see and be seen

Before: high speed right-turns

After: slow speed right-turns

Curb extension and new corner radius must be designed together – see earlier radius discussion

Curb ext. increases likelihood drivers will yield to peds

Curb extensions allow room for street furniture
But use care not to block sight lines

Curb extensions enable signs to be moved in

Curb extensions enable signs to be moved in

Curb extensions enable signs to be moved in

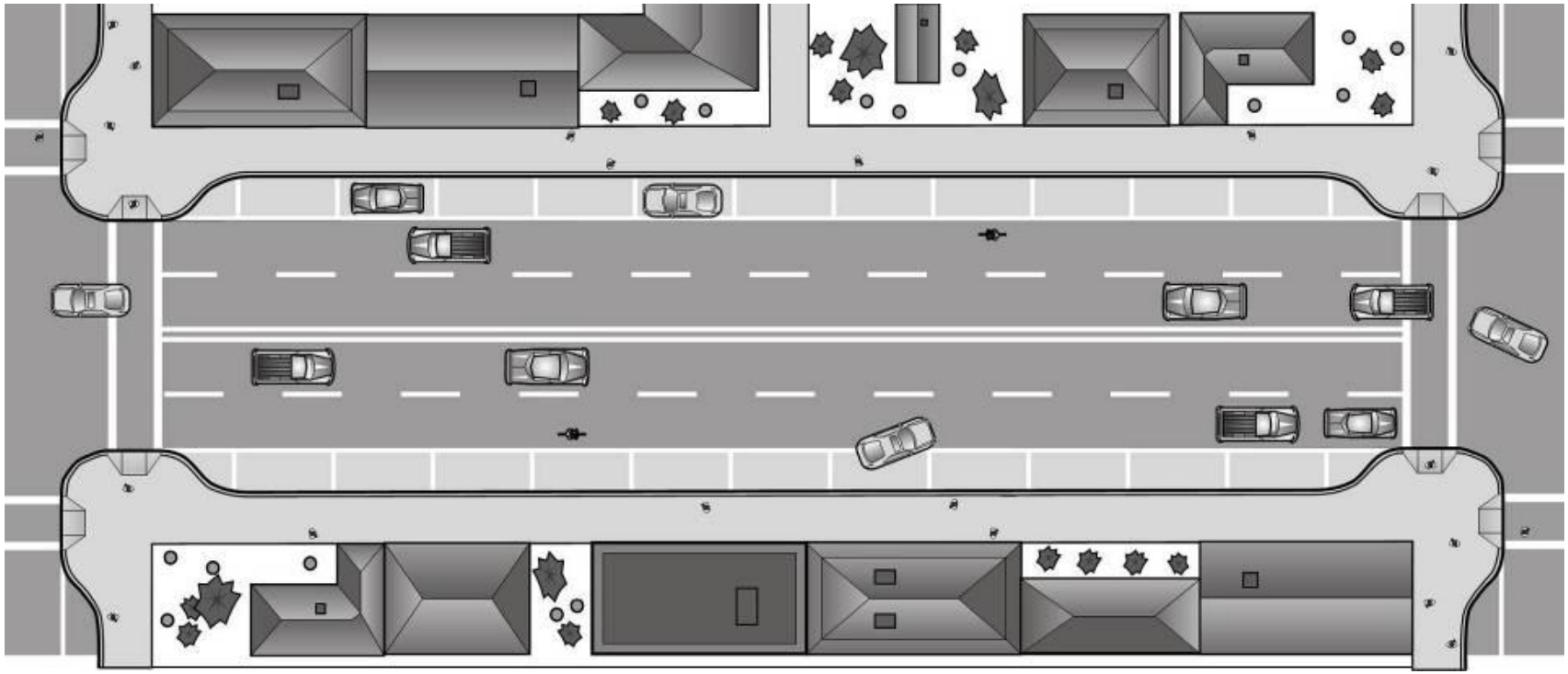
Drainage solutions 1. Additional inlet

Drainage solutions 2. Slotted drain

Drainage solutions 3. Leave original curb + islands

Drainage solutions 4. Same as before + plate

Curb Extension Integrated with the Sidewalk



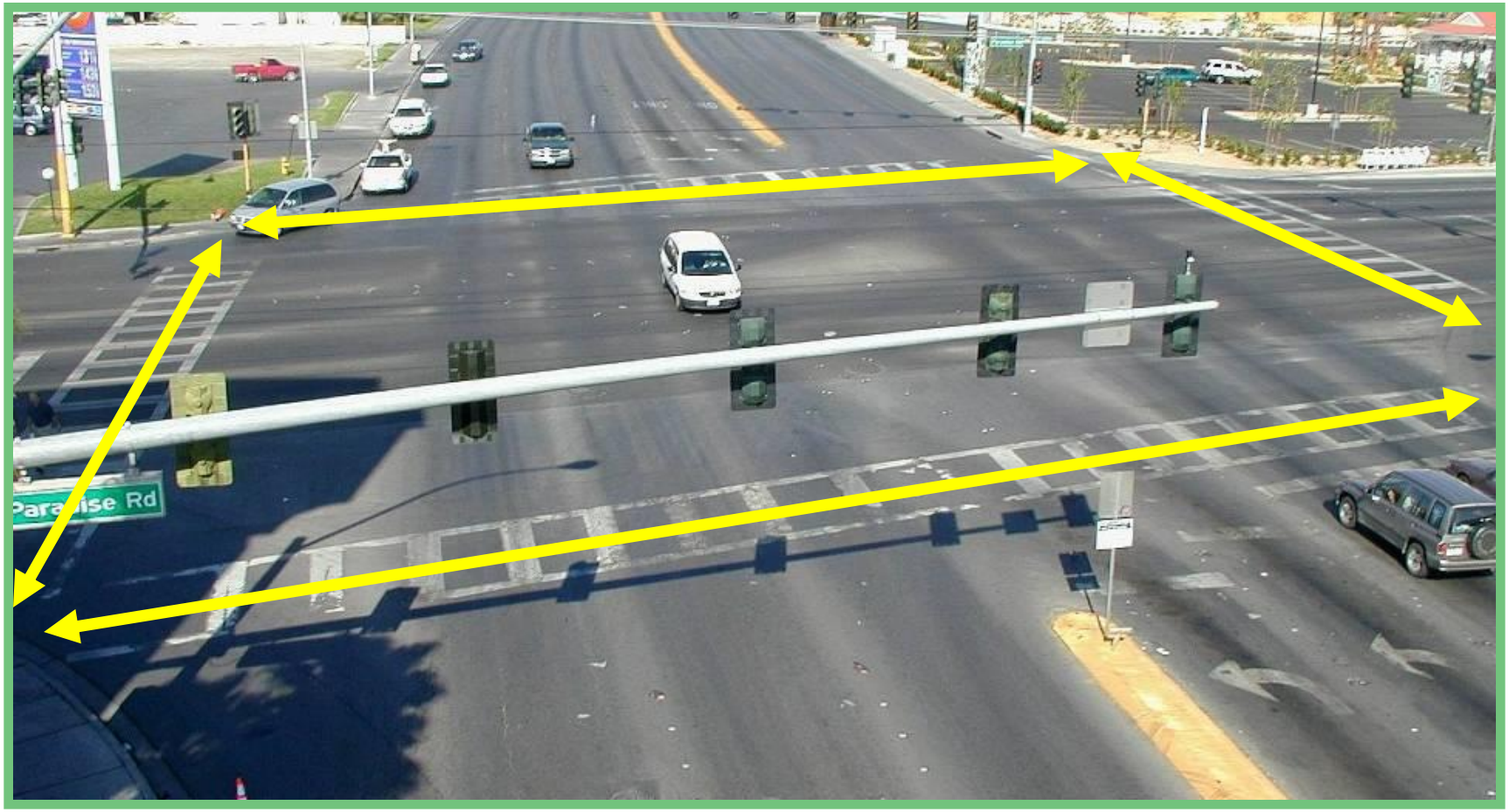
"Parking pockets" in furniture zone have similar surface materials as the sidewalk

Before: road looks and feels wide

After: curb extension integral to sidewalk
Street looks narrow even with no parked cars

Reminder – crosswalks are provided:

1. To tell pedestrians where to cross
2. To tell drivers where to expect pedestrians



Crosswalks should normally be placed on all legs of an intersection

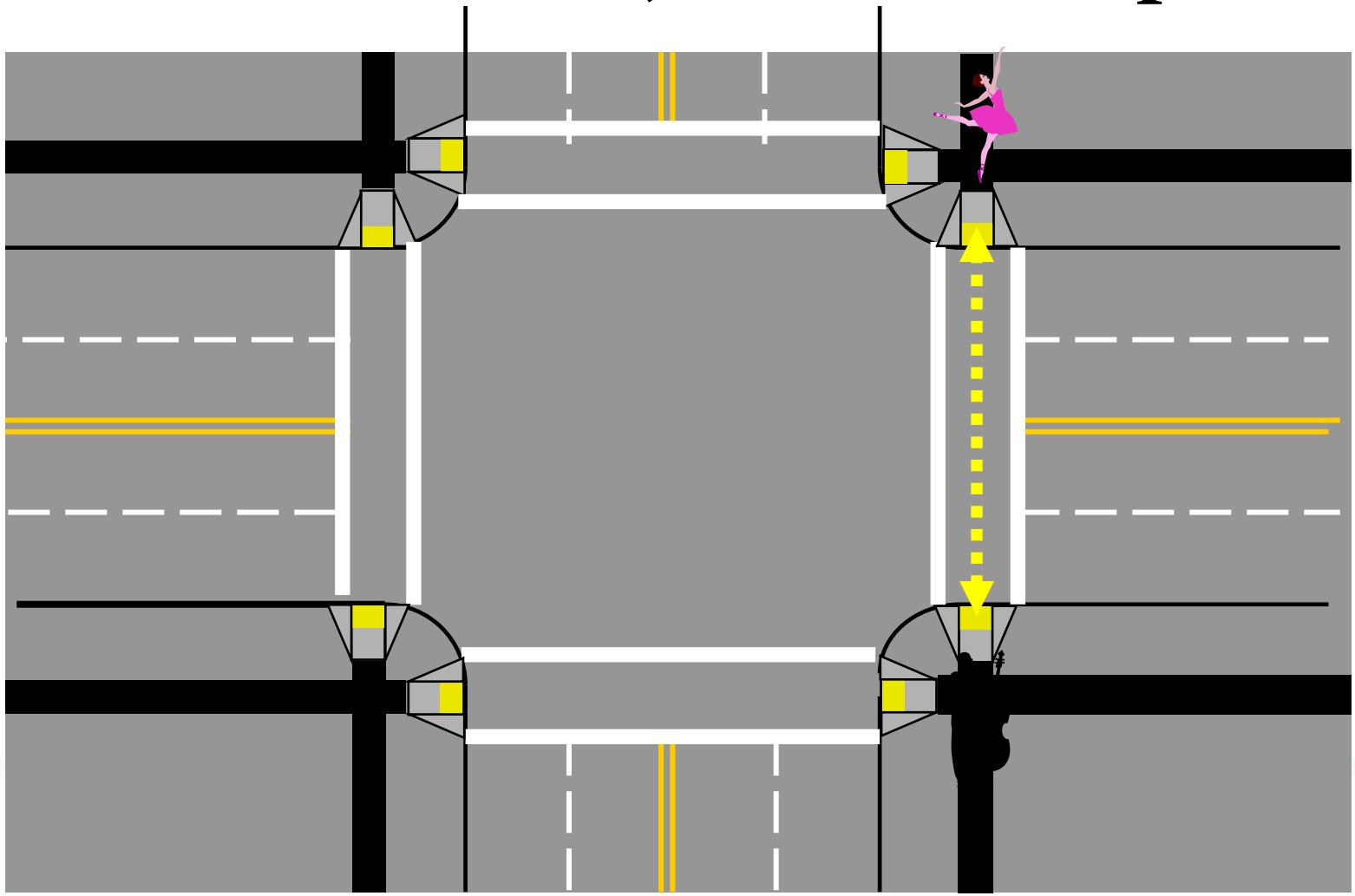
Large intersection is capacity driven, pedestrian unfriendly…

Will she wait?
Is crossing 15 lanes safer than crossing 5 lanes?
Here's what pedestrians are expected to do

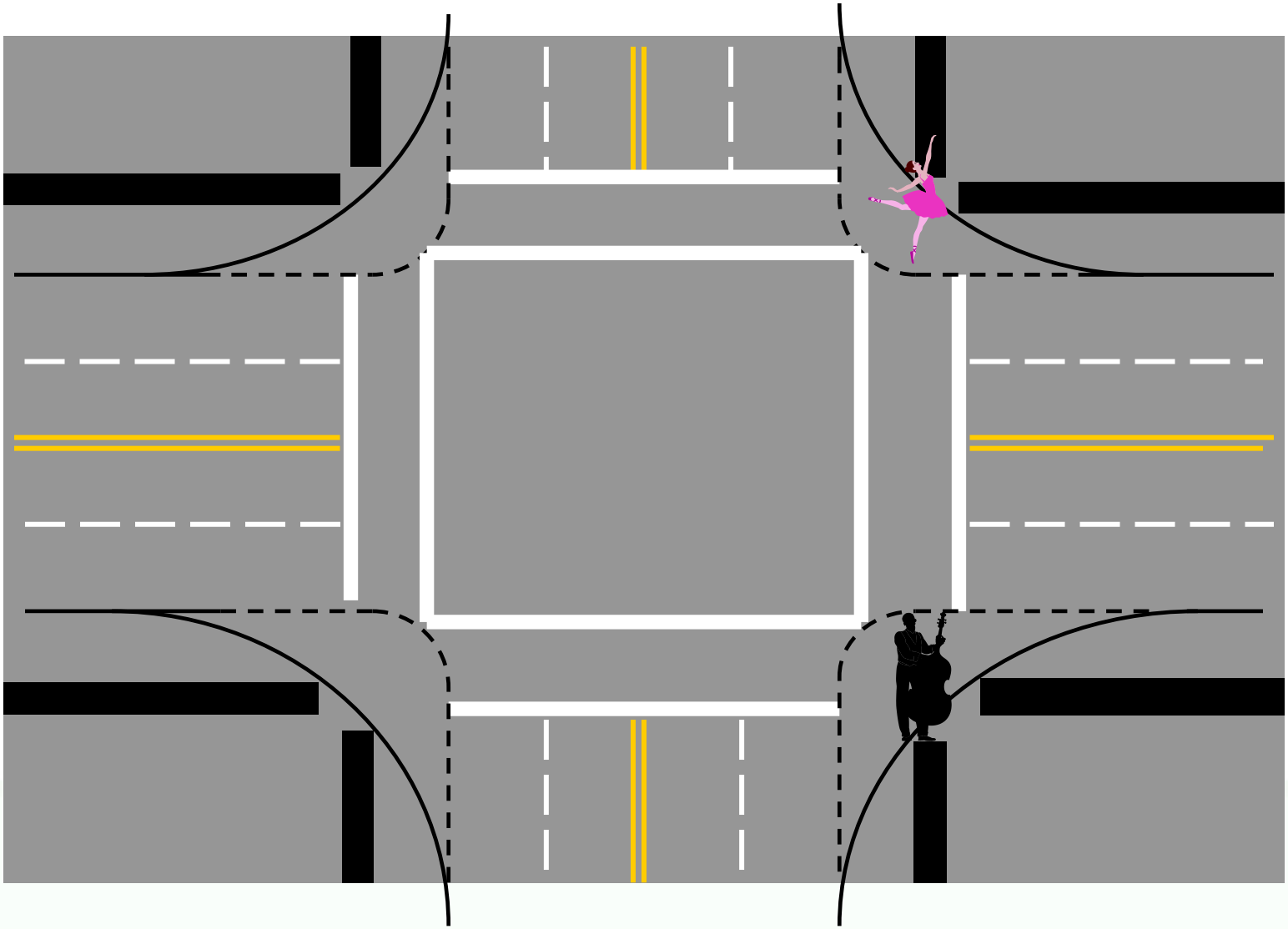
Crosswalk placement requires balancing several goals that sometimes compete:

- ⇨ Shortest crosswalk length
- ⇨ Minimal crosswalk setback to:
  - Reduce out-of-direction travel
  - Provide good sight lines between peds and motorists
- ⇨ Proper ramp placement:
- ⇨ Ramps entirely contained in crosswalk
- ⇨ Two ramps preferred whenever possible

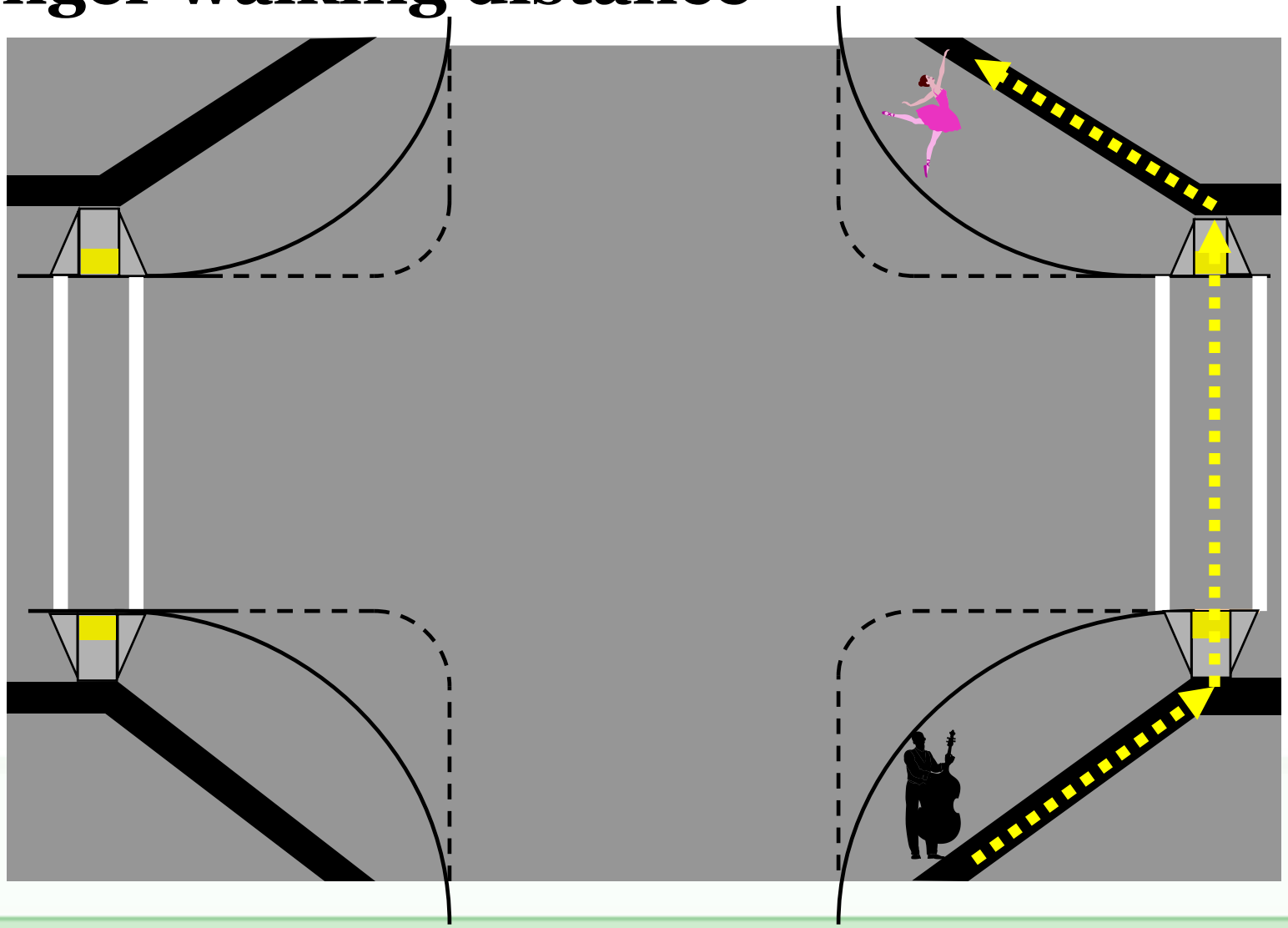
Small corner radii allow two ramps, shortest crosswalks, direct travel paths



Larger radii create large undefined areas



Crosswalks at shortest crossing = longer walking distance



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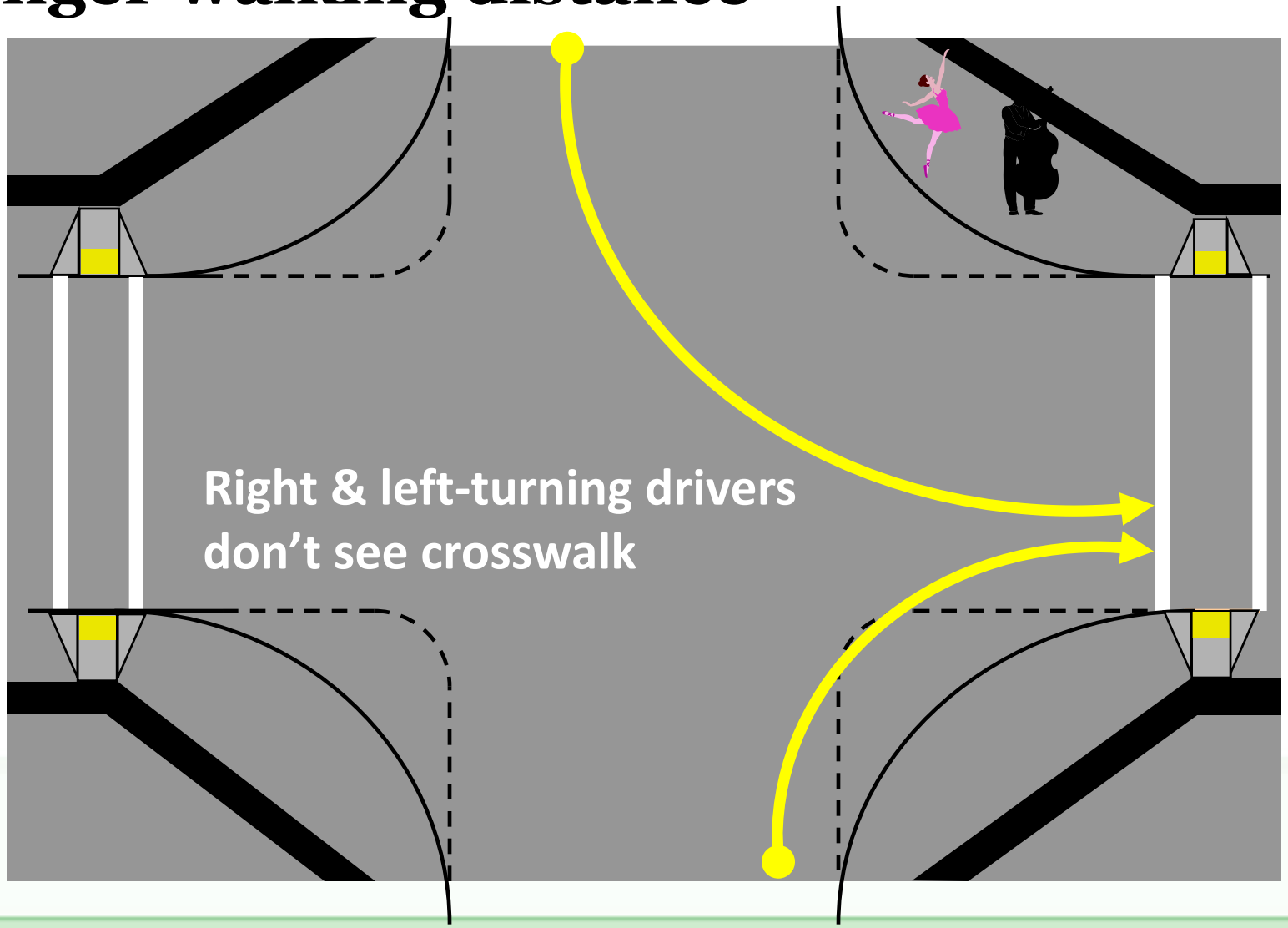
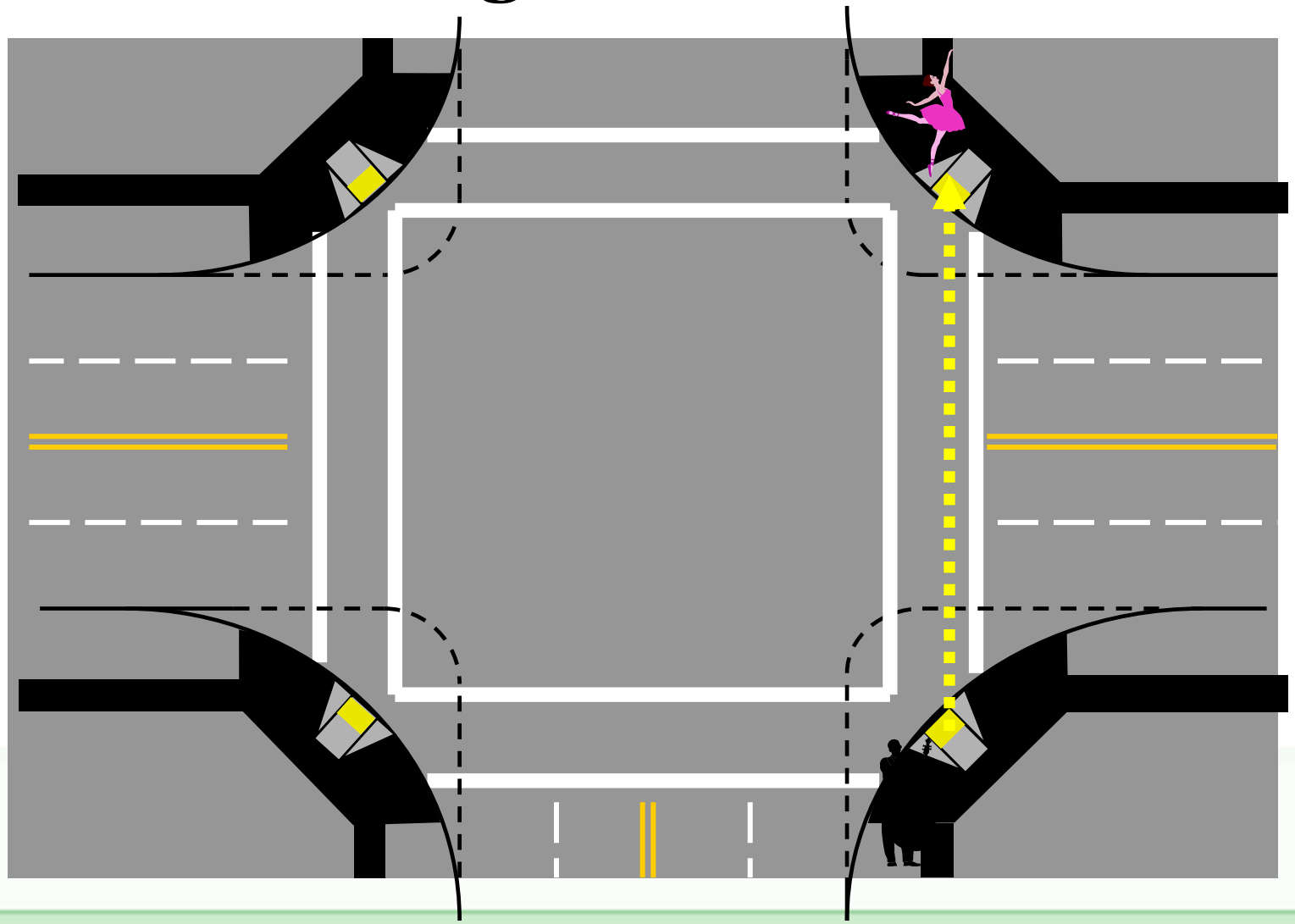
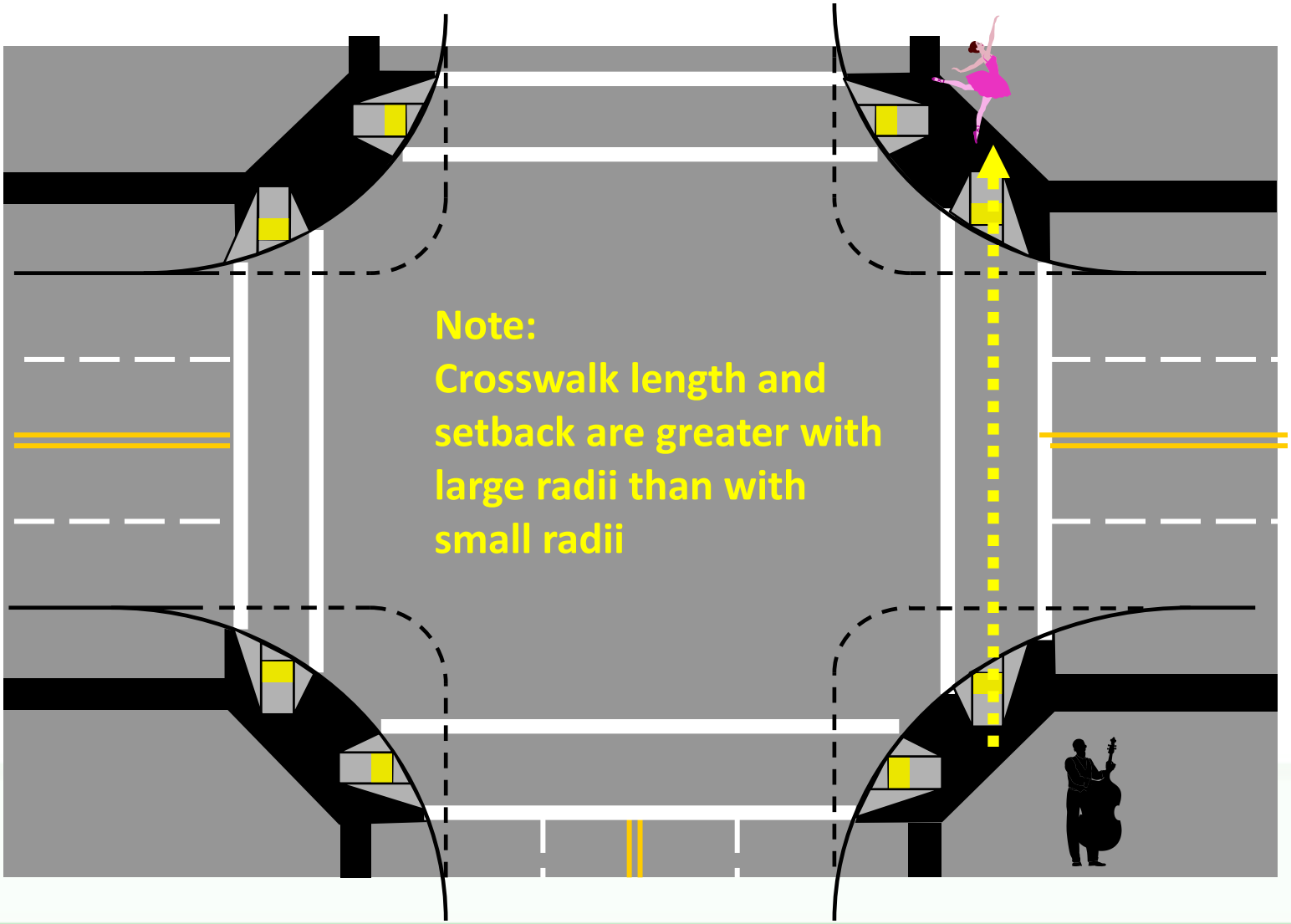


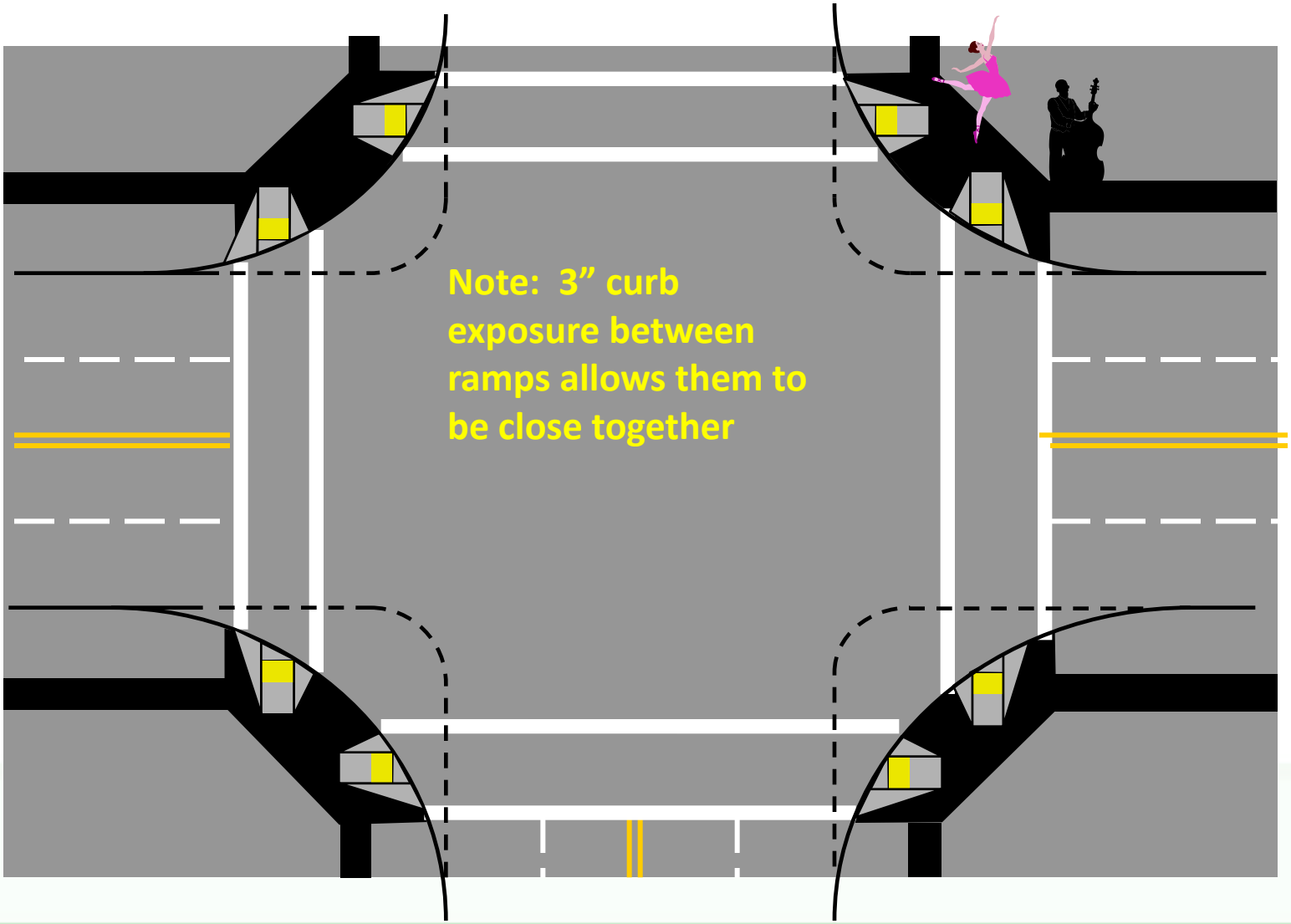
Single ramp reduces crosswalk setback but lengthens crosswalk



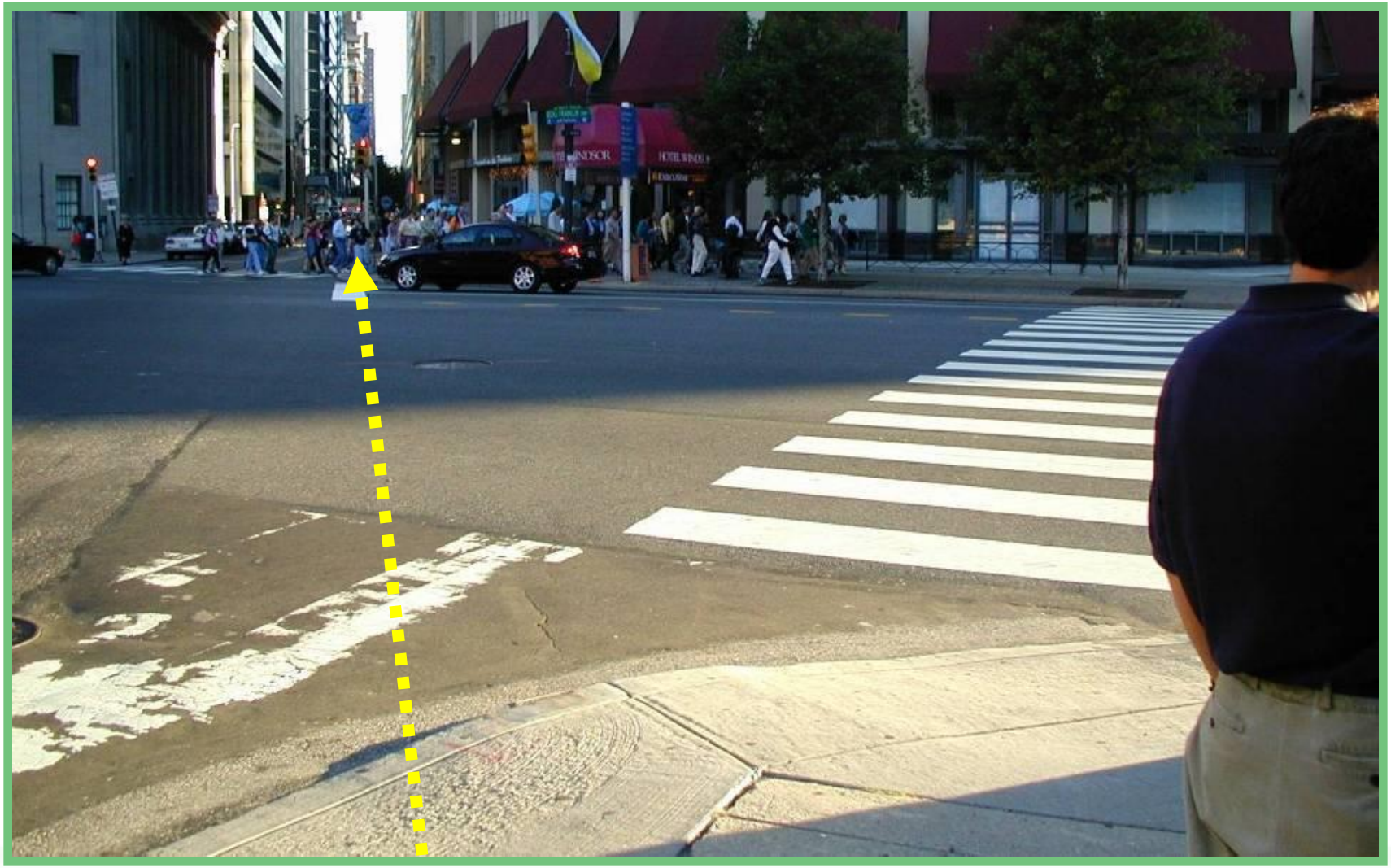
Balancing the goals works best



Balancing the goals works best



Crosswalk placement: Observe pedestrians



Crosswalk placement: Think like a pedestrian

"When in doubt, paint it out!"

Crosswalks can have odd shapes to take pedestrians where they want to go

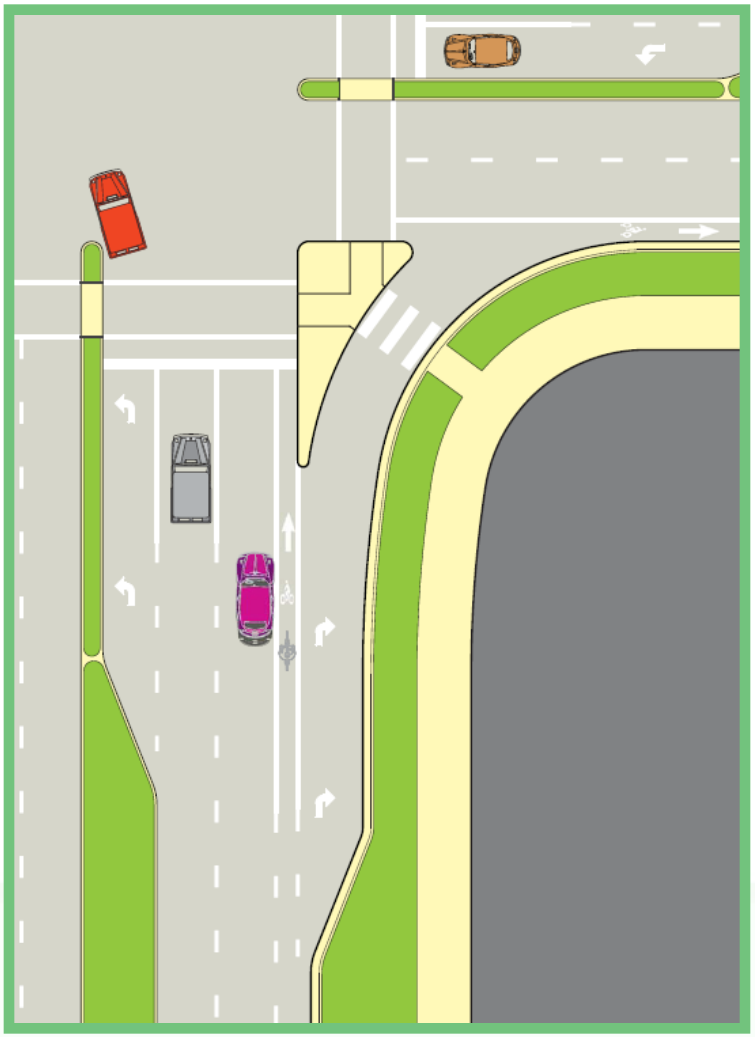
Discussion:

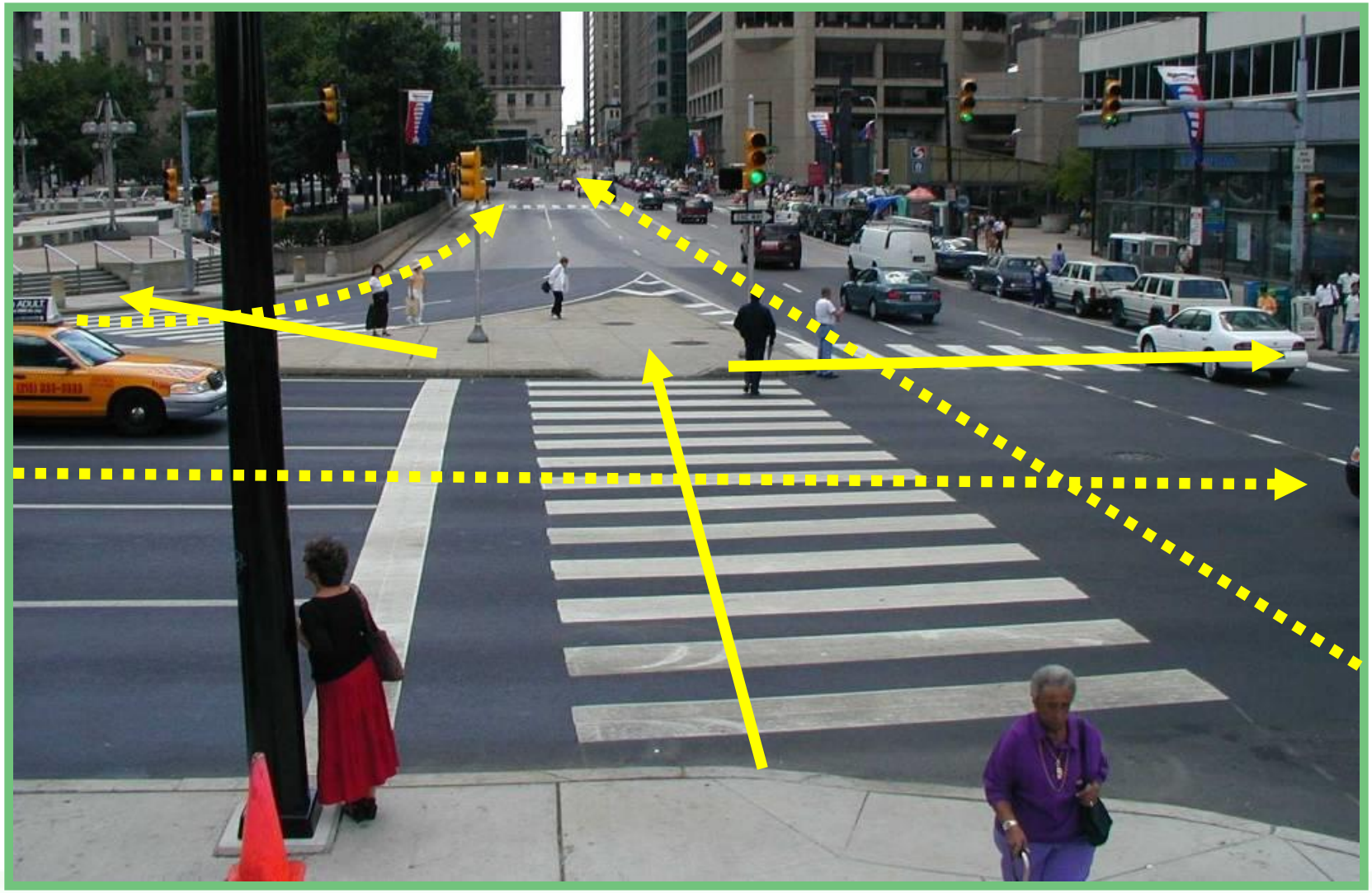
- What are your policies & practices regarding crosswalk placement?

Pedestrian Islands

Benefits:

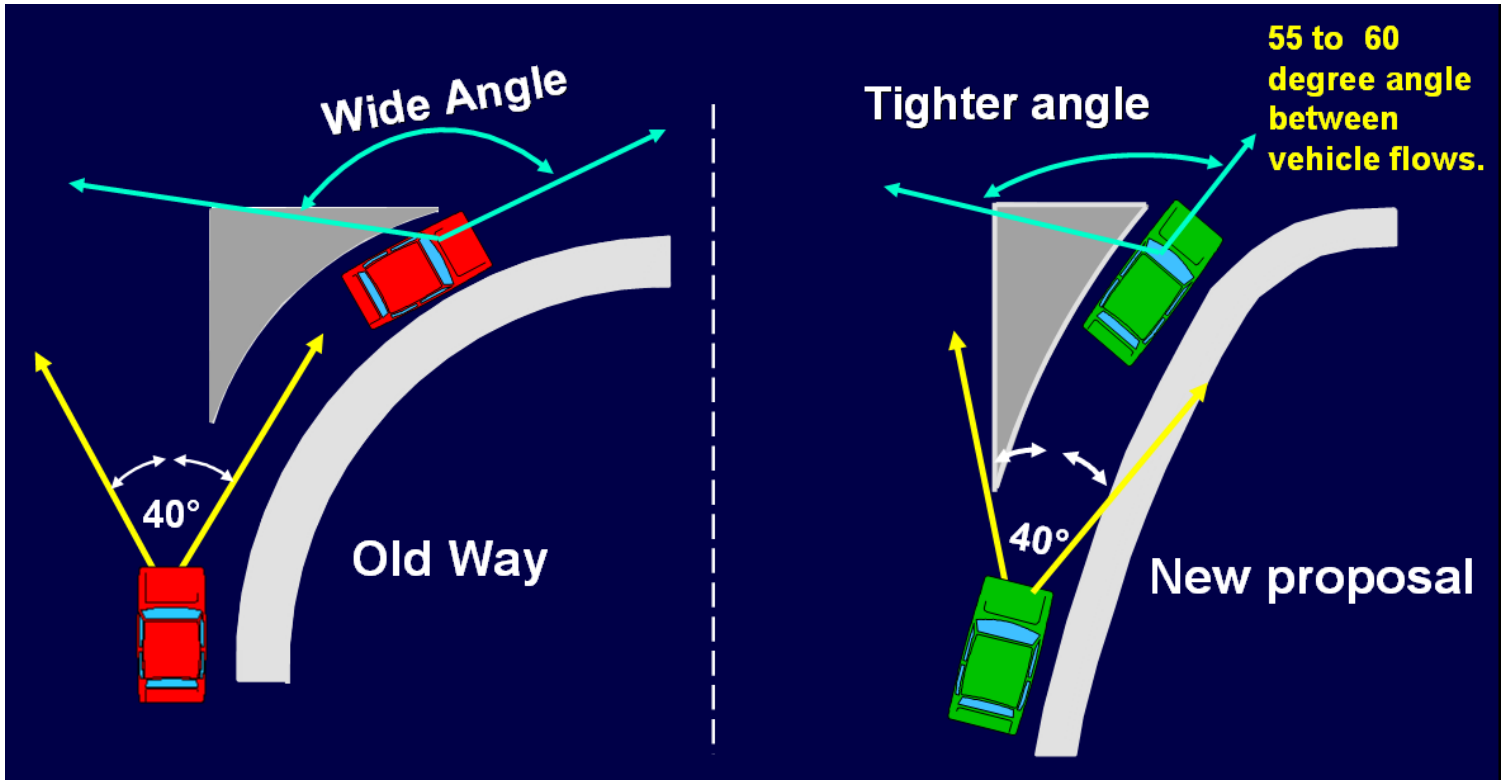
- ⇨ **Separate conflicts & decision points**
- ⇨ **Reduce crossing distance**
- ⇨ **Improve signal timing**
- ⇨ **Reduce crashes**





Imagine the signal timing without island

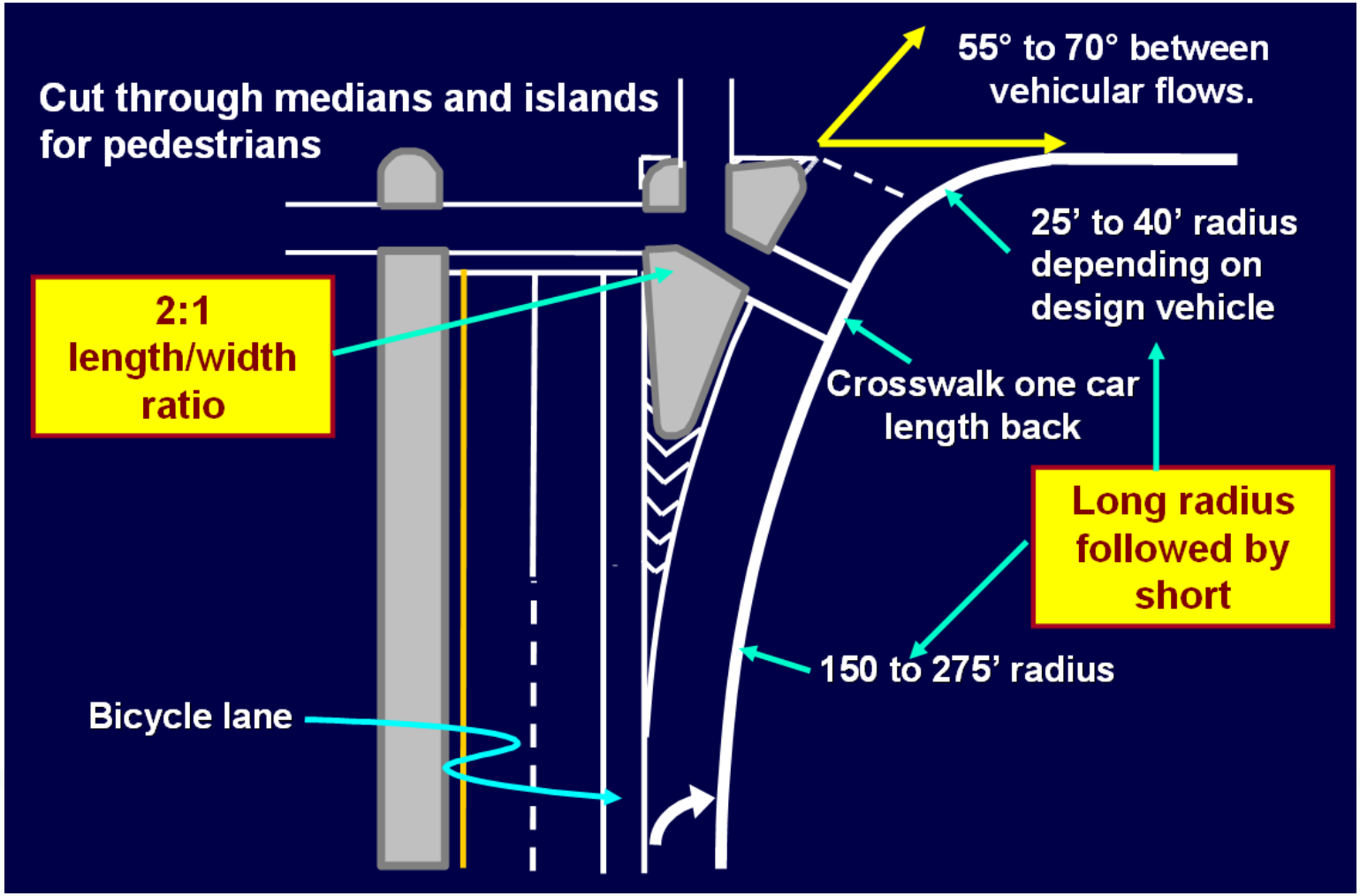
Right-Turn Slip Lane: Design for Pedestrians



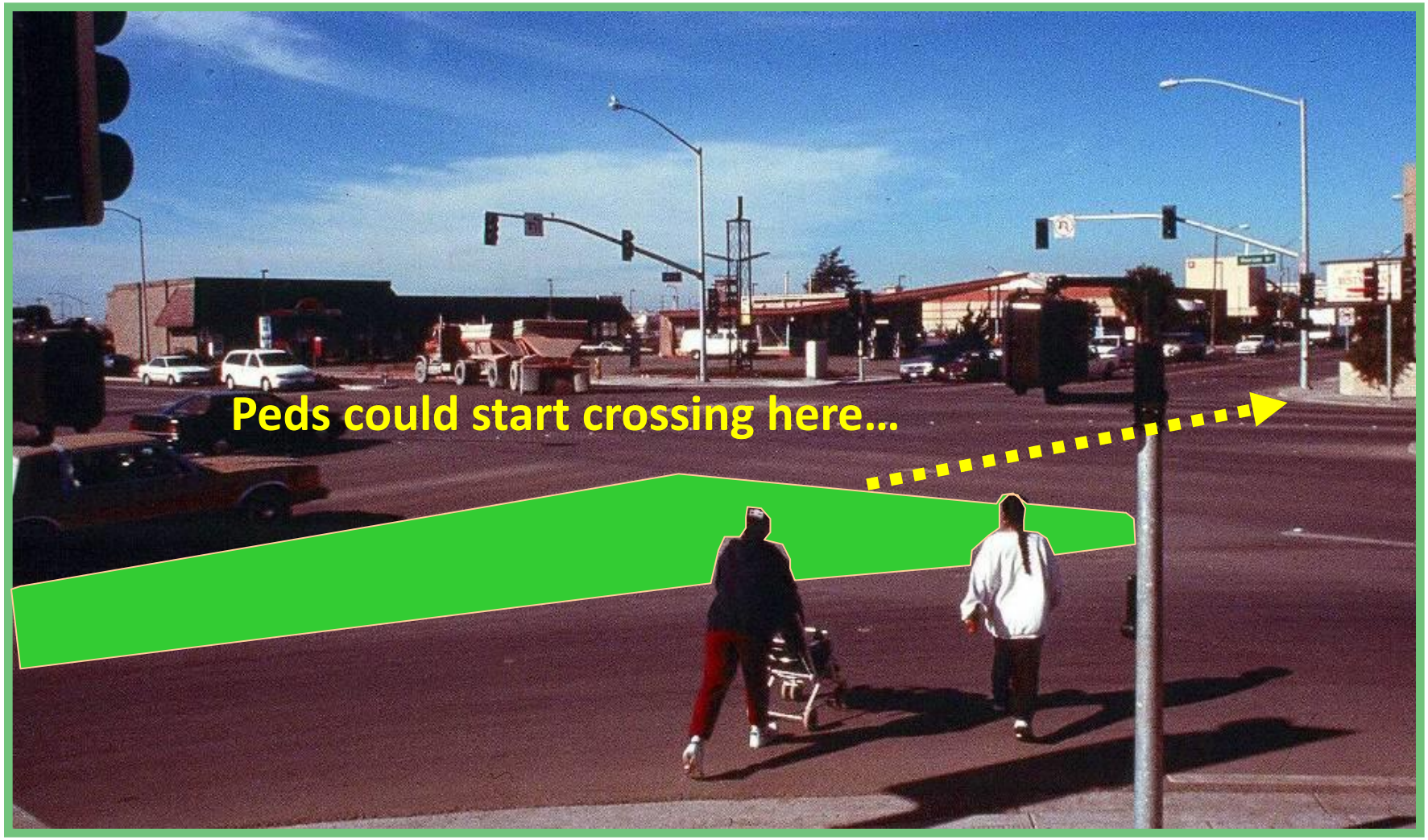
High speed, head turner = low visibility of pedestrians

Slow speed, good angle = good visibility of pedestrians

Right-Turn Slip Lane - Details



Drivers naturally trace the right island shape

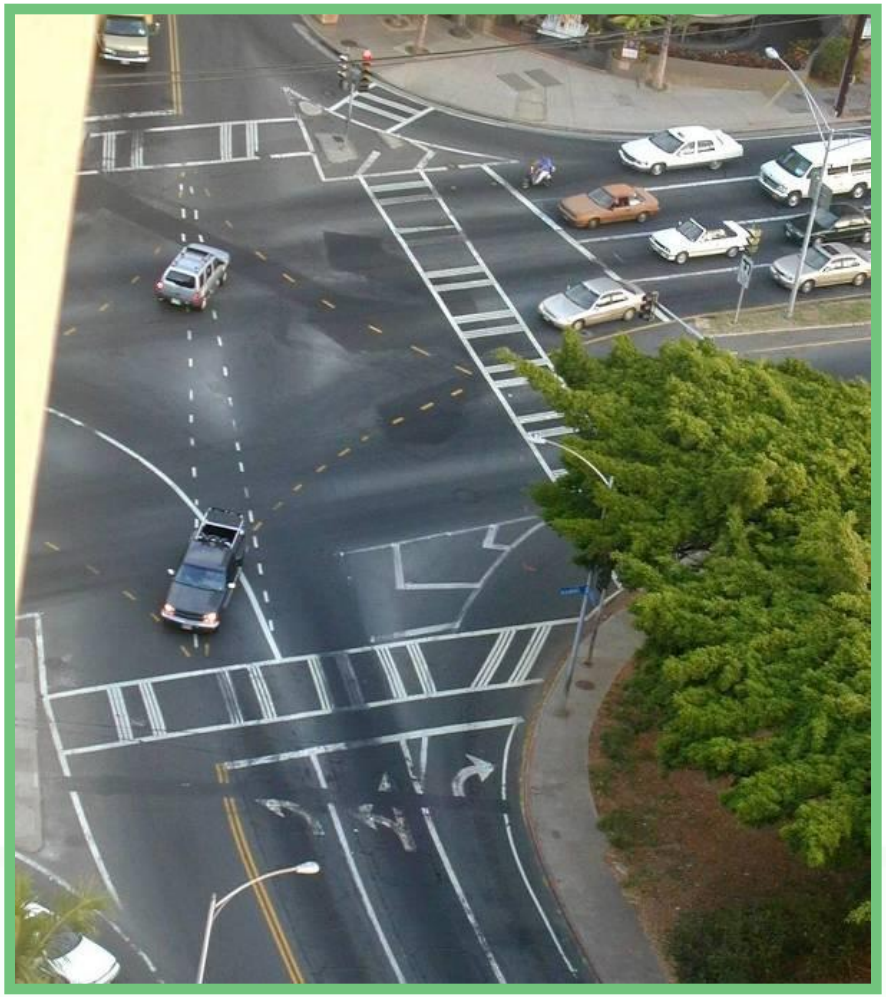

Peds could start crossing here…

… instead of here

Should we mark this crosswalk?

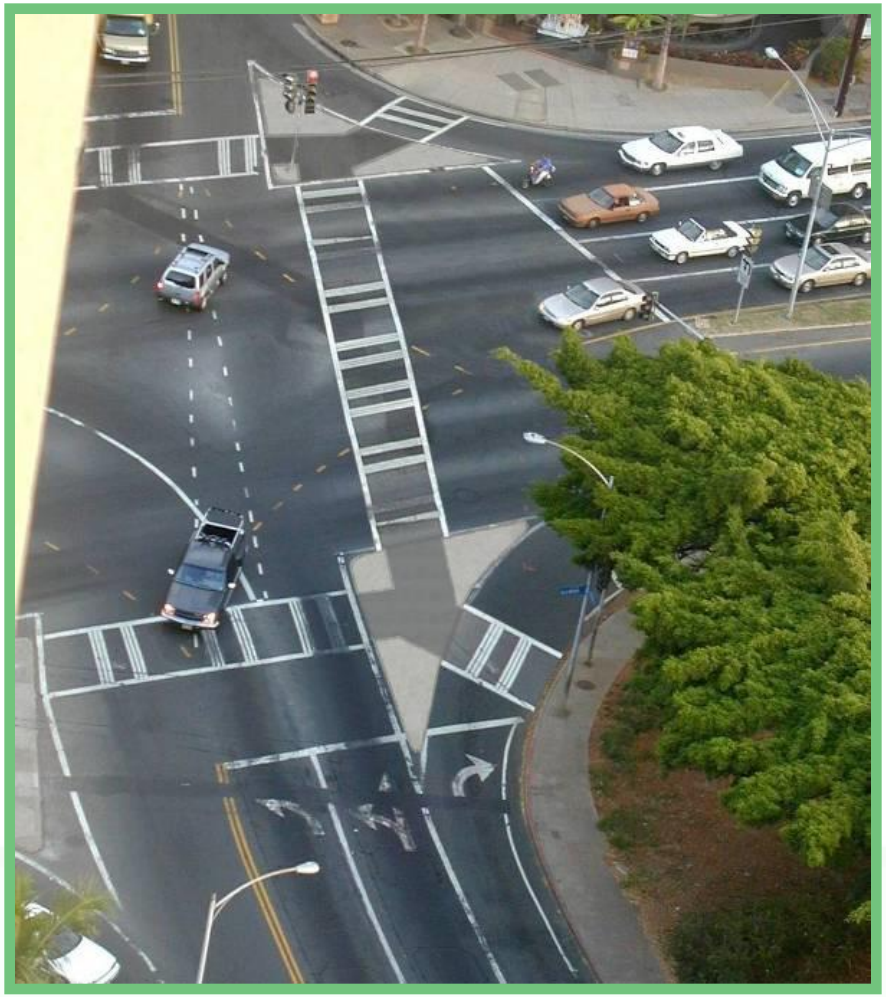
Yes: It's a yield-controlled approach,
and it may not be clear where peds cross.

Raised islands can improve a large multi-lane intersection



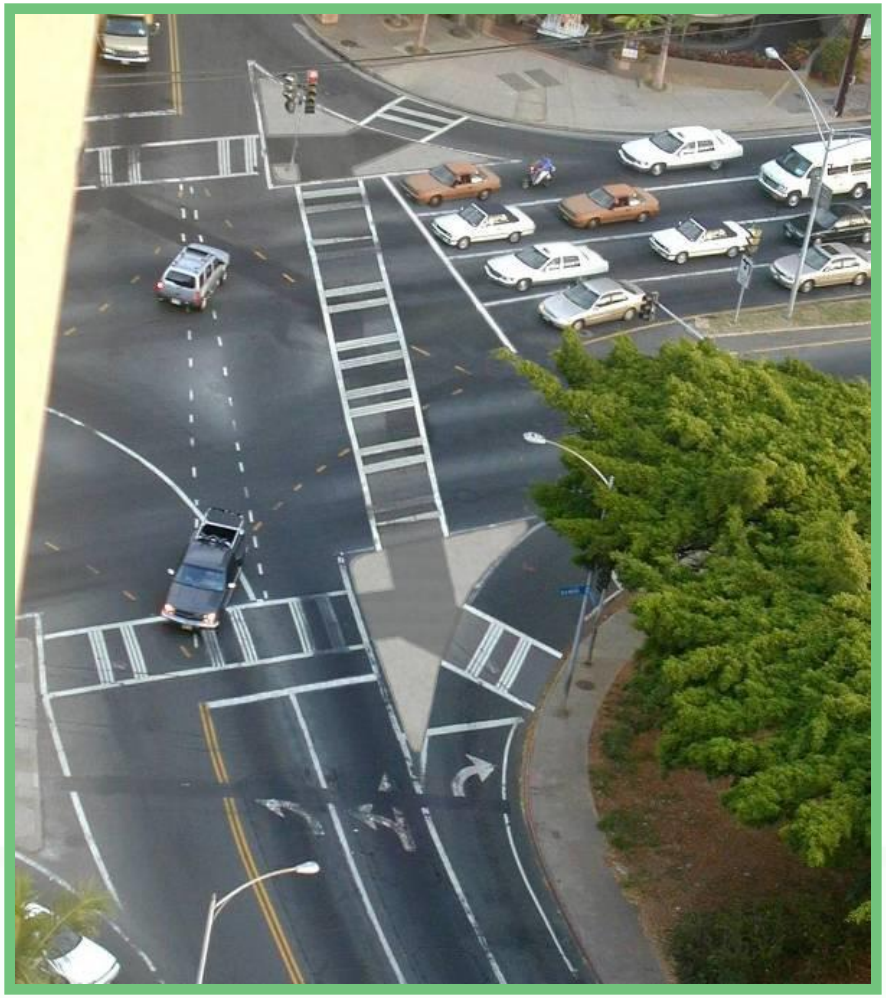
Raised islands can improve a large multi-lane intersection

1. Build raised islands between thru & RT lanes to separate ped/driver conflicts. Consolidate two crosswalks into one.



Raised islands can improve a large multi-lane intersection

1. Build raised islands between thru & RT lanes to separate ped/driver conflicts. Consolidate two crosswalks into one.
2. Move stop bar forward to improve capacity and safety for motorists



Island Design Details

- Cut-through preferred over ramps
- Truncated domes at cut-throughs
- 8’ or more preferred width – 6’ minimum

With ramps, provide at least 48” level area

NOT Okay

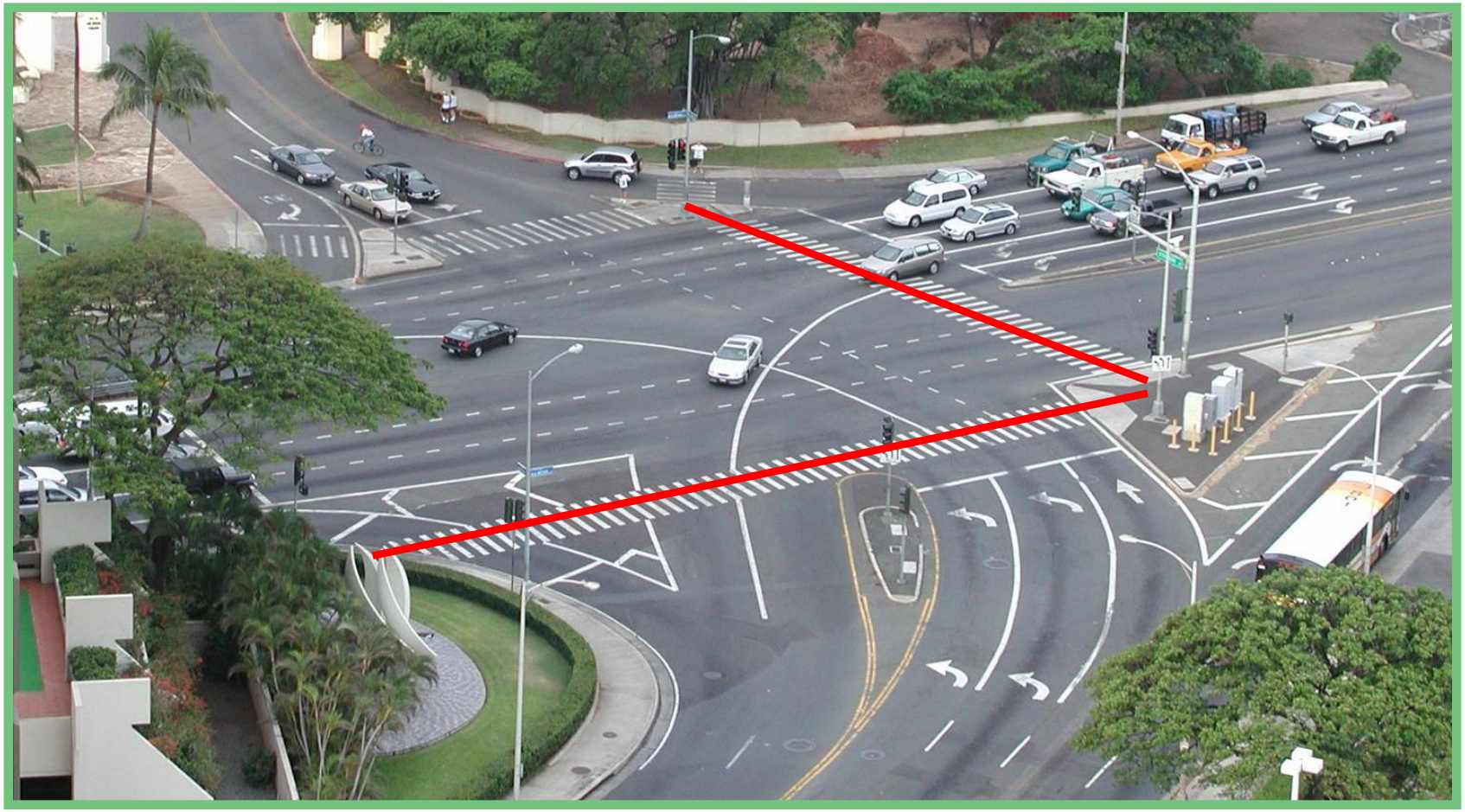
Not acceptable

Acceptable, not great

Best:

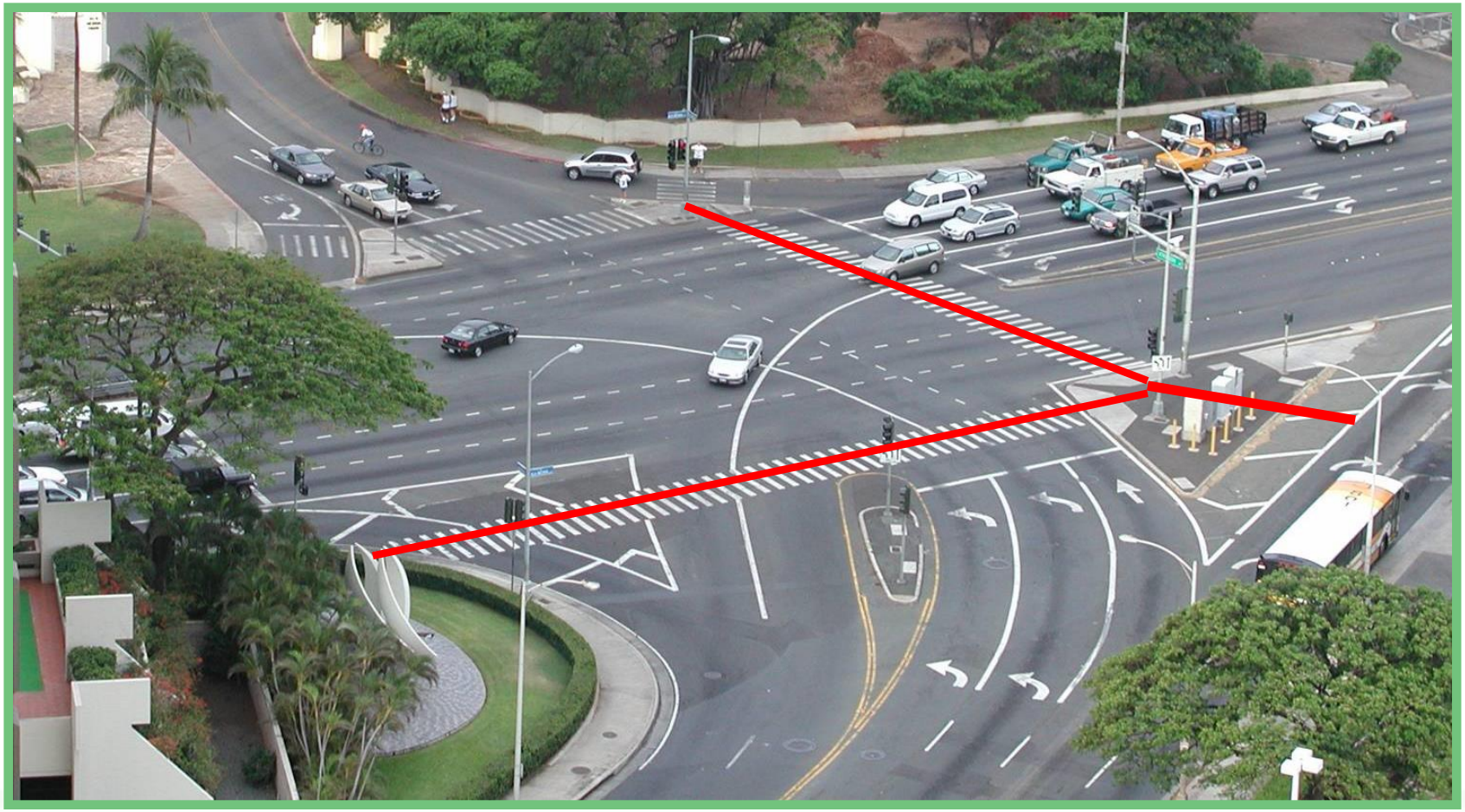
- Bullet nose protects pedestrians from high-speed left-turning cars

How to place a crosswalk at porkchop island



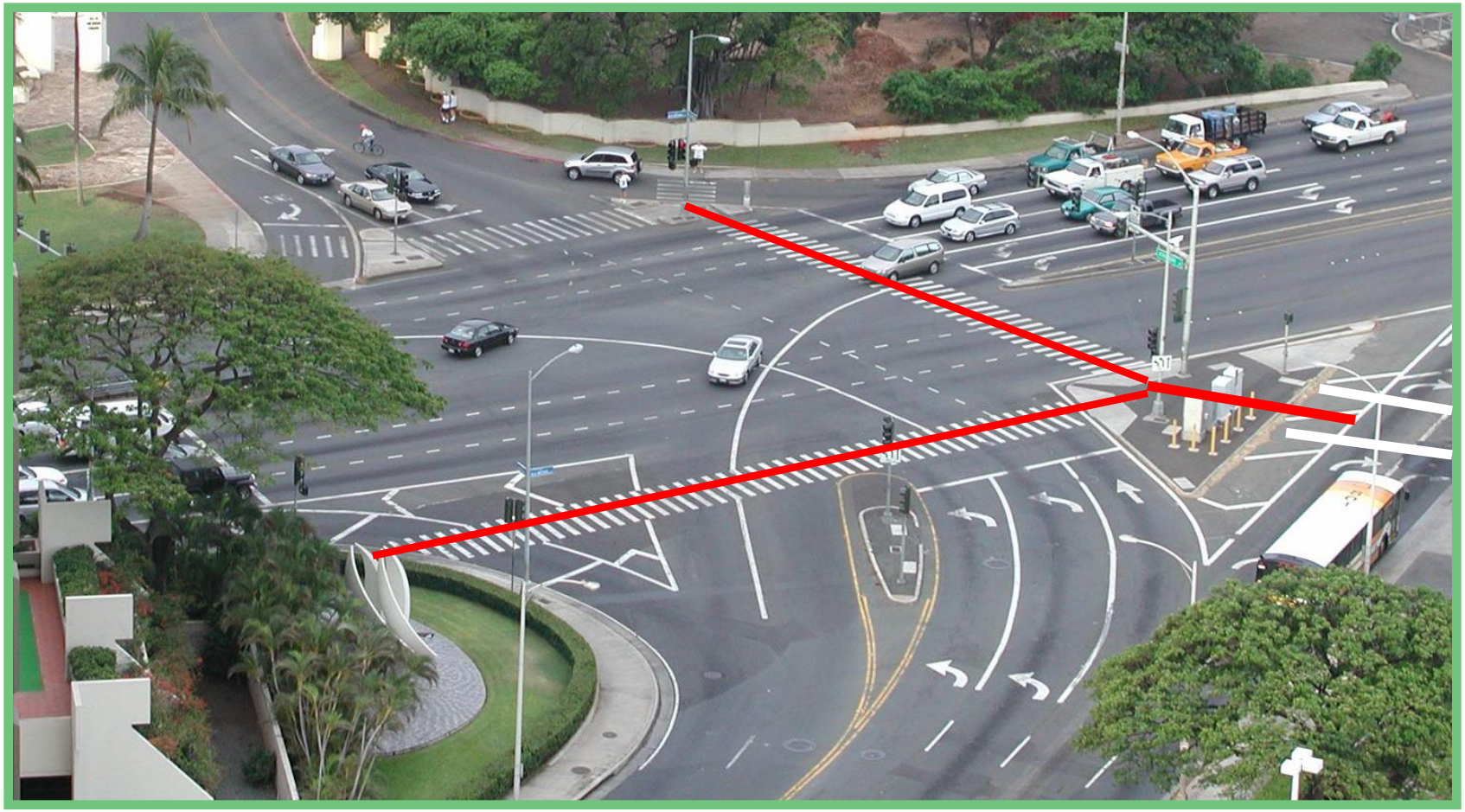
1. Place crosswalks to island

How to place a crosswalk at porkchop island



2. Trace 3rd line where they meet

How to place a crosswalk at porkchop island



3. **Place 3rd crosswalk there**

Discussion:

- What are your policies & practices regarding providing pedestrian islands?

Intersection Geometry: Recap of Design Measures

- Should pedestrians have access to all corners?
  - Yes
- Why?
  - Otherwise peds will dash across anyway
- Intersection geometry should be?
  - Tight (small radii); right angles
- How do you break up complex intersections?
  - With islands
- Where should you place crosswalks?
  - Where pedestrians want to cross and where drivers can see them

Intersection Geometry Learning Outcomes

You should now be able to:

1. **Explain why tight/right angle intersections are best**
2. **Describe why pedestrians need access to all corners**
3. **Assess good crosswalk placement: where peds want to cross & where drivers can see them**
4. **Explain how islands break up complex intersections**

Questions?