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LADOT

IMPLEMENTATION GUIDE **Planning for Stress Free Connections**



Los Angeles Department of Transportation



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Executive Summary



Source: Flickr - Payton Chung (2007)



Source: Flickr - Greg Raisman



Source: Flickr - Greg Raisman

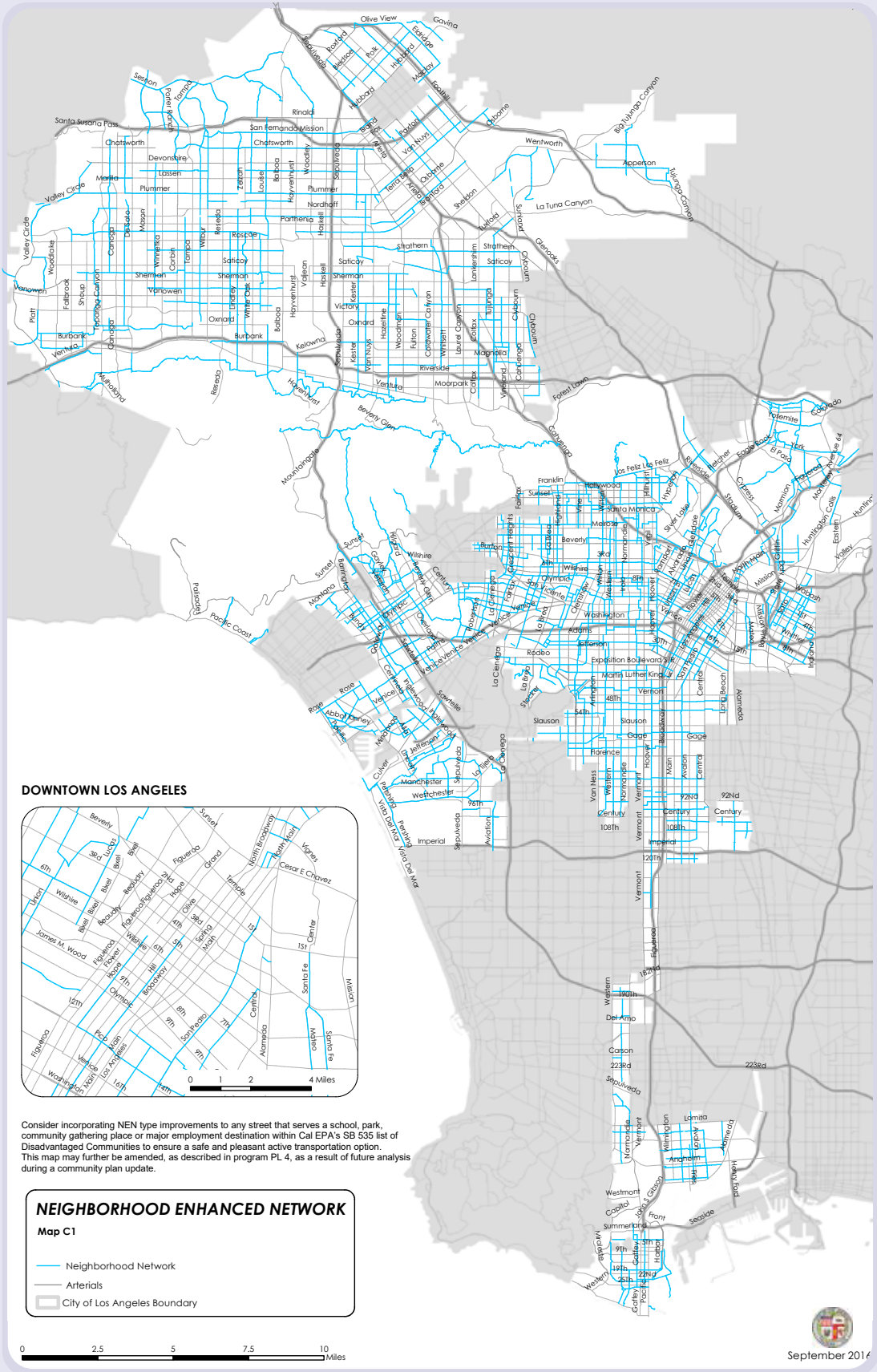


Source: NACTO

The Stress Free Connections Implementation Guide supports and informs the public and decision-making related to the planning and implementation of the City of Los Angeles Neighborhood Enhanced Network (NEN) identified in the [City's Mobility Plan 2035](#). The NEN is defined in Policy 2.4 of the Mobility Plan as a selection of streets that provide comfortable and safe routes for localized travel of slower-moving modes such as walking, bicycling, or other slow speed motorized means of travel on low speed and low volume corridors. The NEN complements the Pedestrian Enhanced Districts, the Bicycle Enhanced Network, and the Bicycle Lane Network by identifying non-arterial streets important for moving people who walk and bike.

Building out the Mobility Plan's Bicycle Enhanced Network has relied on conventional striped (Class II) or protected (Class IV) bike lanes, which are measured based on the linear feet of specific striping components. This is not the case for NEN corridors. NEN corridors can contain a variety of context-sensitive traffic calming devices, traffic diversion, and accessibility accommodations for people that bike, walk, or use wheeled devices such as wheelchairs and strollers. These elements work together to create a comfortable (i.e. less stressful) and connected network that is inviting to a wide range of people, including children and older adults. In some cases, a NEN corridor will not have specific traffic calming elements or enhanced access on some blocks because infrastructure is not needed for every block or intersection to achieve the desired outcome of having a safe and pleasant environment for bicycling and walking. Some NEN segments and corridors may already be generally comfortable and accessible. The physical limits of a designated corridor are not measured strictly based on the presence or absence of specific components. LADOT instead refers to the Level of Travel Stress (LTS) and connectivity metrics, as opposed to lane miles by facility type, for measuring progress of completing functional low-stress NEN corridors. These metrics more accurately reflect the infrastructural needs and how comfortable the streets are for getting around via active travel.

This guide draws on best practices and criteria identified by the National Association of City Transportation Officials (NACTO) to define a NEN corridor. This guide further supplements NACTO's guidance to address local conditions, unique challenges, and opportunities encountered in the Los Angeles context when building out the NEN.



Source: LA Mobility Plan 2035

1 Introduction



Source: LADOT Staff



Source: LADOT Staff

Introduction

The Department of Transportation (LADOT) is tasked with implementing certain goals, objectives, and programs of the City's Mobility Plan 2035, including the following objectives:

- Establish a culturally sensitive, multilingual and neighborhood accessible public outreach approach to complete the protected bicycle lanes and Neighborhood Enhanced Network segments of the Bicycle Enhanced Network by 2035.
- Achieve established performance levels on 100% of the streets within the Neighborhood Enhanced Network by 2035.

This Implementation Guide provides the criteria and corresponding design tools to consider in order to build out the Mobility Plan's Neighborhood Enhanced Network (NEN). Ultimately, successful performance of streets along the NEN rely on achieving three main corridor characteristics:

- Vehicle volumes below 1,500 Average Daily Traffic (ADT)¹, with up to 5,000 ADT² allowed in limited sections
- Vehicle speeds below 25 mph, with 20 mph or lower preferred³
- Creating safe and accessible crossings at major street intersections⁴

In addition to describing the design tools necessary to achieve ideal NEN conditions, this Guide also identifies additional factors that should be incorporated and considered when developing a NEN corridor, including:

- Improving access
- Improving comfort
- Improving route legibility through wayfinding
- Addressing unique barriers

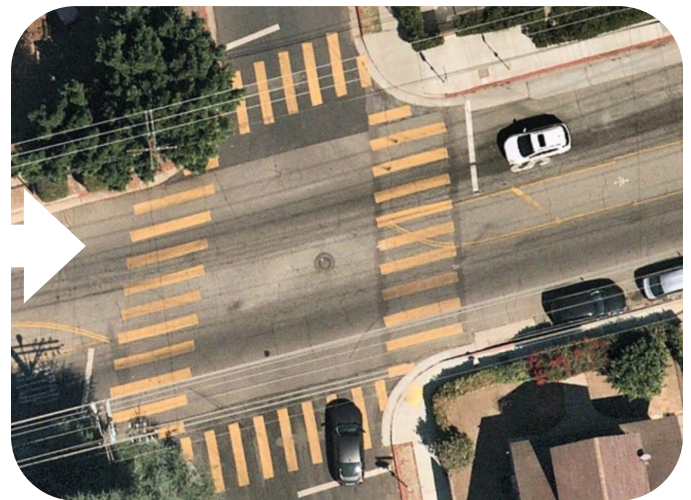
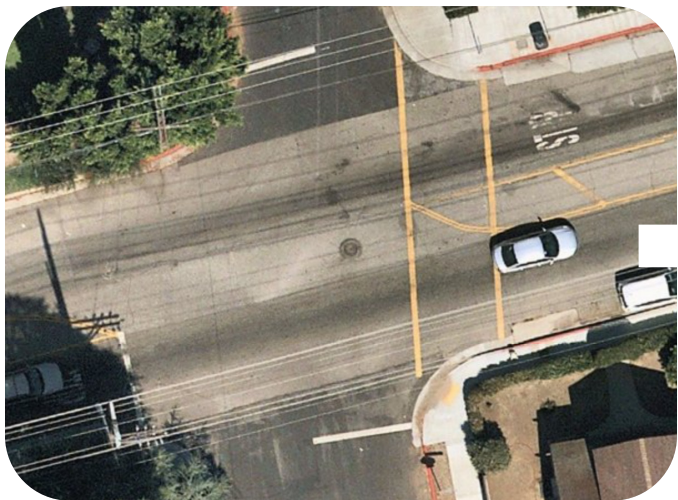
The Implementation Guide should be used to support project and corridor planning along the NEN. It is a complementary design document, similar to the Bureau of Engineering’s Supplemental Design Guide and the City’s Complete Streets Design Guide, and should be consulted as appropriate and applicable.



Source: Flickr - Justin Martin



Source: NACTO



Adding crosswalks to all sides of an intersection is one way to make streets more accommodating to people walking.
Source: Google Maps

¹NACTO Bikeway Design Guide

²Flournoy, Marlon. (2020 March 11) Contextual Guidance for Bike Facilities. [Memorandum]. Caltrans.

<https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/office-of-smart-mobility-and-climate-change/planning-contextual-guidance-memo-03-11-20-a11y.pdf>

³NACTO Bikeway Design Guide

⁴NACTO Bikeway Design Guide

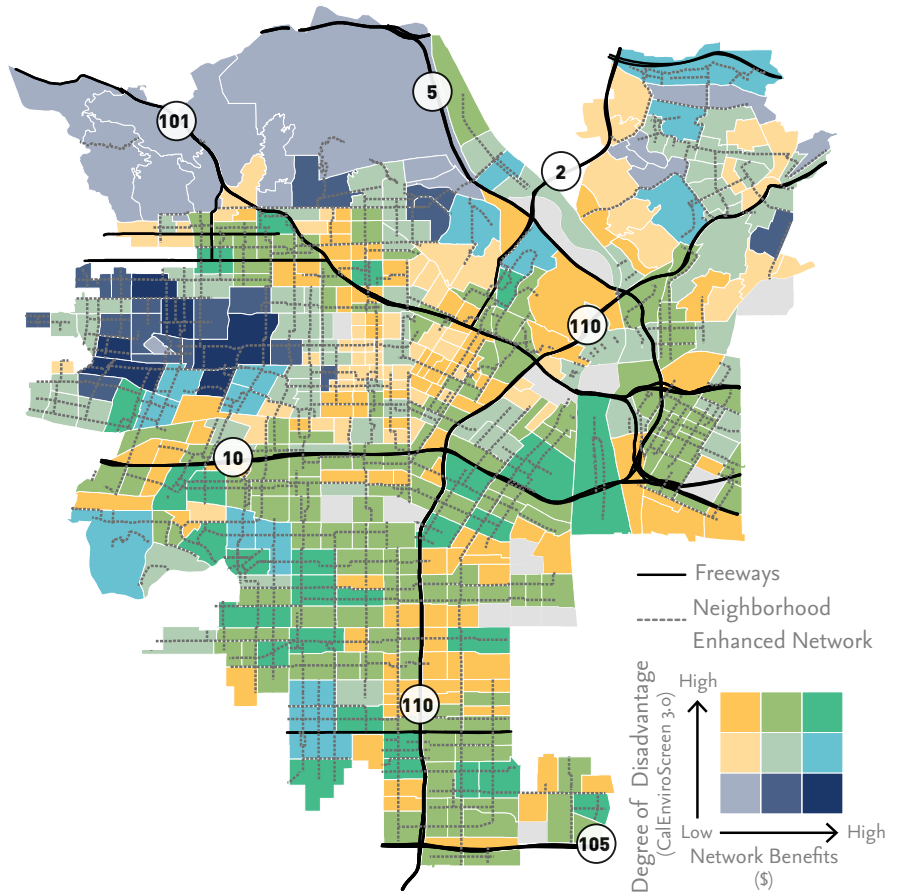
Why Stress Free Connections Matter

In 2018, LADOT surveyed over 700 Angelenos and found that 88% stated they would bicycle more if it were safe, pleasant, and convenient.

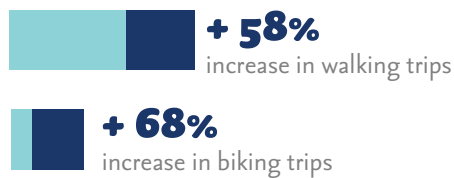
Completing neighborhood networks that are “stress free” is important because if a small portion of a journey is perceived as stressful it can deter people from considering bicycling as an option altogether, even when their destinations are close or if there is comfortable conditions for part of the trip. Based on project polling that reflects national results, Angelenos are interested in bicycling more but have safety concerns that prevent them from doing so to meet daily needs. The general perception of danger and discomfort associated with bicycling limits the City’s ability to address climate change and advance the State’s environmental policy goals. LADOT found that implementing a stress free NEN has a number of co-benefits that reduce emissions, reduce traffic crashes, and increase physical activity. As shown in the Figure on the following page, are findings from LADOT’s analysis of benefits of building out the NEN in the Central City.

The Benefits of Stress Free Connections

If built out, the NEN in the Central City area would deliver both network benefits and invest in disadvantaged communities. Based on data and analysis from LADOT's Planning for Stress Free Connections: Demand, Equity, and Economic Benefits Analysis (March 2021)



More walking and biking



Lower emissions and cleaner air



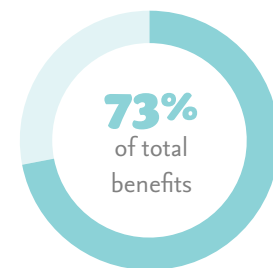
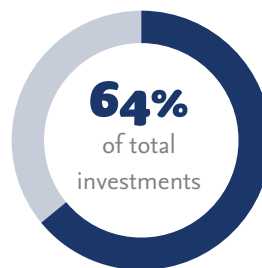
A healthier city



Safer streets



Equitable investments



located in disadvantaged communities (according to CalEnviroScreen 3.0)

Stronger, safer, healthier communities



\$754 million
benefits from reduced air pollution, increased physical activity, improved traffic safety, and household transportation savings.



\$152 million
cost of construction and annual maintenance

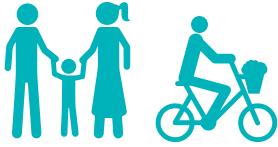
present value of costs and benefits over a 15-year lifecycle

Source: Planning for Stress Free Connections: Demand, Equity, and Economic Benefits Analysis (March 2021)

Key Goals

When successfully implemented, the NEN advances key policy goals in the City's Mobility Plan, Green New Deal, Sustainability pLAN and Executive Directive 25, and the LADOT's Strategic Plan, such as:

Slow speeds and safe facilities



Sustainability transportation



Safe and universally accessible streets



Healthy lifestyles



Increase access to transit



Increase access to green space



- Provide a slow speed network of locally serving streets
- Provide safe, convenient, and comfortable local and regional bicycling facilities for people of all ages and abilities
- Promote sustainable transportation options for trips that do not require driving, especially for short-distance trips
- Create safer, more accessible streets
- Reduce greenhouse gas (GHG) emissions and vehicle miles traveled (VMT)
- Support healthier lifestyles and active movement
- Connect Angelenos to public transit
- Increase access to and create new green space

How to Interpret Effectiveness

How do we determine if something is stressful or stress-free? Simply providing a certain number of shared lane markings or number of speed humps along a street does not necessarily make a corridor more comfortable, especially if there are other barriers that need to be solved for. In optimizing design goals and selecting appropriate tools, one should assess constraints using a ‘Level of Travel Stress’ (LTS) score methodology. Using the LTS method, LADOT assigns a score of 1 through 4 to each street segment and intersection of a NEN corridor in the project area. An LTS score of 4 is the most stressful while an LTS of 1 is considered the least stressful or ‘stress-free’. LTS is generally assigned by understanding characteristics of a street including:

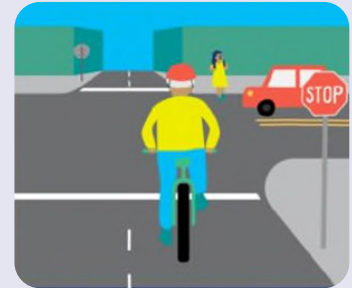
- Vehicle travel speed
- Vehicle volumes
- Accessibility and comfort for people walking and bicycling where the NEN corridors intersect with major streets

All NEN corridors should include a variety of measures to satisfy baseline LTS criteria, but other local factors can affect how stressful a street is. When designing a NEN corridor, one should pay attention to qualitative elements that are not immediately captured in the baseline LTS criteria, such as: shade and cooling, and pavement conditions. In 2020, LADOT developed the LTS score of all streets in the Central City Subregion. Work is ongoing to also assign LTS scores to all streets, citywide. The characteristics of a street that informs LTS is described in the ‘Level of Travel Stress Standard Operating Procedures’ developed by project consultants, ARCADIS.

In addressing LTS constraints, one should prioritize design solutions for the most stressful situations, or for corridor segments with LTS 3 and 4. While LADOT should strive for LTS 1 as the ideal performance outcome, a score of LTS 2 is acceptable standard for some segments or intersections for the purposes of providing an adequate ‘low-stress’ network. Performance criteria that generally align with an acceptable LTS are streets designed for 3,000 or fewer cars per day, travel speeds below 25 mph, and accessible crossings at major intersections. In some cases, if vehicle volume cannot be sufficiently reduced to below the volumes that are comfortable for sharing the road, the corridor may need a separated space for bicycling in the form of a painted or protected bike lane in order to reduce stress and increase user comfort. While NACTO provides a 3,000 ADT maximum limit where lanes can be comfortably shared with traffic, the California Department of Transportation (Caltrans) establishes 5,000 ADT as the maximum limit to consider shared lanes where they

LTS Methodology Scores

4 = Most Stressful



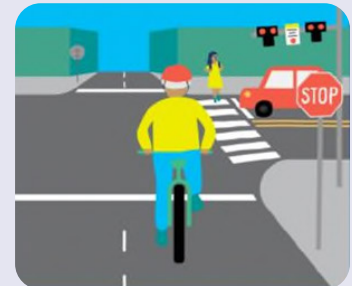
LTS 4: No accommodations across busy street

3 = Medium Stressful



LTS 3: Marked crosswalk on one side without crossing signal

2 = Less Stressful



LTS 2: Marked crossing with assistive signal or warning

1 = Stress Free



LTS 1: Marked crossing with specific accommodations for both walking and bicycling



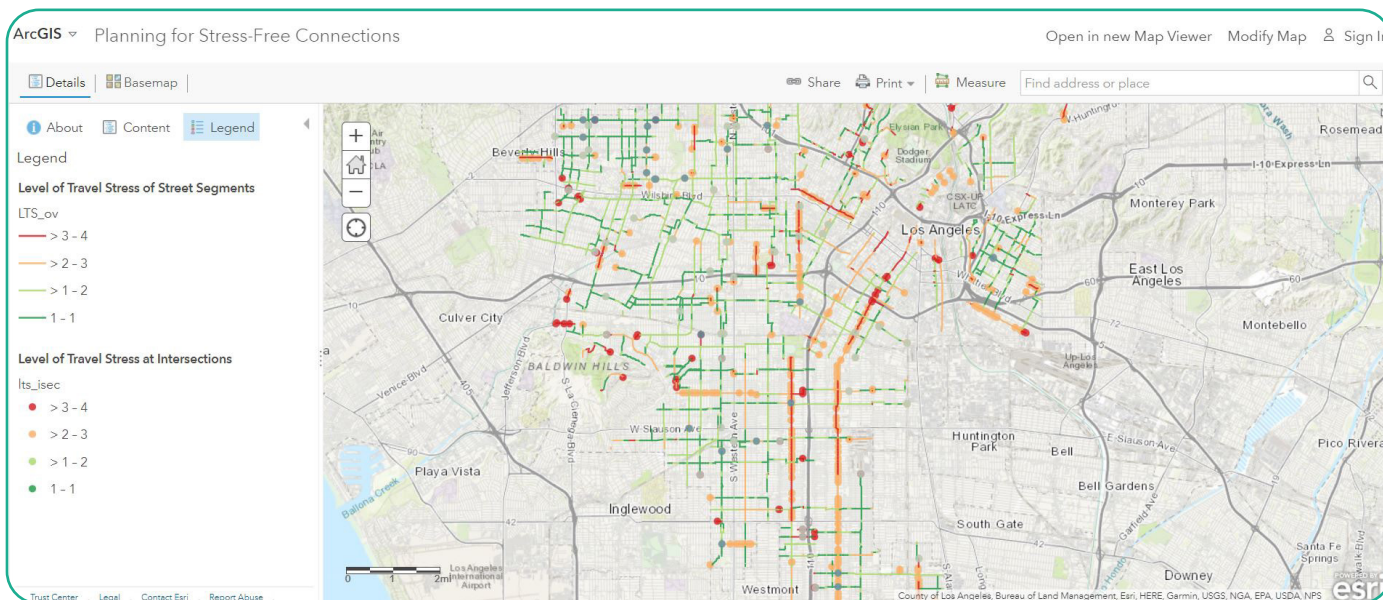
Source: Flickr - Matt Johnson

recommend bicycle lanes along streets with higher traffic volumes.⁵ Building truly stress-free NEN corridors is a context-sensitive process that requires context-sensitive design solutions.

While addressing LTS constraints is the primary objective, one should also give priority to design solutions that maximize network connectivity and improve destination access. For example, installing a controlled crosswalk (such as a Pedestrian Hybrid Beacon) at an arterial intersection could close a critical gap and meaningfully extend a network by connecting substantial lengths of two or more low stress segments and provide low stress access to nearby destinations from people living in a larger area.

Identifying the Right Tools for your Project

The Stress Free Network (SFC) can be found as an interactive tool Online through ESRI showing level of traffic scores for street segments and intersections.



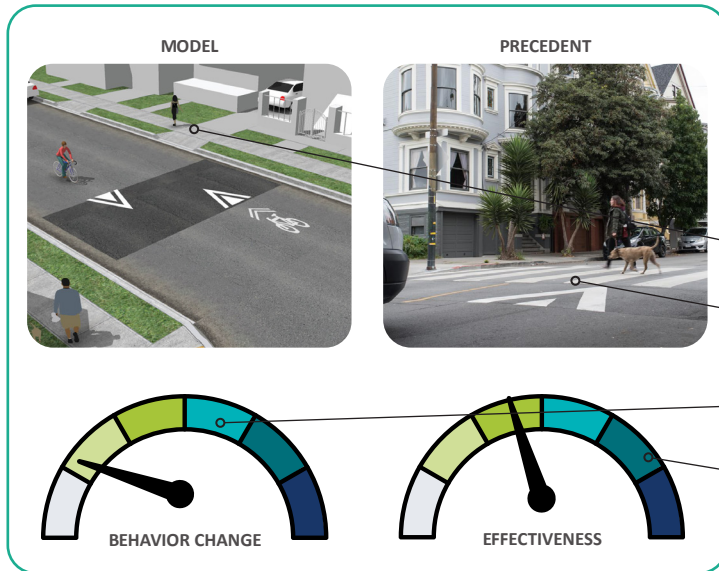
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⁵Flournoy, Marlon. (2020 March 11) Contextual Guidance for Bike Facilities. [Memorandum]. Caltrans.

<https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/office-of-smart-mobility-and-climate-change/planning-contextual-guidance-memo-03-11-20-a11y.pdf>

Identifying the Right Tools for your Project

This guide provides an overview of how various tools, such as speed, volume, access, and crossing control measures vary in their effectiveness of reducing stress and the degree to which they require adjustments in driver behavior. This guide also identifies additional opportunities and benefits of each measure in addition to the primary goal of reducing stress.

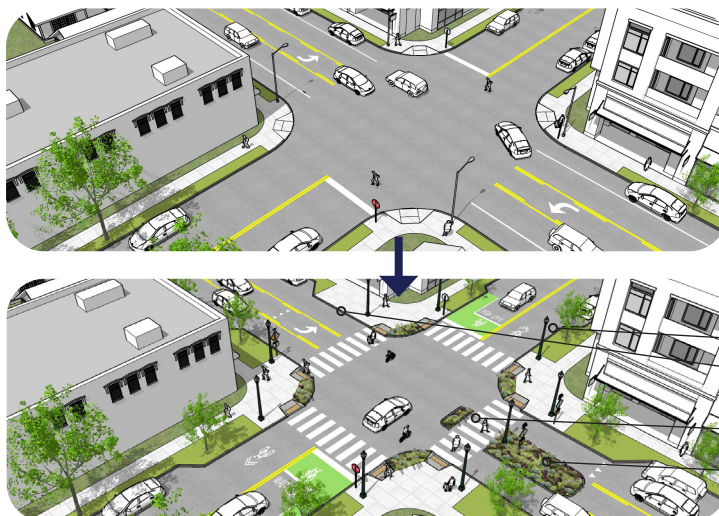


Speed/Volume Control Measures

Each design element in Chapters 2 and 3 includes the following information to describe when they are useful, what issues they address, and design considerations:

- Image of model element
- Image or real life precedent
- Behavior change dial - how does it change driver turning movements, speeds, etc.
- Effectiveness dial - how much does it reduce speed and volume

To address inadequate crossings at intersections of NEN streets and arterials, this guide offers strategies to use existing infrastructure and navigate commonly encountered intersection types. All measures that might be considered will require some level of public outreach, community engagement, and coordination with City partners due to potential changes in circulation patterns and access. City agencies which may require coordination, depending on the project scope, include: Neighborhood Council, Council Office, LADOT, Fire Department (LAFD), Police Department (LAPD) StreetsLA, and Bureau of Sanitation.



Access Measures / Intersection Types

Graphics in Chapter 4 show how various typical intersection configurations are improved with new crossing typologies. This graphic shows Rapid Rectangular Flashing Beacon (RRFB) crossing improvements.

In addition to updated signage and striping based on LADOT standards, they can include additional elements that improve speed, volume, and access control, including:

- pedestrian scale lighting
- curb extensions
- pedestrian refuge island
- landscape areas

How we Measure Effectiveness

How do we measure the effectiveness of our various tools for both speed and volume control? The information presented below gives some insight into the methodology behind how we determine the effectiveness and assumed behavior changes related to each design tool in the following chapters.

1. Literature Review

Past studies and research on traffic calming concepts provide a great baseline of data and information which can inform which design tools are more effective than others. The primary source of data for this methodology is derived from the report: “Investigating the Effectiveness of Traffic Calming Strategies on Driver Behavior, Traffic Flow and Speed” prepared for the Minnesota Local Road Research Board in 2002.⁶ This report studied the wide range of measures identified in this Guide.



2. Collecting Data

The raw data from the source shared above were compiled into one table (below) and highlight the reductions in vehicle speed, and volume, attributed to each design tool. The effectiveness of the speed control measures and volume control measures is derived from the associated volume reduction benefit identified in the 2002 report.

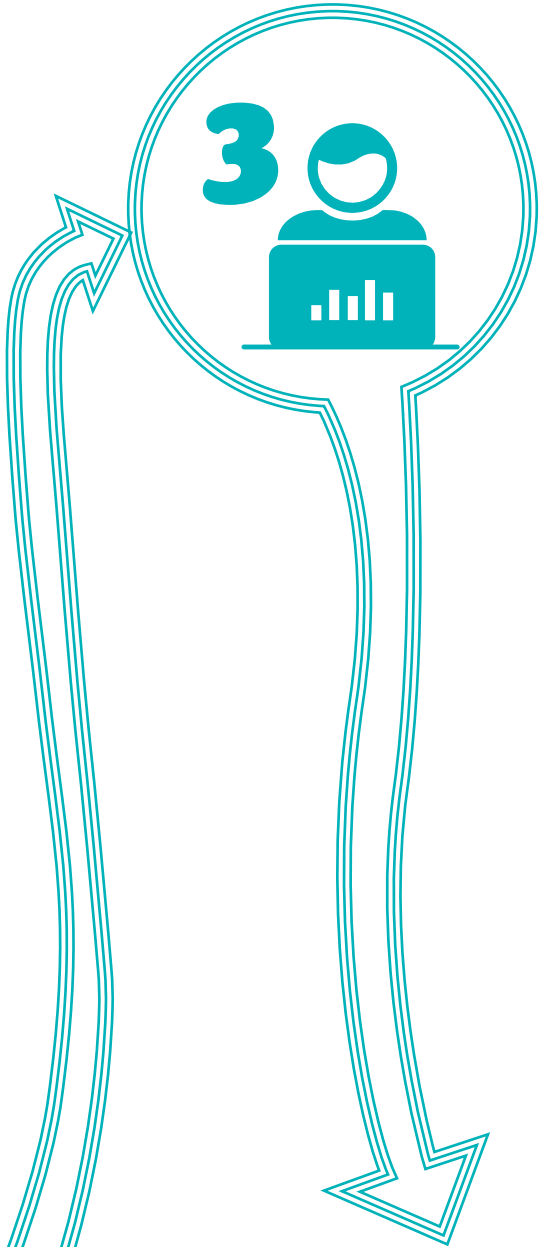
STRESS FREE CONNECTIONS TERMINOLOGY	SPEED REDUCTION	VOLUME REDUCTION
SPEED HUMP	22%	18%
CHICANE	11%	20%
CURB EXTENSION	4%	10%
TRAFFIC CIRCLE	14%	5%
CHANNELIZED INTERSECTION	4%	35%
ENHANCED CURB EXTENSION	NO DATA	42%
MEDIAN ISLAND	NO DATA	42%

See appendix for full chart(s).



⁶Corkle, J., Giese, J., Marti, M. (2022). *Investigating the Effectiveness of Traffic Calming Strategies on Driver Behavior, Traffic Flow and Speed* (Report No. MN/RC-2002-02). Minnesota Local Road Research Board.

https://nacto.org/docs/usdq/investigating_effectiveness_of_traffic_calming_strategies_corkle.pdf



3. Analyzing and Simplifying Data

LADOT assigned values to each of the speed and volume control measures on a simplified scale. The effectiveness and behavior change is given a value between one (1) and six (6) based on the level of impact each design tool has.

EFFECTIVENESS	<5%	5-10%	10-20%	20-30%	30-40%	40%+
ASSIGNED VALUE	1	2	3	4	5	6

BEHAVIOR CHANGE	NO CHANGE	SLOWS DOWN	REQUIRES CAREFULLY NAVIGATING AROUND TRAFFIC MEASURE	MAINTAINS AT LEAST 66% OF 12 INTERSECTION MOVEMENTS*	MAINTAINS AT LEAST 50% OF 12 INTERSECTION MOVEMENTS	MAINTAINS AT LEAST 33% OF 12 INTERSECTION MOVEMENTS
ASSIGNED VALUE	1	2	3	4	5	6

* 12 intersection movements diagramed on page 17

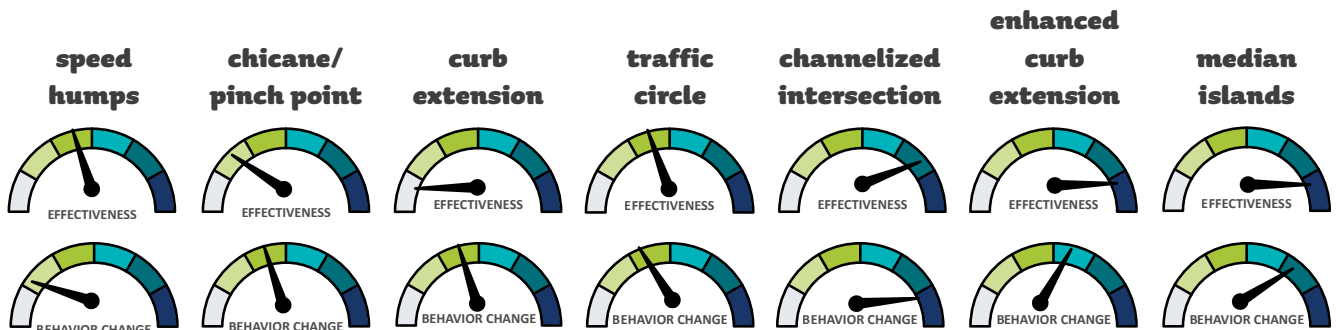
SPEED CONTROL MEASURES	EFFECTIVENESS		BEHAVIOR CHANGE	
	1-3	4-6	1-3	4-6
SPEED HUMP	3	2	2	2
CHICANE	2	3	3	3
CURB EXTENSION	1	3	3	3
TRAFFIC CIRCLE	3	3	3	3

VOLUME CONTROL MEASURES	EFFECTIVENESS		BEHAVIOR CHANGE	
	1-3	4-6	1-3	4-6
CHANNELIZED INTERSECTION	5	6	6	6
ENHANCED CURB EXTENSION	6	4	4	4
MEDIAN ISLANDS	6	5	5	5
ONE-WAY BLOCK	5	6	6	6

See appendix for full chart(s).

4. Traffic Calming Ratings

The values assigned by the methodology above are illustrated in the dials below. Dials that point toward the left represent a low amount of effectiveness and/or behavior change, and dials that point toward the right represent a high amount of effectiveness and/or behavior change.



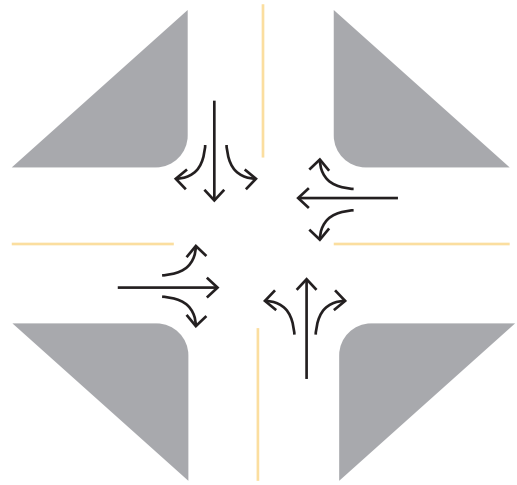
Benefits and Trade-offs of Design Tools

The chart below provides additional benefits and trade-offs to be considered when determining when to apply individual, or a set, or design tools to a location.

	DESIGN ELEMENTS							
	SIGNS & STRIPING	LANE WIDTH	SPEED HUMP	CURB EXTENSION	ADA DIRECTIONAL RAMPS	CHICANE / PINCH POINT	REFUGE ISLAND	TRAFFIC CIRCLE
OVERALL BENEFITS & TRADE-OFFS								
Bicycle & Pedestrian Safety	LOW	LOW	MEDIUM	HIGH	HIGH	MEDIUM	HIGH	MEDIUM
Behavior Changes	MEDIUM	LOW	LOW	MEDIUM	LOW	MEDIUM	HIGH	MEDIUM
Effectiveness	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW	HIGH	MEDIUM
INDIVIDUAL BENEFITS & TRADE-OFFS								
Reduce Vehicle Speeds	✓	✓	✓	✓		✓	✓	✓
Reduce Cut Through Traffic	✓							
Reduce Bicycle Trip Times								
Increase Visibility	✓	✓		✓	✓		✓	
Green Infrastructure / Open Space / Opportunity				✓		✓	✓	✓
Reduced Collisions / Conflict Points	✓	✓			✓		✓	
Increase Vehicle Trip Times / Partial street closure to cars			✓					
Slight Reduction of On-Street Parking				✓		✓		
Cost	LOW	LOW	LOW	MEDIUM	LOW	MEDIUM	MEDIUM	HIGH
Implementation Time	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH

12 Intersection Movements

The diagram to the right shows the 12 movements at an typical intersection: straight through, left-turn, or right-turn from all four directions.



PEDESTRIAN SCALE LIGHTING	DESIGN ELEMENTS						INTERSECTION CONTROL TYPES		
	BIKE BOX	ENHANCED CURB EXTENSION	CHANNEL INTERSECTION	MEDIAN ISLAND	LEADING PEDESTRIAN INTERVAL	3 PHASE SIGNAL	RRFB	PHB	Toucan
MEDIUM	MEDIUM	HIGH	HIGH	HIGH	HIGH	MEDIUM	LOW	MEDIUM	HIGH
LOW	MEDIUM	MEDIUM	HIGH	HIGH	LOW	HIGH	LOW	MEDIUM	MEDIUM
MEDIUM	MEDIUM	HIGH	HIGH	HIGH	HIGH	MEDIUM	MEDIUM	MEDIUM	HIGH
				✓					
		✓	✓	✓			LOW	LOW	HIGH
✓	✓	✓	✓	✓		✓			
		✓	✓	✓		✓			
	✓	✓	✓	✓	✓	✓			
		✓	✓	✓		✓			
		✓	✓						
HIGH	LOW	HIGH	HIGH	MEDIUM	LOW	MEDIUM	LOW	MEDIUM	HIGH
MEDIUM	LOW	HIGH	HIGH	HIGH	LOW	MEDIUM	LOW	MEDIUM	HIGH

2 Managing Speed



Managing Speed

Excessive travel speeds pose disproportionate safety risks for people that travel by bike or on foot. Sharing the road with cars that travel at higher speeds discourages people from bicycling. Although traffic may be infrequent on local streets, and posted speed limits may be 25 mph, the mere possibility that a driver can attain a high rate of speed creates an uncomfortable situation for someone who might consider bicycling. It is essential to create an environment on designated NEN corridors where drivers do not exceed 25 mph and ideally travel below 20 mph. The most common speed deterrent used on residential streets in Los Angeles over many decades is the speed hump. But speed humps are just one tool in the toolbox and may not always be the best solution to achieve the desired traffic calming and speed reduction outcomes.

Tools to consider when developing stress free connections include:

- Speed humps
- Chicanes
- Curb extensions
- Traffic circle



Source: LADOT Staff



Source: ACHD Idaho

NACTO Design Speed Considerations and Recommendations

Lowering injuries and fatalities remains a crucial goal for our cities. In 2011, 4,432 pedestrians were killed and 69,000 injured in motor vehicle crashes, according to the National Highway Traffic Safety Administration (NHTSA). Of the fatalities, 73% occurred in urban areas. This equates to 146 people killed or injured in cities everyday.

Design streets using target speed, the speed you intend for drivers to go, rather than operating speed. The 85th percentile of observed target speeds should fall between 10–30 mph on most urban streets.

The maximum target speed for urban collector or local streets is 30 mph.

Bring the design speed in line with the target speed by implementing measures to reduce and stabilize operating speeds as appropriate. Narrower lane widths, roadside landscaping, speed humps, and curb extensions reduce traffic speeds and improve the quality of the bicycle and pedestrian realm.

Speed plays a critical role in the cause and severity of crashes. There is a direct correlation between higher speeds, crash risk, and the severity of injuries. Lower design speeds reduce observed speeding behavior, providing a safer place for people to walk, park, and drive.



Driver's Peripheral Vision and Crash Risk at 10-15 MPH



Driver's Peripheral Vision and Crash Risk at 20-25 MPH



Driver's Peripheral Vision and Crash Risk at 30-35 MPH



Driver's Peripheral Vision and Crash Risk at 40+ MPH

SPEED (MPH)	STOPPING DISTANCE (FT)*	CRASH RISK (%)†	FATALITY RISK (%)†
10–15	50-100	5	2
20–25	125-150	15	5
30–35	200-250	55	45
40+	300+	90	85

* Stopping Distance includes perception, reaction, and braking times.

† Source: Traditional Neighborhood Development: Street Design Guidelines (1999), ITE Transportation Planning Council Committee 5P-8.

Source: NACTO Design Speed, Urban Design Guide.

Speed Humps

Speed humps are paved asphalt “humps” that raise the level of the street for 3 to 6 feet at a time and discourage excessive speeding by having the front and back of a vehicle at different elevations as they travel over the traffic calming device.

Design Outcomes

- Reduces vehicle speeds over speed hump based on design
- Can improve pedestrian safety along residential streets, in school zones, and near pedestrian crossings

Design Considerations

- Size of speed hump (height and length determines allowable speed)
- Can be designed near or with other street treatments (like crosswalks, curb extensions, chicanes) to improve overall effectiveness
- Cannot be placed immediately adjacent to driveway
- Generally can place one or two speed humps per block, pending block length
- Subject to placement criteria identified in LADOT’s Speed Hump Program



Examples



Chicane/Pinch Point

Chicanes (pronounced “chick-ain”) introduce elements such as medians and sidewalk extensions that curve and sometimes narrow the path of travel for traffic. This requires drivers to be more attentive of their surroundings by eliminating an unobstructed straight line of travel. Chicanes can also provide opportunities for new street trees, which have a demonstrated complementary traffic calming effect.



Design Outcomes

- Introduce elements into street to heighten driver awareness and improve safety
- Narrow roadways to slow speeds while allowing oncoming vehicles to pass
- Can be used to create physical separation between bicycles and cars

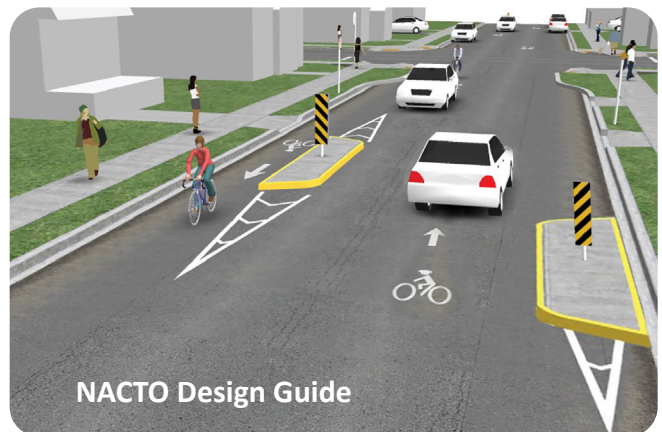
Design Considerations

- Chicanes and pinch points can be created by:
 - Curb extensions
 - Edge islands
 - Parking bays
 - Tree wells/landscaping
- May require adjustment to stormwater drainage
- Can result in loss of on-street car parking

Examples



Austin, TX



NACTO Design Guide

Curb Extensions

Curb extensions extend the width of the sidewalk at intersections. This reduces the overall crossing distance and exposure to vehicular traffic for pedestrians. By physically narrowing the roadway, this requires more careful and slower turning movements from cars at intersections.

Design Outcomes

- Widens an existing sidewalk at intersections or midway along street:
 - Slows turning vehicle speeds
 - Shortens crossing distances for pedestrians



Design Considerations

- Typically between 3-8ft wide
- May require adjustment to stormwater drainage
- Sidewalk and landscape area can provide:
 - Bioswale or stormwater capture
 - Seating area
 - Community garden
- Can result in on-street car parking loss



Examples



Seattle, WA



NACTO Design Guide

Traffic Circles

Traffic circles are round and sometimes landscaped concrete medians placed in the center of intersections that require all traffic traverse the intersection in a circular motion. Creating a uniform path of travel for all movements (whether turning right, left, or traveling straight), this reduces the number of potential conflict points and creates a calmer, more predictable intersection.



Design Outcomes

- Reduces collisions in intersections by:
 - Updating intersection configuration
 - Reducing vehicle speeds
 - Reducing conflict points

Design Considerations

- Can be raised and include a curb
- Circle size can vary depending on turning radius needs
- Rolled curbs can be used to provide access necessary for larger vehicles
- Can be planted or designed as a bioswale
- Street tree provides more shade and greenspace
- May require relocating pedestrian curb ramps
- Can result in on-street car parking loss

Examples



Berkeley, CA



NACTO Design Guide

3 Managing Volume



Managing Volume



Source: Flickr - Steve Vance



Source: Flickr - Varrie Cizauskas

Reducing the overall volume of cars on NEN corridors by discouraging cut-through trips and limiting vehicle access to locals only can reduce stress levels. In some cases, the solutions for reducing cut-through volume and reducing speed may be related and addressed in tandem. For example, design solutions that channelize turn movements to require right turns only may achieve both a reduction in speed and volume. In most cases, managing speeds without addressing volumes will likely be insufficient to create a comfortable NEN corridor. NACTO recommends keeping ADT below 1,500, although in limited segments volumes can peak at 3,000 ADT. Caltrans establishes 5,000 ADT as the maximum limit that people on bikes should share lanes with drivers. When developing NEN corridors one should consider volume management techniques to maintain volumes within the desired range or where there is a broad desire to discourage cut-through traffic. Because volume control measures change circulation patterns, they will require greater outreach and collaboration across City agencies and may require coordination with Bureau of Sanitation to address trash collection, LAFD and LAPD to address emergency access.

Tools available to manage traffic volumes include:

- Channelized intersection
- Enhanced curb extension
- Median refuge island
- One-way block conversion

NACTO Volume Management Considerations and Recommendations

On roadways with shared travel lanes such as bicycle boulevards, motor vehicle traffic volumes significantly impact bicyclist comfort . Higher vehicle volumes decrease comfort and may lead to a greater potential for conflicts, as well as a loss of perceived safety. If intervention is needed to reduce or maintain low motor vehicle volumes along the corridor, volume management treatments can prohibit motor vehicle turning or through movements while allowing passage by bicyclists and pedestrians. Such treatments should be implemented with consideration for emergency vehicles and neighborhood access.

Typical Applications

- Along target streets on which reductions in motor vehicle volumes are needed to meet the volume thresholds for bicycle boulevards (i.e., below 1,500ADT preferred; 3,000 ADT maximum). Bicycle boulevards may be designated along short segments of roadways that accommodate traffic volumes above the established threshold, if necessary, to complete the corridor. Above 1,500 ADT, speeds should be low and additional signs used to increase visibility of the bicycle boulevard. Above 3,000ADT, a bike lane, cycle track, or other treatments can be considered where speed or volume management treatments cannot reduce volumes below the threshold.
- Along streets where conversion to a bicycle boulevard may otherwise encourage cut-through traffic through the removal of stop signs.
- At the intersection of two bicycle boulevards.
-



Palo Alto, CA



Portland, OR



Berkeley, CA

Source: NACTO Volume Management, Urban Design Guide.

Channelized Intersection

Channelized intersections prevent through vehicle traffic on two local streets by requiring all traffic turn right (or left, depending on the design). This eliminates some intersection conflicts, creates opportunities for landscaping, and maintains through access for people walking, bicycling, and emergency vehicles.

Design Outcomes

- Widens an existing sidewalk at intersections or midway along street:
 - Slows turning vehicle speeds
 - Shortens crossing distances for pedestrians
 - Reduces parking near intersections and improves overall visibility



Design Considerations

- Typically between 3-8ft wide
- May require adjustment to stormwater drainage
- Sidewalk and landscape area can provide:
 - Bioswale or stormwater capture
 - Seating area
 - Community garden
- May require coordination with other City agencies, including: Bureau of Sanitation, LAFD, LAPD, StreetsLA



Examples



Enhanced Curb Extension

Enhanced curb extensions prevent cars from entering a street by extending the sidewalk 10+ feet or providing a pedestrian island that physically prevents through vehicle access. This device can also be designed to allow entry but eliminating exiting traffic. In any design, bicycle and emergency vehicle access is maintained.



Design Outcomes

- Reduces collisions in intersections by:
 - Updating intersection configuration to eliminate conflict points
 - Reducing vehicle speeds for turning vehicles

Design Considerations

- Can be raised and include a curb
- Rolled curbs can be used to provide access necessary for larger vehicles
- Can be planted or designed as a bioswale
- Street tree provides more shade and greenspace
- May require coordination with other City agencies, including: Bureau of Sanitation, LAFD, LAPD, StreetsLA

Examples



Vancouver, BC



MCTO Design Guide

Median Refuge Island

Median refuge islands are similar to conventional crossing islands but extend to prevent all left turns where two streets meet. Removing the opportunity for vehicles to turn left creates a more predictable environment and enhances protection for pedestrians while also discouraging cut-through traffic. Variations of a median refuge island can permit some left turns where needed and in all cases maintain through and left turning access for bicycles and emergency vehicles.

Design Outcomes

- Limits vehicle turning and/or straight movements on minor streets
- Maintains through bicycle movement



Design Considerations

- What turning movements to restrict for vehicles
- Can be combined with other elements like curb extensions
- May require adjustments to trip patterns
- May require coordination with other City agencies, including: Bureau of Sanitation, LAFD, LAPD, StreetsLA



Examples



One-Way Blocks:

Almost all conventional local streets operate with two-way traffic, even when the streets are quite narrow. Strategically converting a specific block or two from two-way to one-way traffic can prevent vehicle cut-through while preserving space for a “contraflow” bike lane.



Design Outcomes

- Maintains street access for one direction of travel for vehicle traffic
- Maintains two-way travel for people walking and bicycling
- Reduces cut-through from one direction
- Only requires striping and signage

Design Considerations

- Deciding ideal block to convert to one-way operation
- Trash collection may need to occur from only one side of the street
- Possibility to take advantage of blocks that have City owned property on one side of street
- May require coordination with other City agencies, including: Bureau of Sanitation, LAFD, LAPD, StreetsLA

Examples



Source: Joe Linton

Working with Temporary and Interim Materials

Both speed and volume control measures can be implemented with interim or temporary materials. Working with low-cost and removable materials has the added benefit of allowing project designers and residents to: pilot measures, assess their effectiveness, and tweak project elements to maximize benefits and minimize undesired outcomes. Temporary materials can also allow for relatively immediate action compared to waiting years for funding to rebuild an intersection or install more extensive civil components along a street. Due to the temporary nature of interim materials such as striping, plastic bollards, and raised pavement markers, any measure tested with these materials may not be as effective as their concrete counterparts but should offer a good approximation of the anticipated outcomes. Where temporary materials involve diverting traffic, LADOT may need to coordinate with other agencies, including LAFD. Below are visual examples of speed and volume control measures implemented with low-cost materials.



Source: Google Maps



Source: LA Times



Source: LADOT Staff



Source: Google Maps

4 Major Street Crossings



Major Street Crossings

Los Angeles has NEN corridors where vehicle speeds and volumes are already low, though they fail to become usable networks for people on foot or bike because major intersection crossings are a barrier. Installing traditional traffic signals can have the adverse impact of incurring more cut-through traffic and undermining the low-travel stress performance of a NEN corridor if it provides the same utility and connections to cars as parallel commercial arterials.

When bridging gaps across busy streets, not every major crossing is created equal. Some crossings may require more intensive infrastructure than others in order to become safe and comfortable for crossing by foot and bicycle. LADOT already has guidance that determines whether a flashing-yellow Rectangular Rapid Flashing Beacon (RRFB) is sufficient to improve a crossing or if the red signal of a Pedestrian Hybrid Beacon (PHB) is more appropriate. This Implementation Guide does not stray from existing LADOT warrants and thresholds but applies them in the context of creating stress free connections and offers additional solutions that can be used.



Source: City of Fort Collins



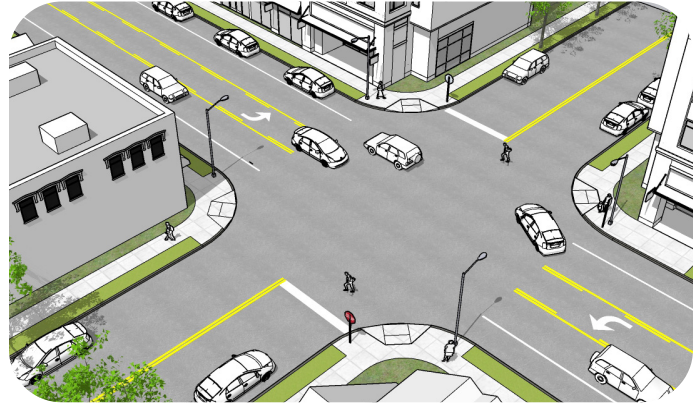
Source: TAPCO

RRFB

Rectangular Rapid-Flashing Beacon

Opportunities / Improvements

- RRFBs are a type of warning sign that provides rapid flashing yellow lights when people walking or bicycling push a button before crossing the street. RRFBs enhance the visibility of crosswalks in use and improve yield compliance from drivers when people are actively crossing. Although RRFBs can be applied to a wide range of contexts, they are most effective and suitable when applied to crossing lower volume, lower speed, and narrower arterial streets no more than 64 feet wide.
- RRFBs installed along NEN corridors should include crosswalks on both sides of the crossing and incorporate bike boxes and bicycle-oriented push buttons that can be activated without requiring people bicycling to mount the sidewalk.
- RRFBs can be complemented with additional measures such as curb extensions and pedestrian crossing islands. These elements can be added with temporary materials such as striping, signage, and bollards.
- If funds are available, temporary materials can be upgraded with concrete and landscaping



Existing Condition



Phase 1 Design



Phase 2 Design

References for Appropriate Design

LADOT Complete Street Design Guide: lane widths;

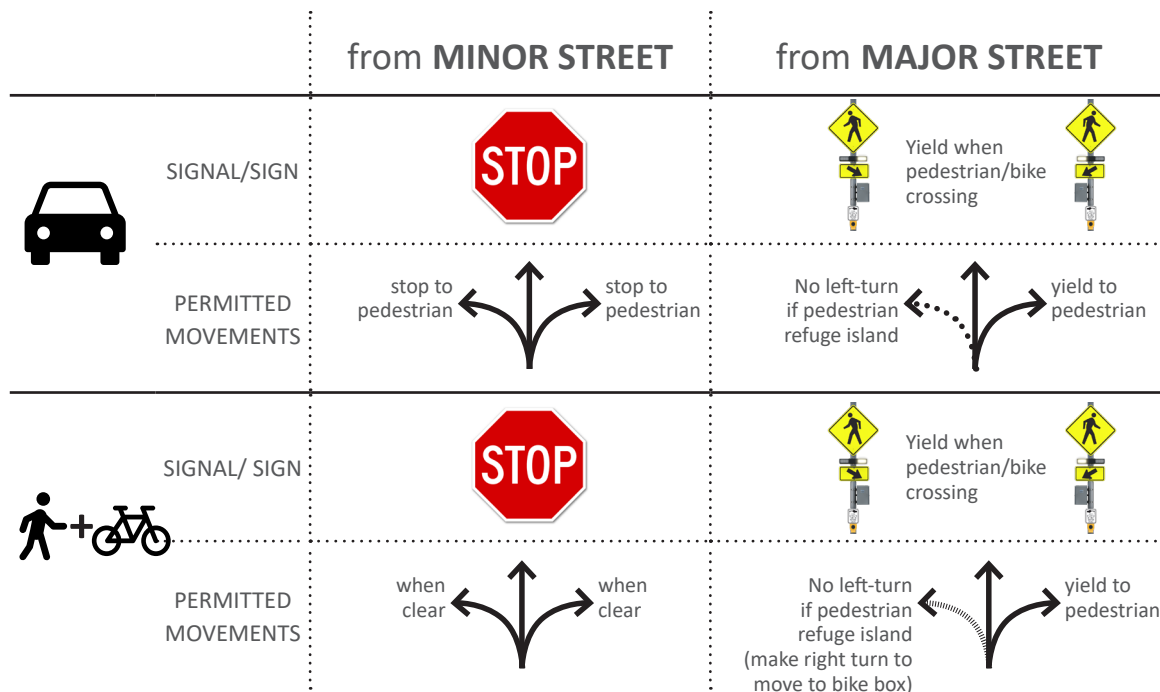
NACTO: corner turn radius; vehicle lane widths; bicycle facilities standards; street trees and landscape

CA MUTCD: signage standards; street marking standards;

Table of Traffic Volumes (ADT), Number of Lanes, and Speed Limits for Appropriate Intersection Designs

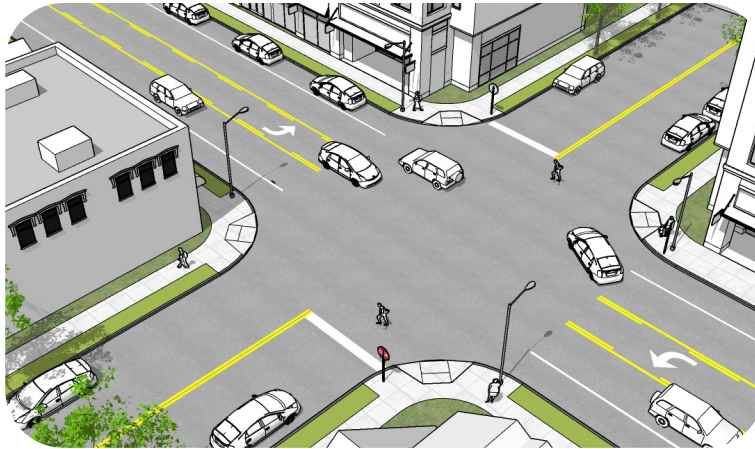
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		< 30 mph	35 mph	> 40 mph	< 30 mph	35 mph	> 40 mph	< 30 mph	35 mph	> 40 mph
	2 LANES NO LEFT TURN	RRFB	RRFB PHB	PHB	RRFB	RRFB PHB	PHB	RRFB PHB	PHB	PHB
	2 LANES RAISED MEDIAN	RRFB	RRFB PHB	PHB	RRFB PHB	RRFB PHB	PHB	RRFB PHB	PHB	PHB
	2 LANES LEFT TURN LANE	RRFB PHB	RRFB PHB	PHB	RRFB PHB	RRFB PHB	PHB	RRFB PHB	PHB	PHB
	3+ LANES RAISED MEDIAN	RRFB PHB	PHB	PHB	RRFB PHB	PHB	PHB	PHB	PHB	PHB
	3+ LANES LEFT TURN LANE	RRFB PHB	PHB	PHB	RRFB PHB	PHB	PHB	PHB	PHB	PHB

RRFB IS BEST FOR: Low vehicle speed and volume



RRFB

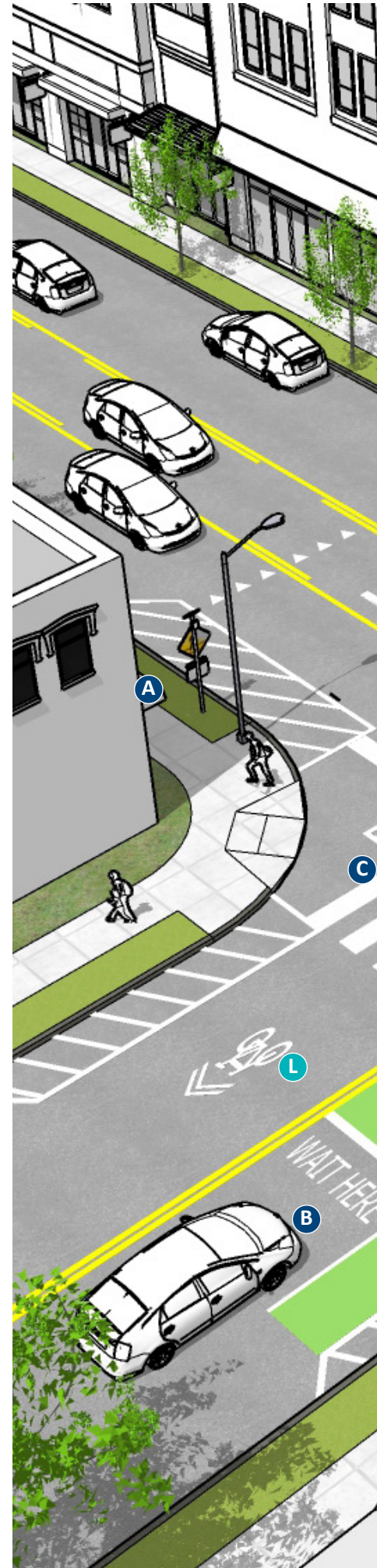
Phase 1 Intersection Design



Existing Condition

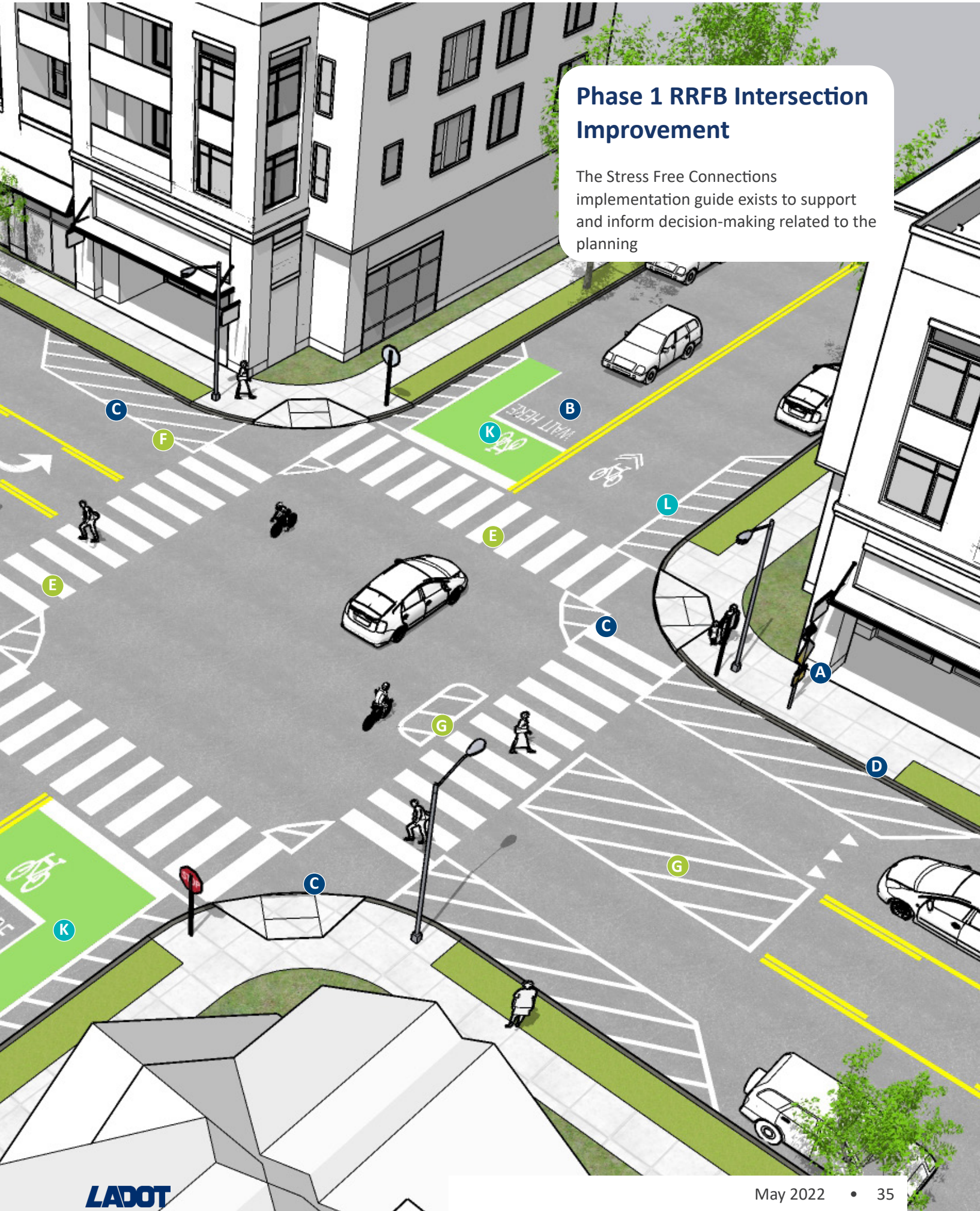
- | | | |
|------------------------------------|----------|------------|
| New RRFB Signal | A | ROADWAY |
| “Wait Here” Striping | B | |
| Curb Extension / Sidewalk Widening | C | |
| Bus stop (if applicable) | D | |
| High Visibility Crosswalks | E | PEDESTRIAN |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | |
| Pedestrian-scale Lighting | H | |
| Landscape Area / Street Trees | I | BICYCLE |
| Dedicated Bicycle Facility | J | |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement



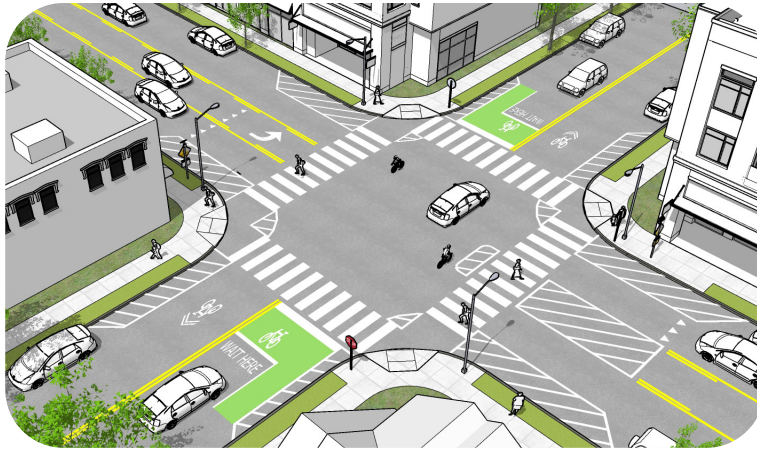
Phase 1 RRFB Intersection Improvement

The Stress Free Connections implementation guide exists to support and inform decision-making related to the planning



RRFB

Phase 2 Intersection Design



Phase 1 Design

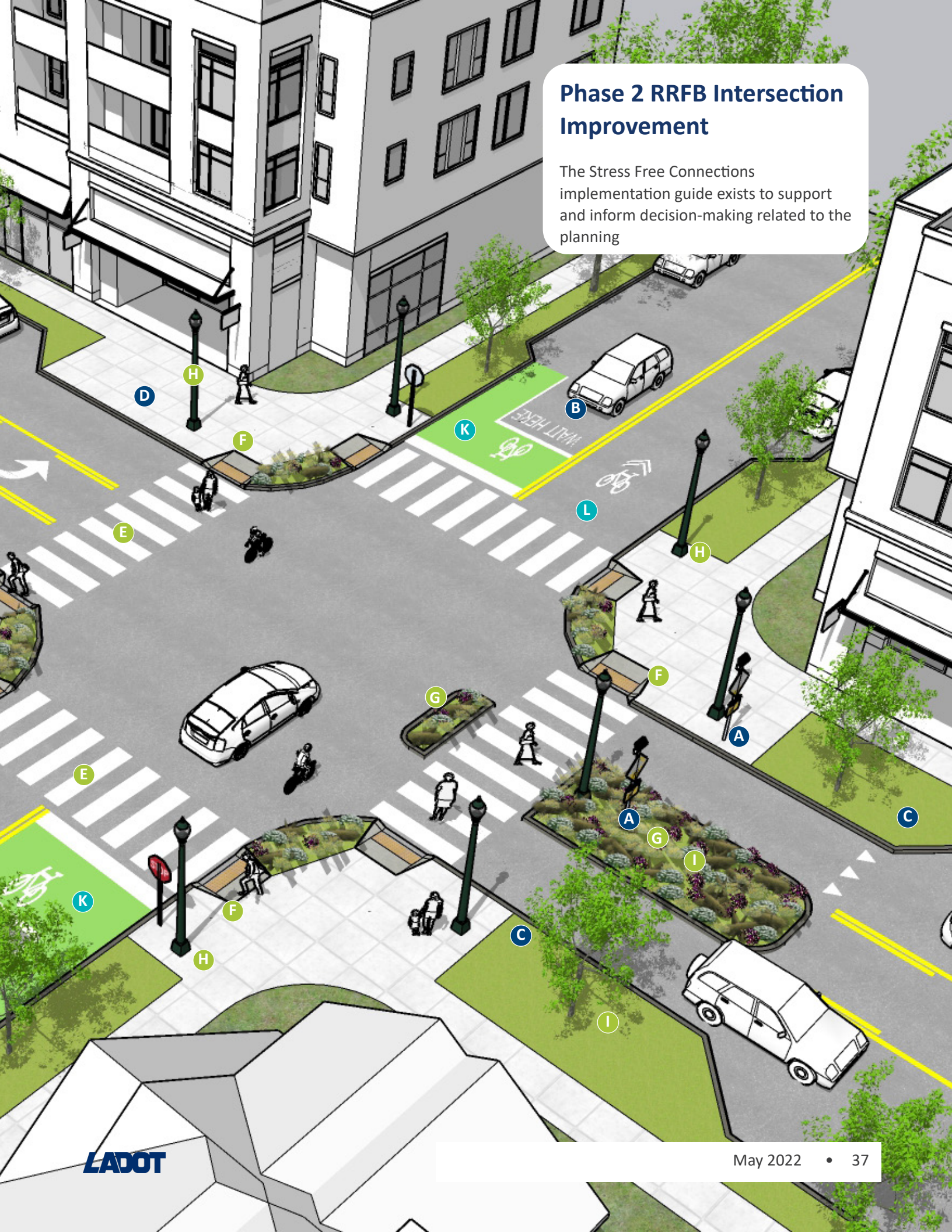
- | | | |
|------------------------------------|----------|------------|
| New RRFB Signal | A | ROADWAY |
| “Wait Here” Striping | B | |
| Curb Extension / Sidewalk Widening | C | PEDESTRIAN |
| Bus stop (if applicable) | D | |
| High Visibility Crosswalks | E | |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | PEDESTRIAN |
| Pedestrian-scale Lighting | H | |
| Landscape Area / Street Trees | I | |
| Dedicated Bicycle Facility | J | BICYCLE |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement



Phase 2 RRFB Intersection Improvement

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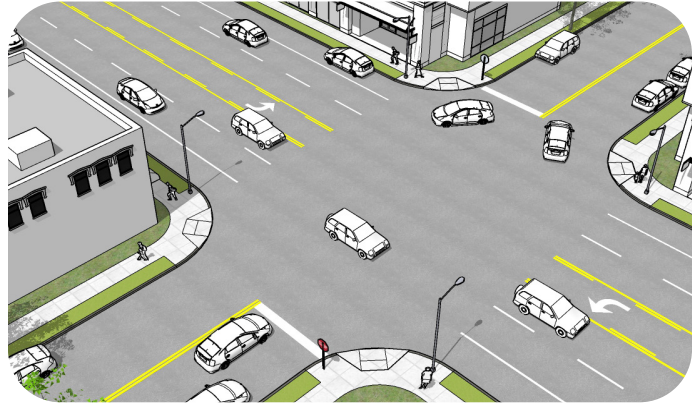


PHB

Pedestrian Hybrid Beacon

Opportunities / Improvements

- PHBs are a traffic control device that provide flashing red stop lights that require traffic along an arterial to stop when people walking or bicycling push the button before crossing the street. PHBs enhance access at major street intersection crossings without providing any accommodations or restrictions on vehicle movement. PHBs are more suitable to larger and busier crossings than RRFBs because they require traffic to come to a full stop when activated rather than simply yield.
- PHBs installed along NEN corridors should include crosswalks on both sides of the crossing and incorporate bike boxes and bicycle-oriented push buttons that can be activated without requiring people bicycling to mount the sidewalk.
- PHBs can be complemented with additional measures such as curb extensions and pedestrian crossing islands. These elements can be added with temporary materials such as striping, signage, and bollards.
- If funds are available, temporary materials can be upgraded with concrete and landscaping



Existing Condition



Phase 1 Design



Phase 2 Design

References for Appropriate Design

PRECEDENT:
Eagle Rock / Merton
Los Angeles, CA

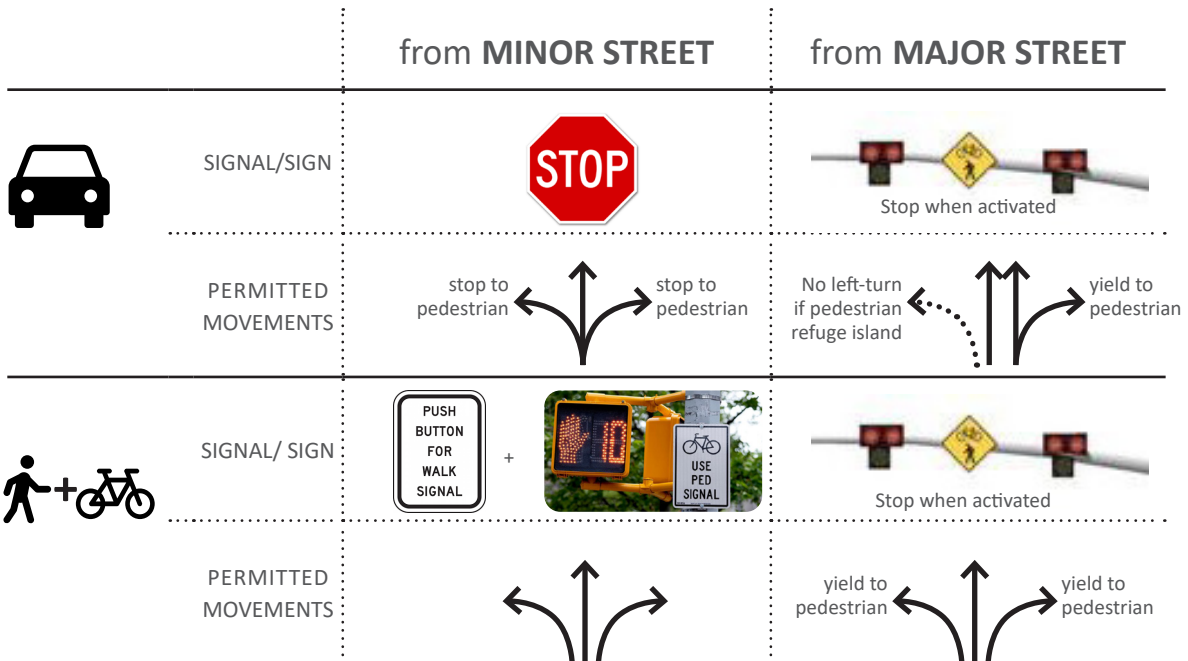


Source: LADOT Staff

Table of Traffic Volumes (ADT), Number of Lanes, and Speed Limits for Appropriate Intersection Designs

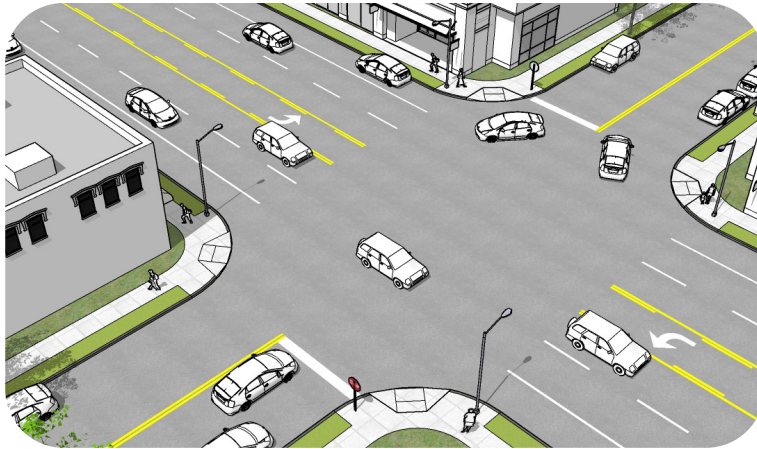
	VEHICLE ADT < 9,000			VEHICLE ADT = 9,000 - 15,000			VEHICLE ADT > 15,000		
	< 30 mph	35 mph	> 40 mph	< 30 mph	35 mph	> 40 mph	< 30 mph	35 mph	> 40 mph
2 LANES NO LEFT TURN	RRFB	RRFB PHB	PHB	RRFB	RRFB PHB	PHB	RRFB PHB	PHB	PHB
2 LANES RAISED MEDIAN	RRFB	RRFB PHB	PHB	RRFB PHB	RRFB PHB	PHB	RRFB PHB	PHB	PHB
2 LANES LEFT TURN LANE	RRFB PHB	RRFB PHB	PHB	RRFB PHB	RRFB PHB	PHB	RRFB PHB	PHB	PHB
3+ LANES RAISED MEDIAN	RRFB PHB	PHB	PHB	RRFB PHB	PHB	PHB	PHB	PHB	PHB
3+ LANES LEFT TURN LANE	RRFB PHB	PHB	PHB	RRFB PHB	PHB	PHB	PHB	PHB	PHB

BEST FOR: Medium to high vehicle speed and volume



PHB

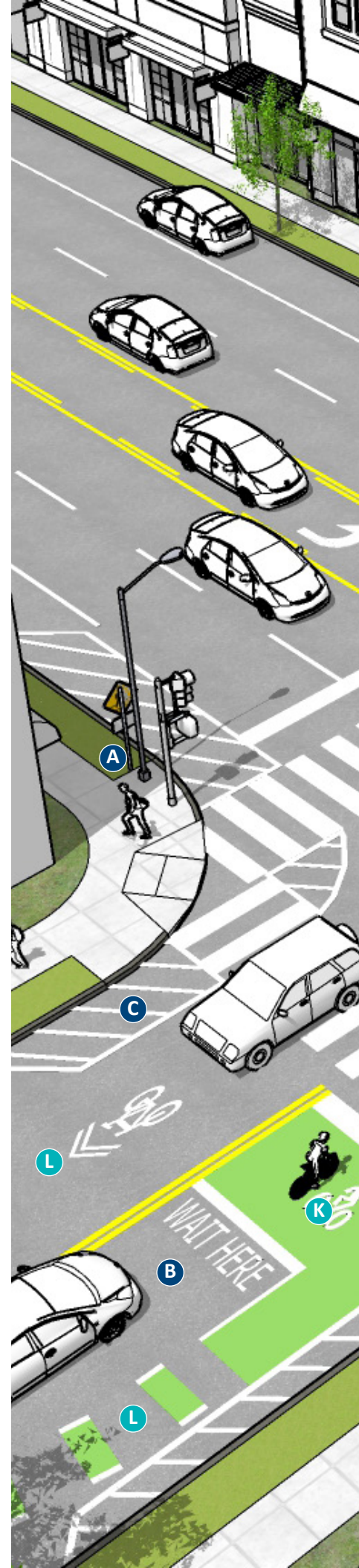
Phase 1 Intersection Design



Existing Condition

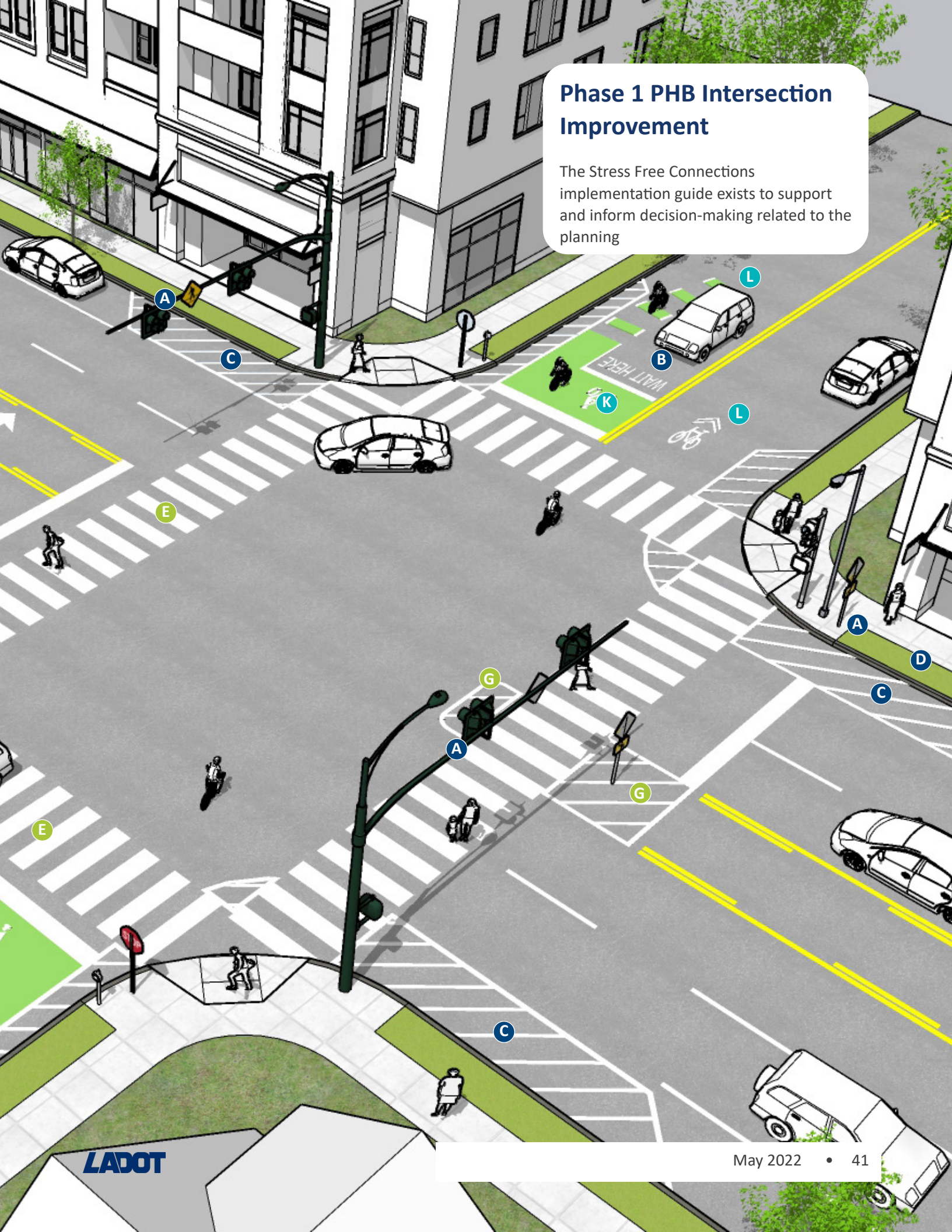
- | | | |
|------------------------------------|----------|------------|
| New PHB Signal | A | ROADWAY |
| “Wait Here” Striping | B | |
| Curb Extension / Sidewalk Widening | C | PEDESTRIAN |
| Bus stop (if applicable) | D | |
| High Visibility Crosswalks | E | |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | BICYCLE |
| Pedestrian-scale Lighting | H | |
| Landscape Area / Street Trees | I | |
| Dedicated Bicycle Facility | J | |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement



Phase 1 PHB Intersection Improvement

The Stress Free Connections implementation guide exists to support and inform decision-making related to the planning



PHB

Phase 2 Intersection Design



Phase 1 Design

- | | | |
|------------------------------------|----------|------------|
| New PHB Signal | A | ROADWAY |
| “Wait Here” Striping | B | |
| Curb Extension / Sidewalk Widening | C | PEDESTRIAN |
| Bus stop (if applicable) | D | |
| High Visibility Crosswalks | E | |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | BICYCLE |
| Pedestrian-scale Lighting | H | |
| Landscape Area / Street Trees | I | |
| Dedicated Bicycle Facility | J | |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement



Phase 2 PHB Intersection Improvement

The Stress Free Connections implementation guide exists to support and inform decision-making related to the planning

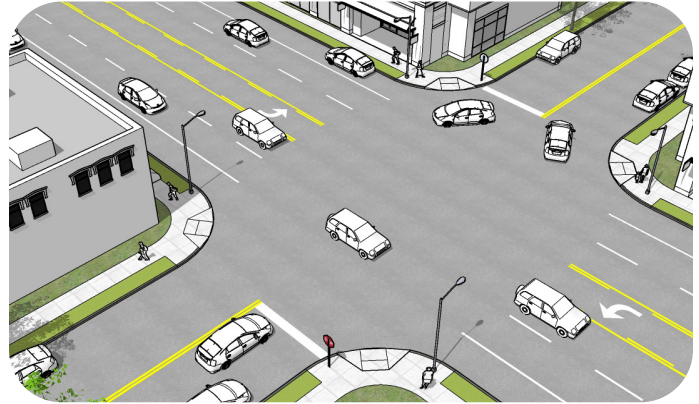


Standard Toucan

“Two-can” - Bicycles and pedestrians cross together

Opportunities / Improvements

- A Toucan is a traffic control device that functionally operates like a traditional traffic signal, however when the light is green for the minor street only people walking and bicycling are permitted to proceed straight for through travel. Toucans have two primary benefits: 1) they enhance access for walking and bicycling and 2) prevent through traffic on local minor streets
- Shown here is a Toucan type which only allows vehicle traffic on the minor street to turn right. Traffic from the major street, however, is still permitted to turn onto the minor street.
- Toucans installed along NEN corridors should include crosswalks on both sides of the crossing and incorporate bike boxes and bicycle-oriented loop detectors and/or push buttons that can be activated without requiring people bicycling to mount the sidewalk.
- Toucans can be complemented with additional measures such as curb extensions and pedestrian crossing islands. These elements can be added with temporary materials such as striping, signage, and bollards.
- If funds are available, temporary materials can be upgraded with concrete and landscaping



Existing Condition



Phase 1 Design



Phase 2 Design

References for Appropriate Design

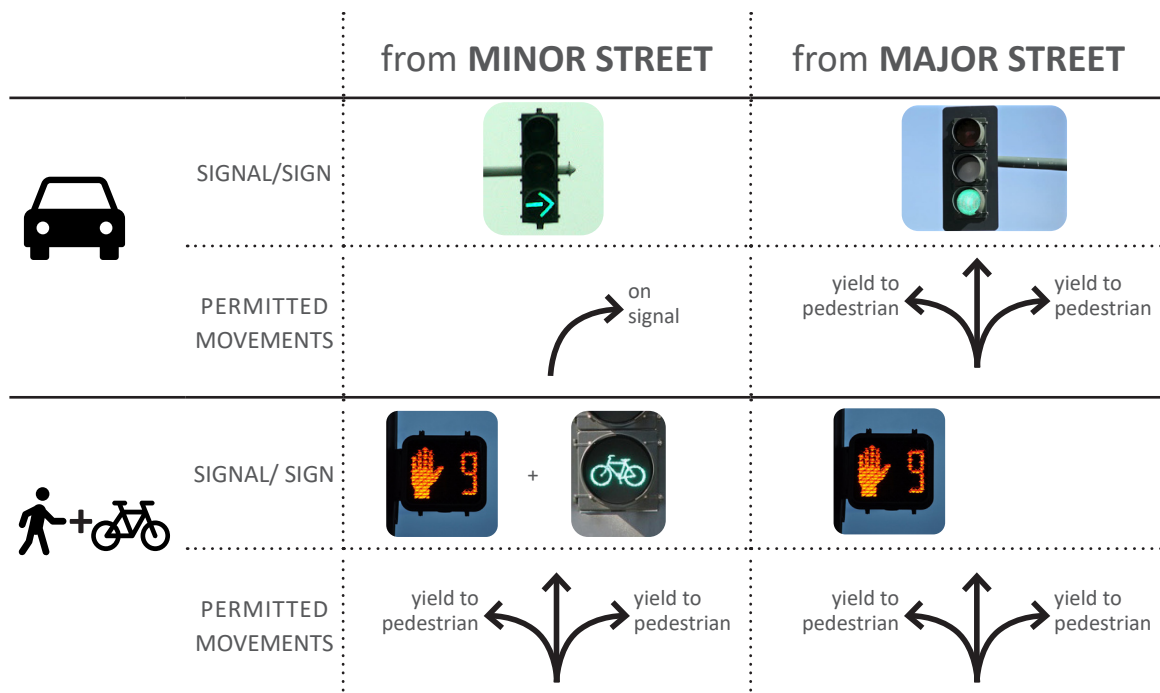
- See Attached Signal Warrant
- Standard Toucan is appropriate for locations where eliminating left turns and through movement from the minor street is acceptable or desired.



PRECEDENT:
Rosewood / La Brea
Los Angeles, CA

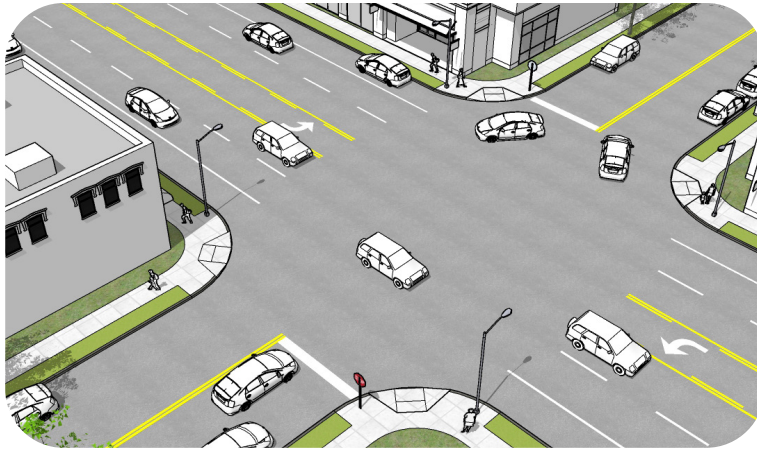
Source: Joe Linton

BEST FOR: Medium to high vehicle speed and volume



Standard Toucan

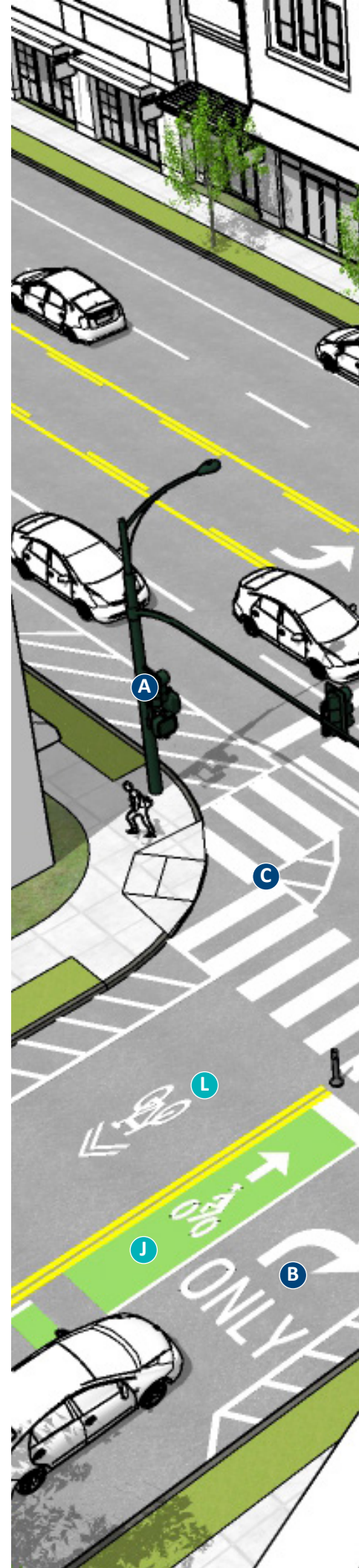
Phase 1 Intersection Design



Existing Condition

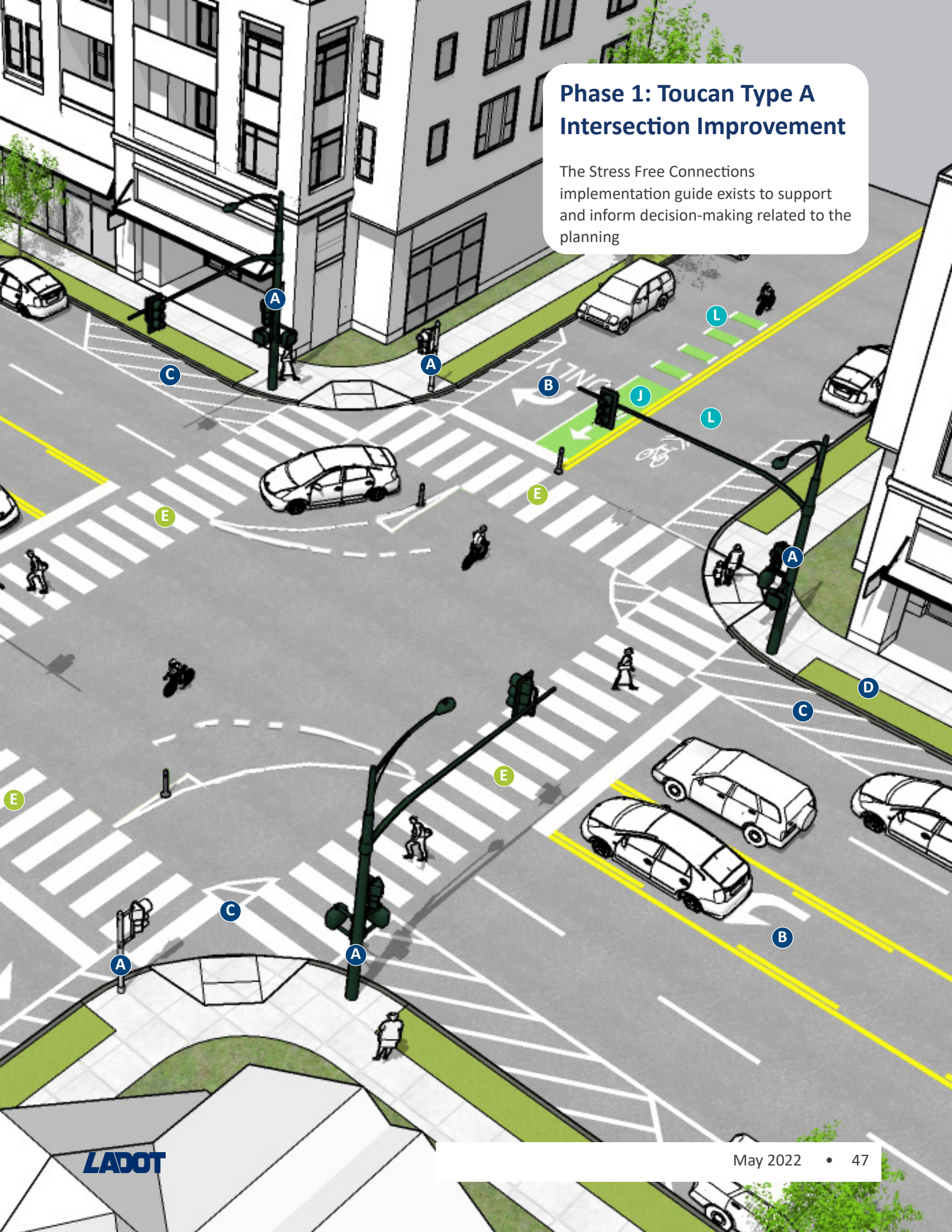
- | | | |
|------------------------------------|----------|------------|
| New Toucan Signal | A | ROADWAY |
| Vehicle Movement Striping | B | |
| Curb Extension / Sidewalk Widening | C | |
| Bus stop (if applicable) | D | PEDESTRIAN |
| High Visibility Crosswalks | E | |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | |
| Pedestrian-scale Lighting | H | BICYCLE |
| Landscape Area / Street Trees | I | |
| Dedicated Bicycle Facility | J | |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement



Phase 1: Toucan Type A Intersection Improvement

The Stress Free Connections implementation guide exists to support and inform decision-making related to the planning



Standard Toucan

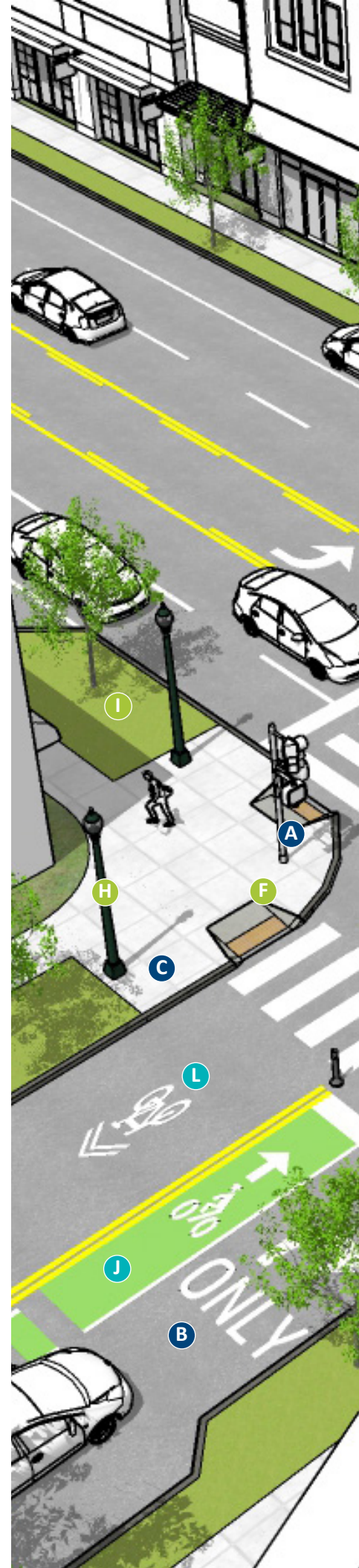
Phase 2 Intersection Design



Phase 1 Design

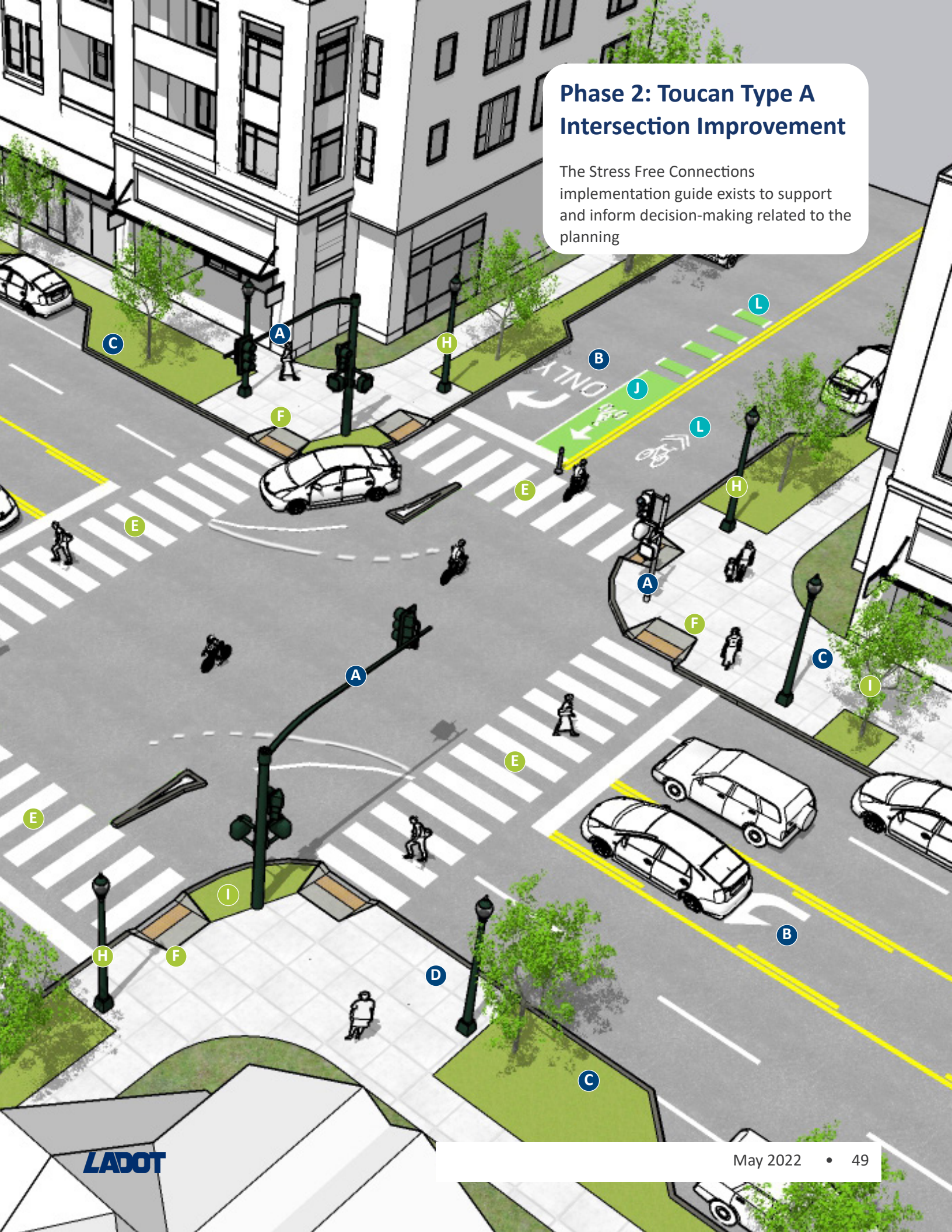
- | | | |
|------------------------------------|----------|------------|
| New Toucan Signal | A | ROADWAY |
| Vehicle Movement Striping | B | |
| Curb Extension / Sidewalk Widening | C | |
| Bus stop (if applicable) | D | |
| High Visibility Crosswalks | E | PEDESTRIAN |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | |
| Pedestrian-scale Lighting | H | PEDESTRIAN |
| Landscape Area / Street Trees | I | |
| Dedicated Bicycle Facility | J | BICYCLE |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement



Phase 2: Toucan Type A Intersection Improvement

The Stress Free Connections implementation guide exists to support and inform decision-making related to the planning

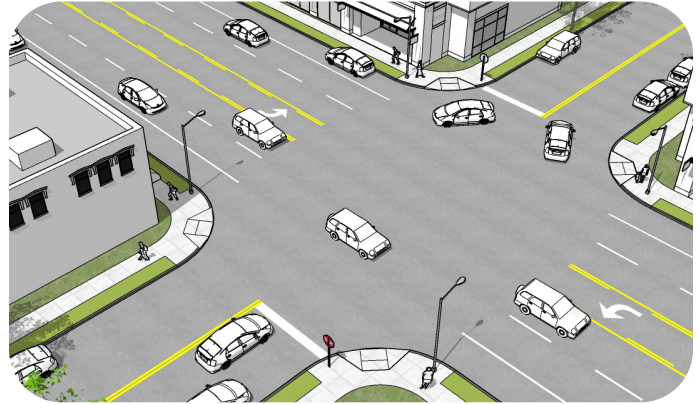


“Exit Only” Toucan

“Two-can” - Bicycles and pedestrians cross together

Opportunities / Improvements

- A Toucan is a traffic control device that functionally operates like a traditional traffic signal, however when the light is green for the minor street only people walking and bicycling are permitted to proceed straight for through travel. Toucans have two primary benefits: 1) they enhance access for walking and bicycling and 2) prevent through traffic on local minor streets
- Shown here is a Toucan type which allows vehicle traffic on the minor street to turn left or right. Traffic from the major street, however, is not permitted to turn onto the minor street.
- Toucans installed along NEN corridors should include crosswalks on both sides of the crossing and incorporate bike boxes and bicycle-oriented loop detectors and/or push buttons that can be activated without requiring people bicycling to mount the sidewalk.
- Toucans can be complemented with additional measures such as curb extensions and pedestrian crossing islands. These elements can be added with temporary materials such as striping, signage, and bollards.
- If funds are available, temporary materials can be upgraded with concrete and landscaping



Existing Condition



Phase 1 Design



Phase 2 Design

References for Appropriate Design

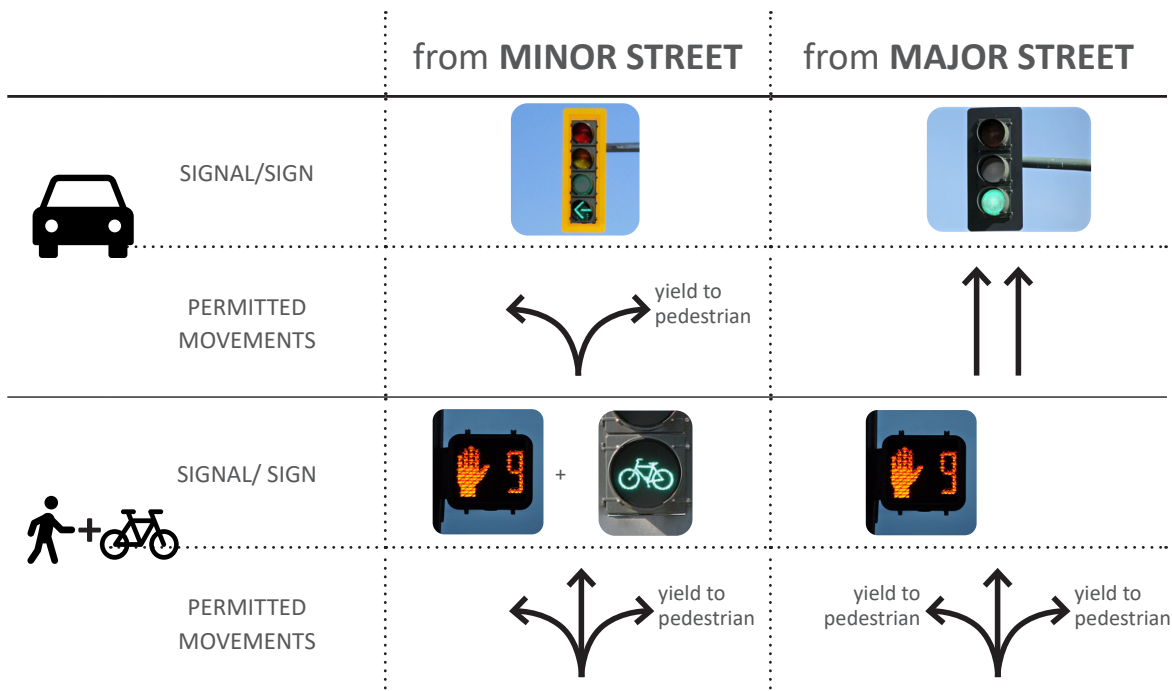
- See Attached Signal Warrant
- “Exit Only” Toucan is appropriate for locations where there is desire to maintain left and right turns or a desire to prevent traffic from main street to enter the minor street



PRECEDENT:
Clinton / Cesar Chavez
Portland, OR

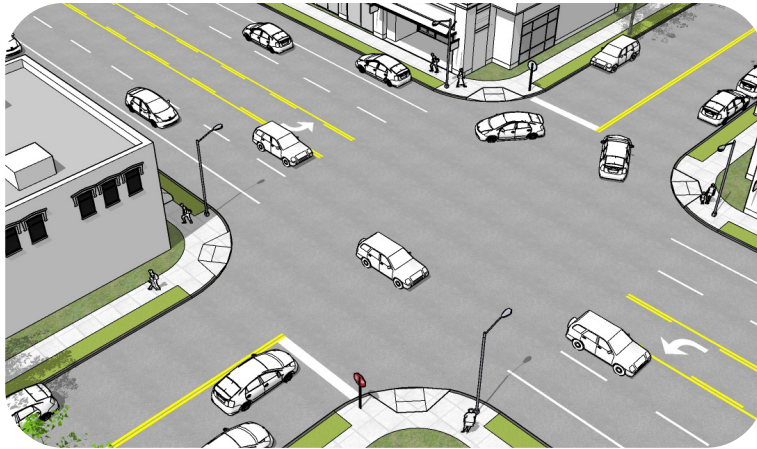
Source: Bike Portland

BEST FOR: Medium to high vehicle speed and volume



“Exit Only” Toucan

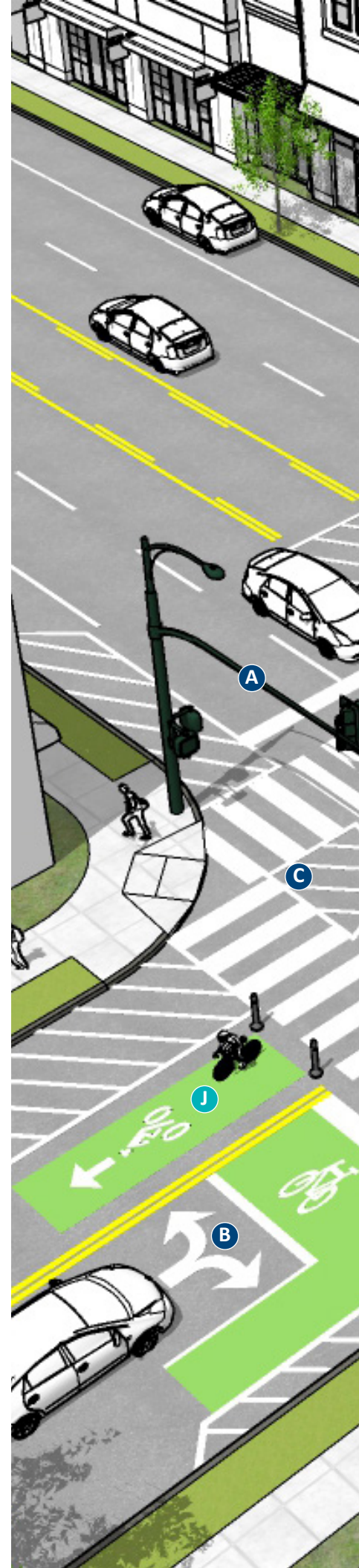
Phase 1 Intersection Design



Existing Condition

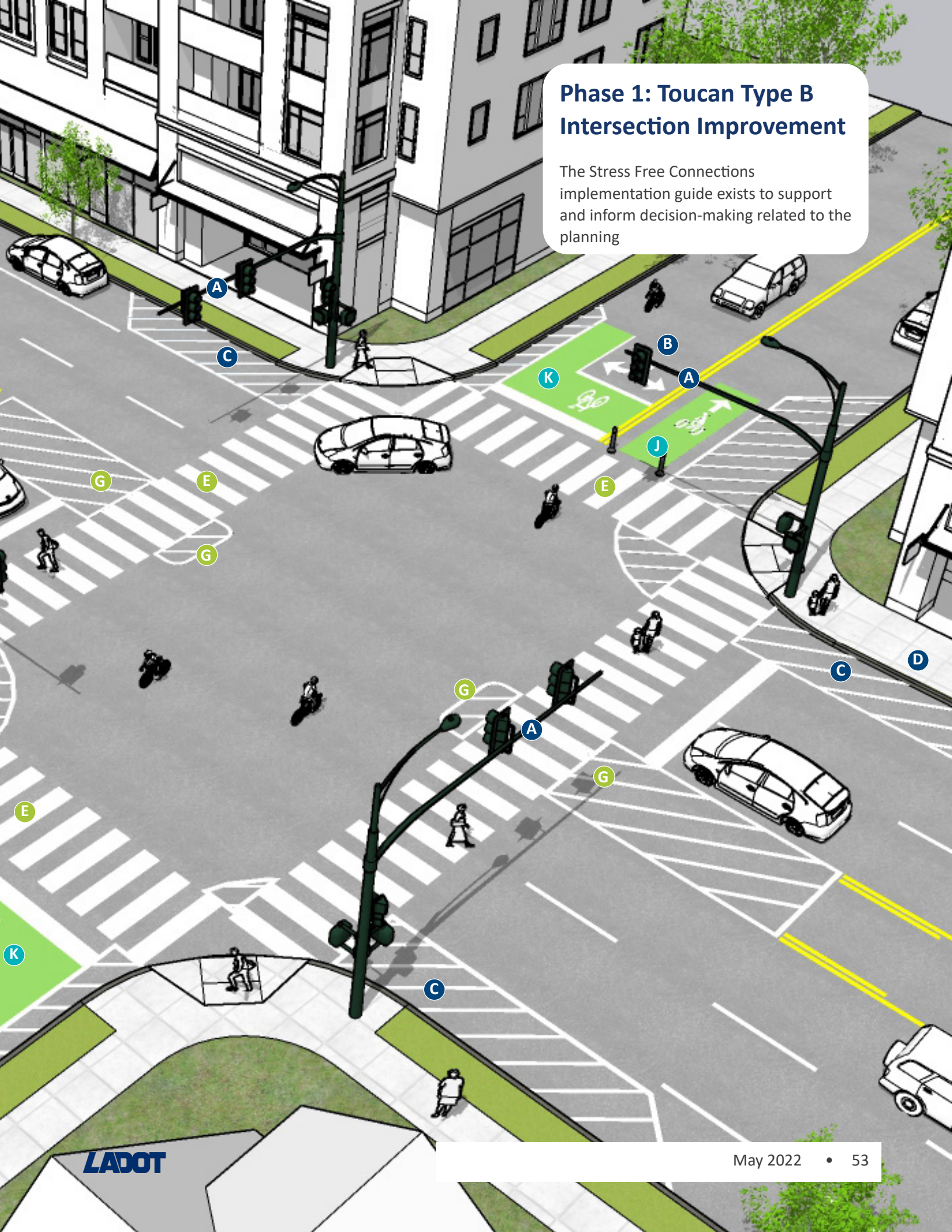
- | | | |
|------------------------------------|----------|------------|
| New Toucan Signal | A | ROADWAY |
| Vehicle Movement Striping | B | |
| Curb Extension / Sidewalk Widening | C | |
| Bus stop (if applicable) | D | PEDESTRIAN |
| High Visibility Crosswalks | E | |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | |
| Pedestrian-scale Lighting | H | BICYCLE |
| Landscape Area / Street Trees | I | |
| Dedicated Bicycle Facility | J | |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement



Phase 1: Toucan Type B Intersection Improvement

The Stress Free Connections implementation guide exists to support and inform decision-making related to the planning



“Exit Only” Toucan

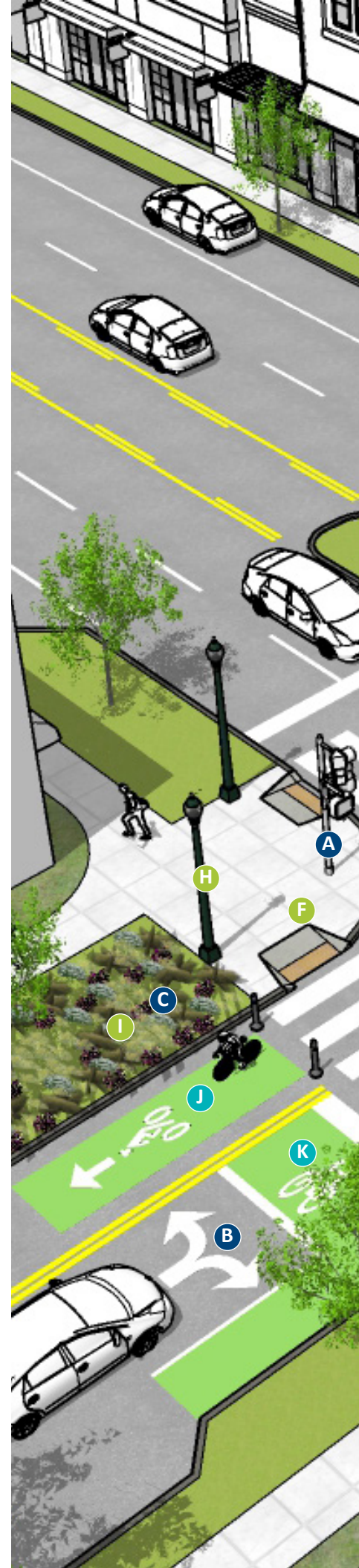
Phase 2 Intersection Design



Phase 1 Design

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|------------------------------------|----------|-------------------------------|
| New Toucan Signal | A | ROADWAY |
| Vehicle Movement Striping | B | |
| Curb Extension / Sidewalk Widening | C | |
| Bus stop (if applicable) | D | PEDESTRIAN |
| High Visibility Crosswalks | E | |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | |
| Pedestrian-scale Lighting | H | LANDSCAPE AREA / STREET TREES |
| Landscape Area / Street Trees | I | |
| Dedicated Bicycle Facility | J | BICYCLE |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement



Phase 2: Toucan Type B Intersection Improvement

The Stress Free Connections implementation guide exists to support and inform decision-making related to the planning



Off-Set Intersection

SAFETY IMPROVEMENTS/OPPORTUNITIES

Opportunities / Improvements

- Some residential street corridors identified in the NEN have off-set intersections where people walking and bicycling have no choice but to momentarily travel on a busy, major street. Such intersections can be retrofitted to make this a more pleasant, and stress free experience.
- In addition to providing crossing opportunities on both sides of the off-set, there should be context-sensitive and appropriate accommodations such as providing protected bike lanes through the off-set to provide continuity in safety and comfort. Sometimes the major street being crossed has protected bike lanes identified in the City's Mobility Plan so providing such a facility through the intersection can mark the beginning of two developing Mobility Plan networks. However, implementing a Mobility Plan 2035 network along a greater portion of the crossing arterial corridor is not a prerequisite for including a bicycle facility within the off-set intersection.



Existing Condition



Phase 1 Design



Phase 2 Design

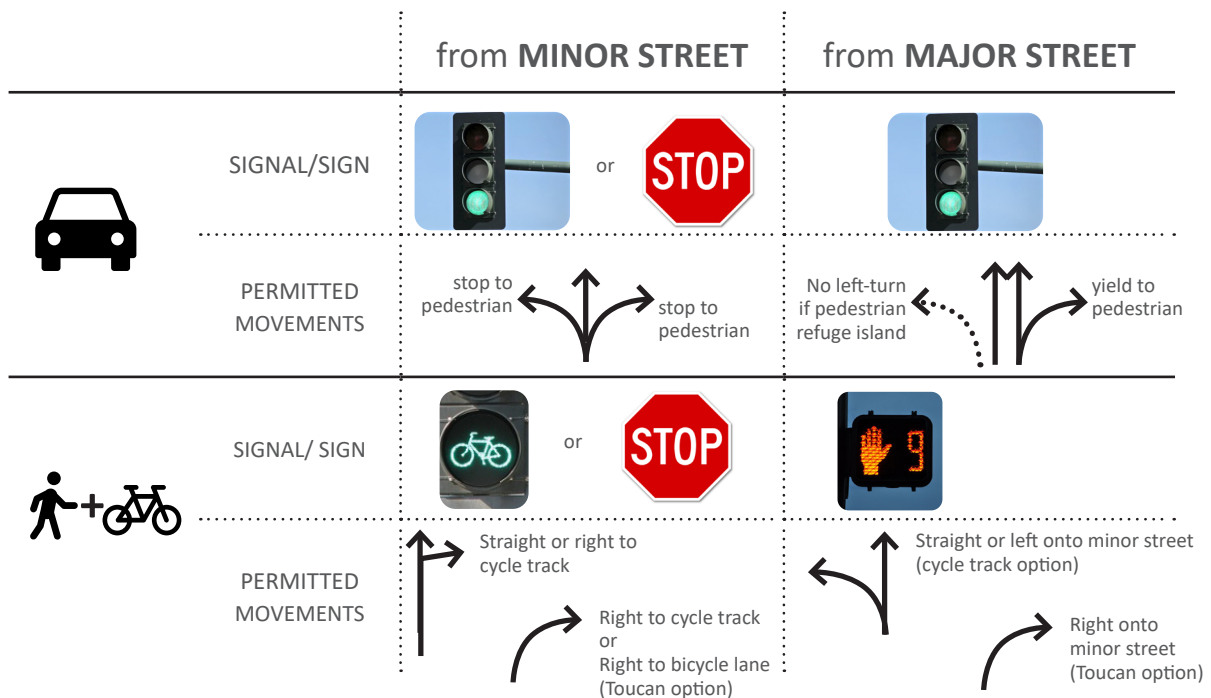
References for Appropriate Design



PRECEDENT:
Rosemead Blvd.
Temple City, CA

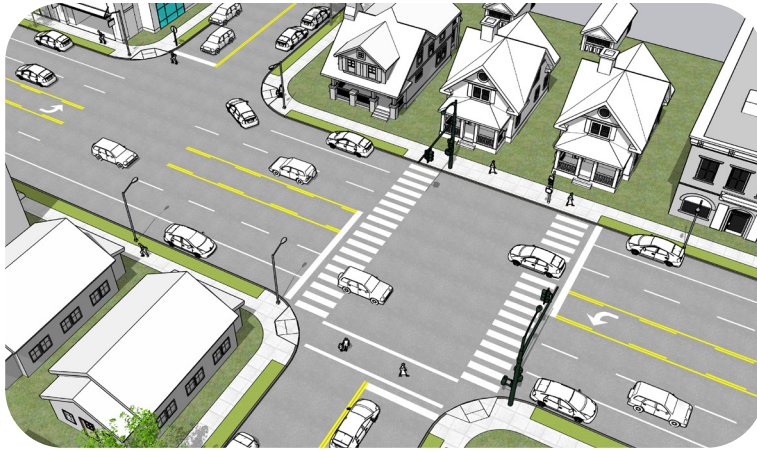
Source: Joe Linton

BEST FOR: Existing signals, gap closures

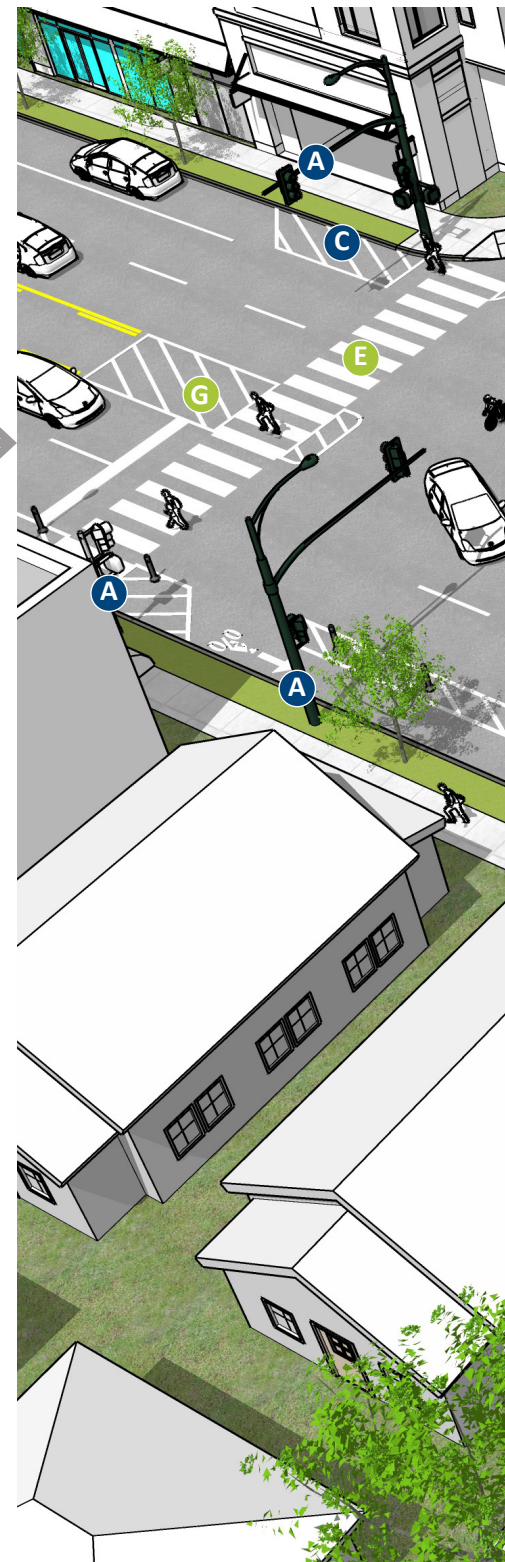


Off-Set Intersection

Phase 1 Intersection Design

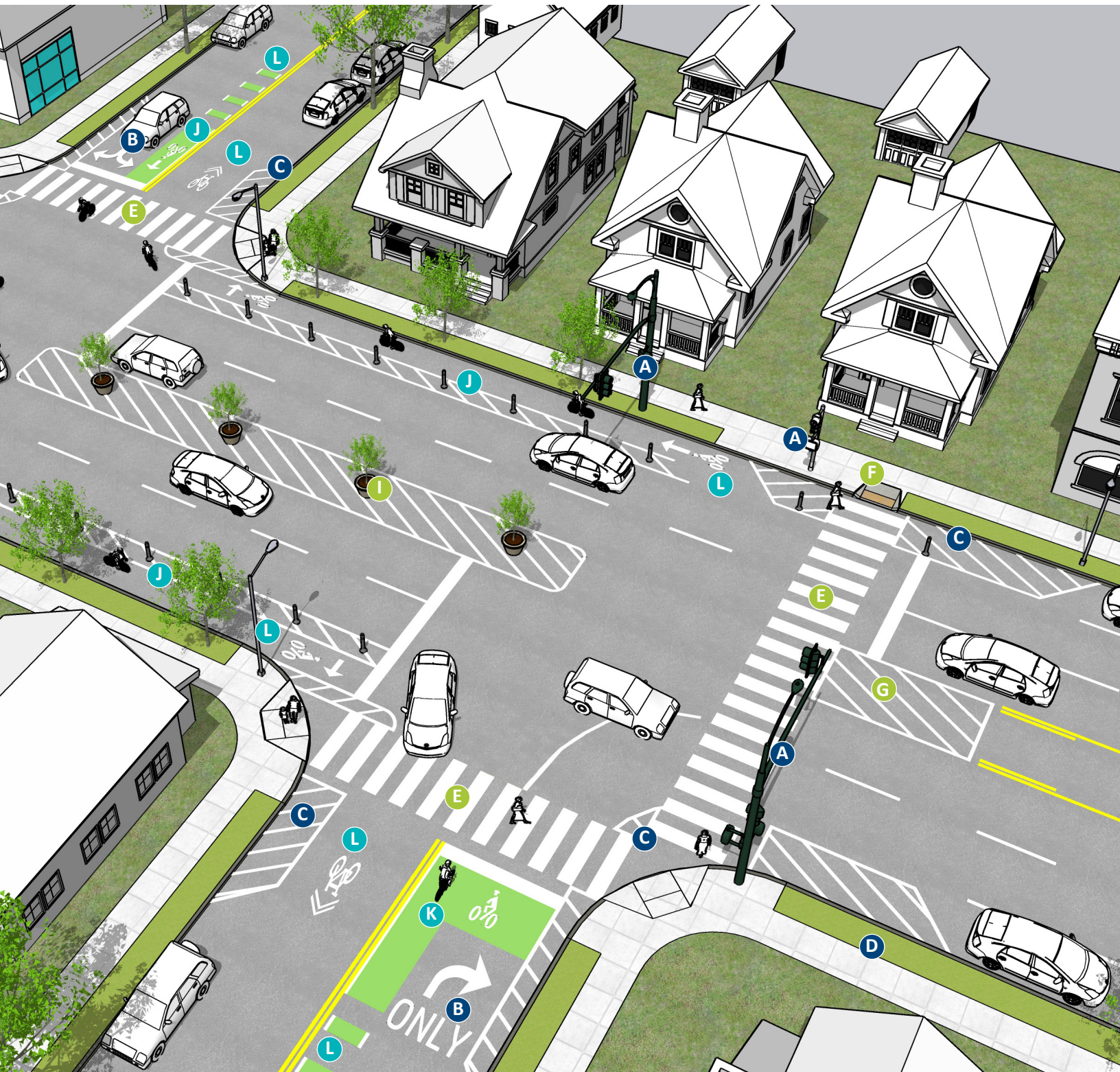


Existing Condition



- | | | |
|------------------------------------|----------|------------|
| New Signal | A | ROADWAY |
| Vehicle Movement Striping | B | |
| Curb Extension / Sidewalk Widening | C | |
| Bus stop (if applicable) | D | PEDESTRIAN |
| High Visibility Crosswalks | E | |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | |
| Pedestrian-scale Lighting | H | BICYCLE |
| Landscape Area / Street Trees | I | |
| Dedicated Bicycle Facility | J | |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement

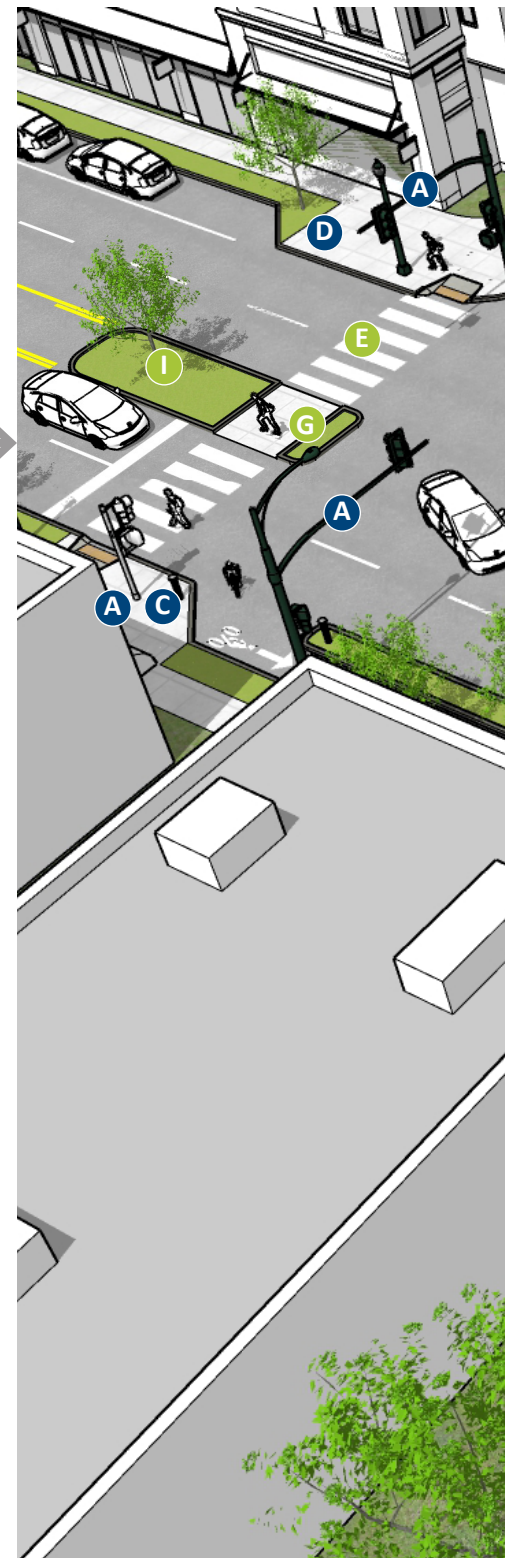


Off-Set Intersection

Phase 2 Intersection Design



Phase 1 Design



- | | | |
|------------------------------------|----------|------------|
| New Signal | A | ROADWAY |
| Vehicle Movement Striping | B | |
| Curb Extension / Sidewalk Widening | C | |
| Bus stop (if applicable) | D | |
| High Visibility Crosswalks | E | PEDESTRIAN |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | |
| Pedestrian-scale Lighting | H | |
| Landscape Area / Street Trees | I | BICYCLE |
| Dedicated Bicycle Facility | J | |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement

Phase 2: Off-Set Intersection Improvement

The Stress Free Connections implementation guide exists to support and inform decision-making related to the planning



Off-Set Intersection

Right-Jog Intersection

Opportunities / Improvements

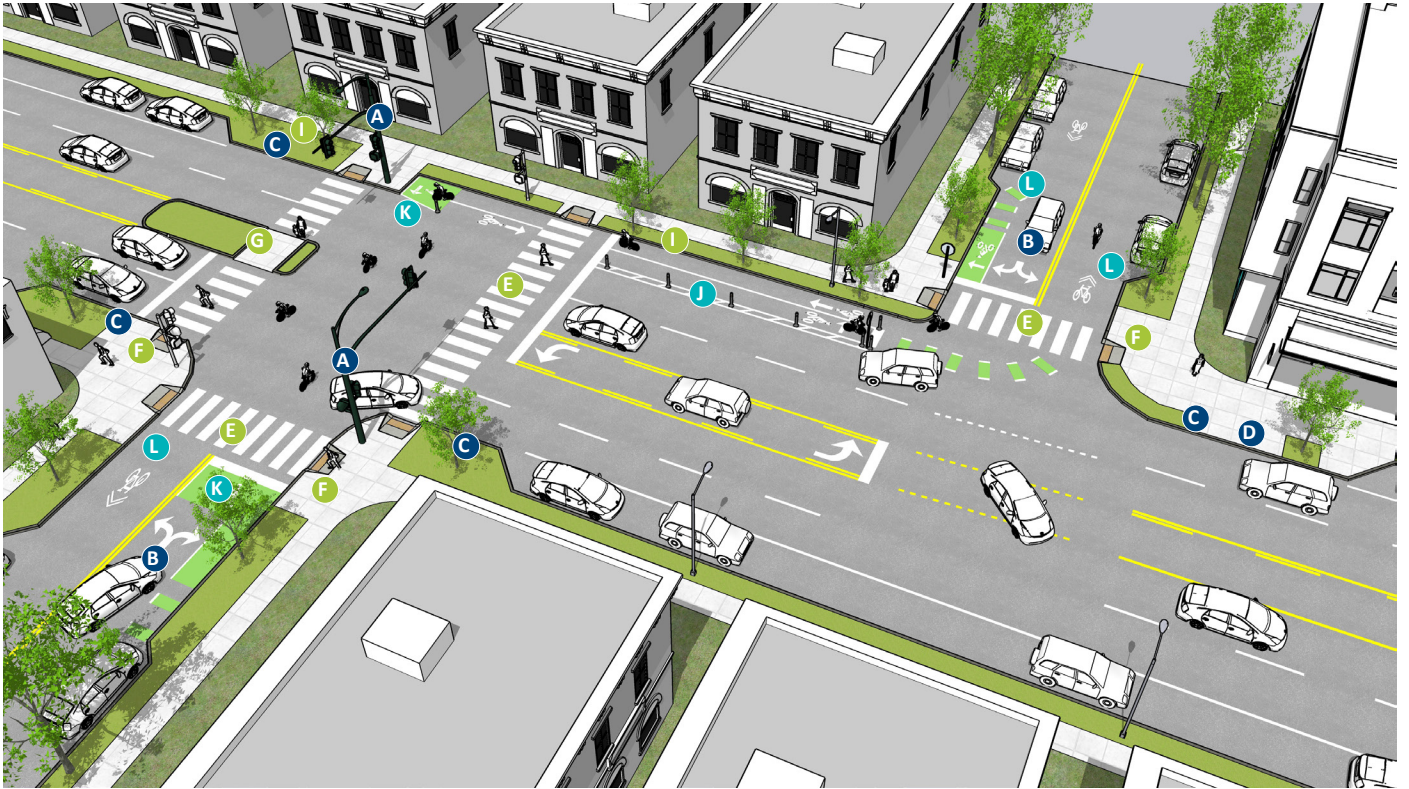
- Offset intersections can occur as both left-jog (shown on previous pages) or right-jog (shown on this page) conditions. The same approaches for bicycle and pedestrian crossings can apply to both types, but specific designs may need to be modified for specific conditions at each location.
- Page 63 shows two options for right-jog offset intersection: 2-way cycle track on one side of the street, and protected bicycle lanes on each side of the street.



- | | | | | | | | | |
|------------------------------------|----------|-------------------------------|----------------------------|----------|------------|----------------------------|----------|---------|
| New Signal | A | ROADWAY | High Visibility Crosswalks | E | PEDESTRIAN | Dedicated Bicycle Facility | J | BICYCLE |
| Vehicle Movement Striping | B | | Directional ADA Ramps | F | | Bicycle Box | K | |
| Curb Extension / Sidewalk Widening | C | | Pedestrian Refuge Island | G | | Bicycle Street Markings | L | |
| Bus stop (if applicable) | D | | Pedestrian-scale Lighting | H | | | | |
| | | Landscape Area / Street Trees | I | | | | | |

indicates optional improvement

2-Way Cycle Track Option



Protected Bicycle Lane Option

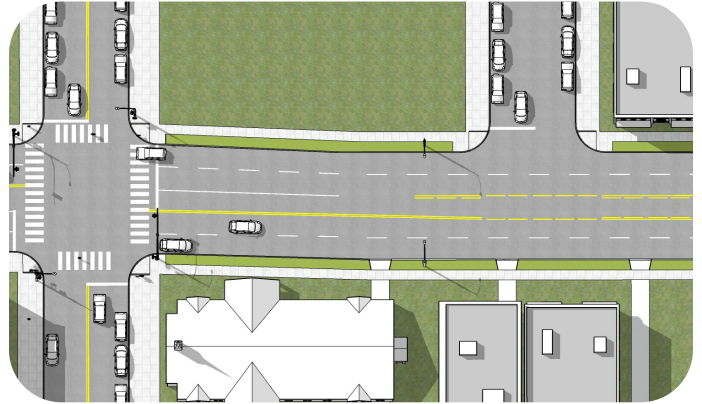


Off-Set Intersection 2

SAFETY IMPROVEMENTS/OPPORTUNITIES

Opportunities / Improvements

- Sometimes, residential street corridors identified in the NEN have off-set routing. This is distinct from an off-set intersection because the route prescribed in the NEN deviates one block away from a traditional signalized intersection. In situations like this, minor retrofits can be implemented to provide clarity and continuity in the stress free experience expected when traveling along a NEN corridor.
- Where a NEN route is off-set at a typical intersection with a major street, a low-cost measure can be to implement a block-long segment of two-way protected bike lane on one side of the street. Depending on the conditions, this may require removing some on-street parking and/or narrowing or removing existing travel lanes.
- For the direction of bicycle travel exiting the protected bike lane at the signalized intersection, a two-stage queuing box can be provided on the far-side of the intersection. This may require instituting a “No Right on Red” for the adjacent minor street. Additionally pavement markings and warning signage should be provided to raise road-user awareness of the measure.



Existing Condition



Phase 1 Design



Phase 2 Design

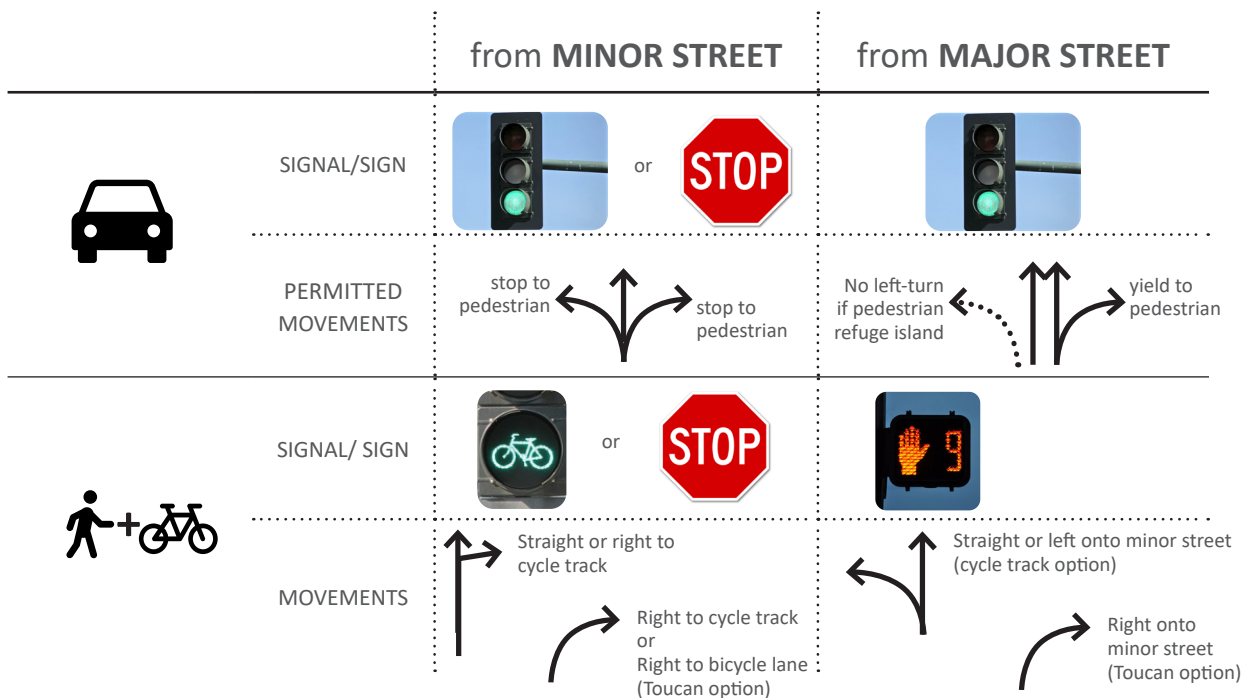
References for Appropriate Design



PRECEDENT:
87th / Division
Portland, OR

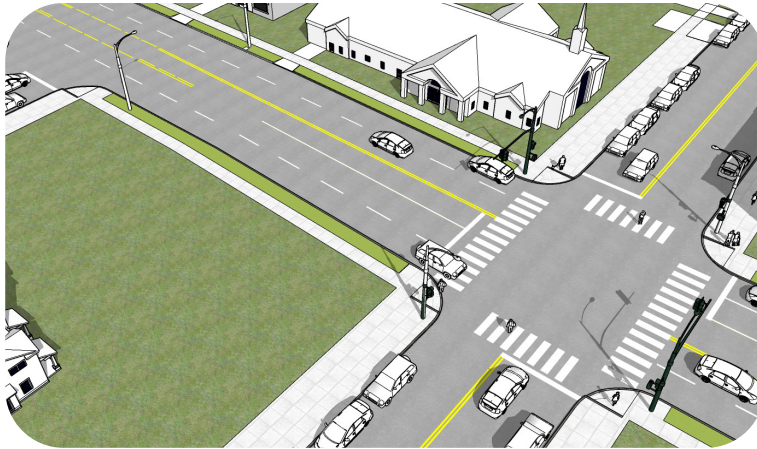
Source: Flickr - Greg Raisman

BEST FOR: Existing signals, gap closures

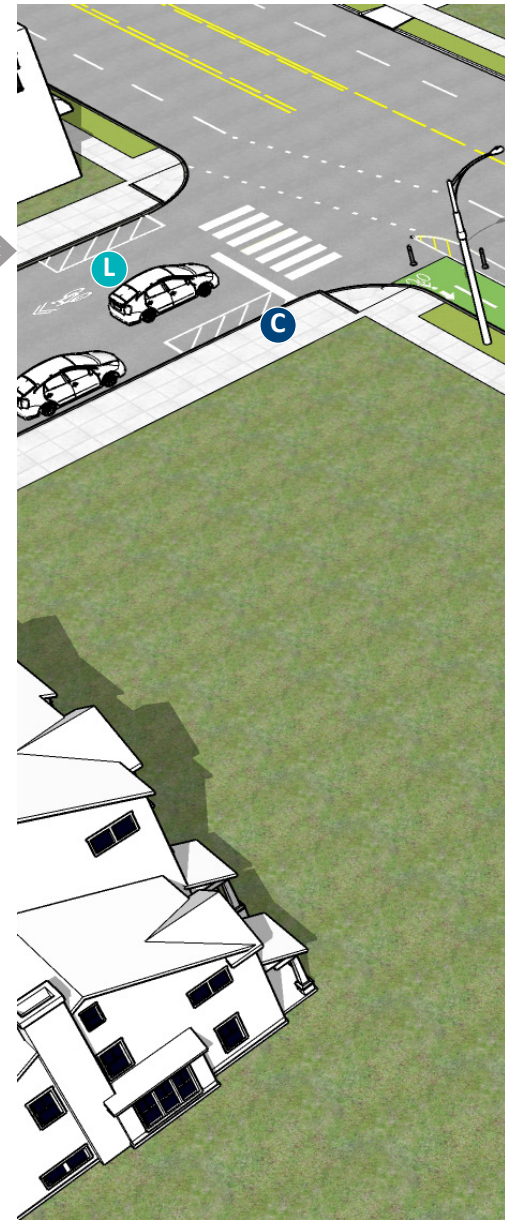


Off-Set Intersection 2

Phase 1 Intersection Design

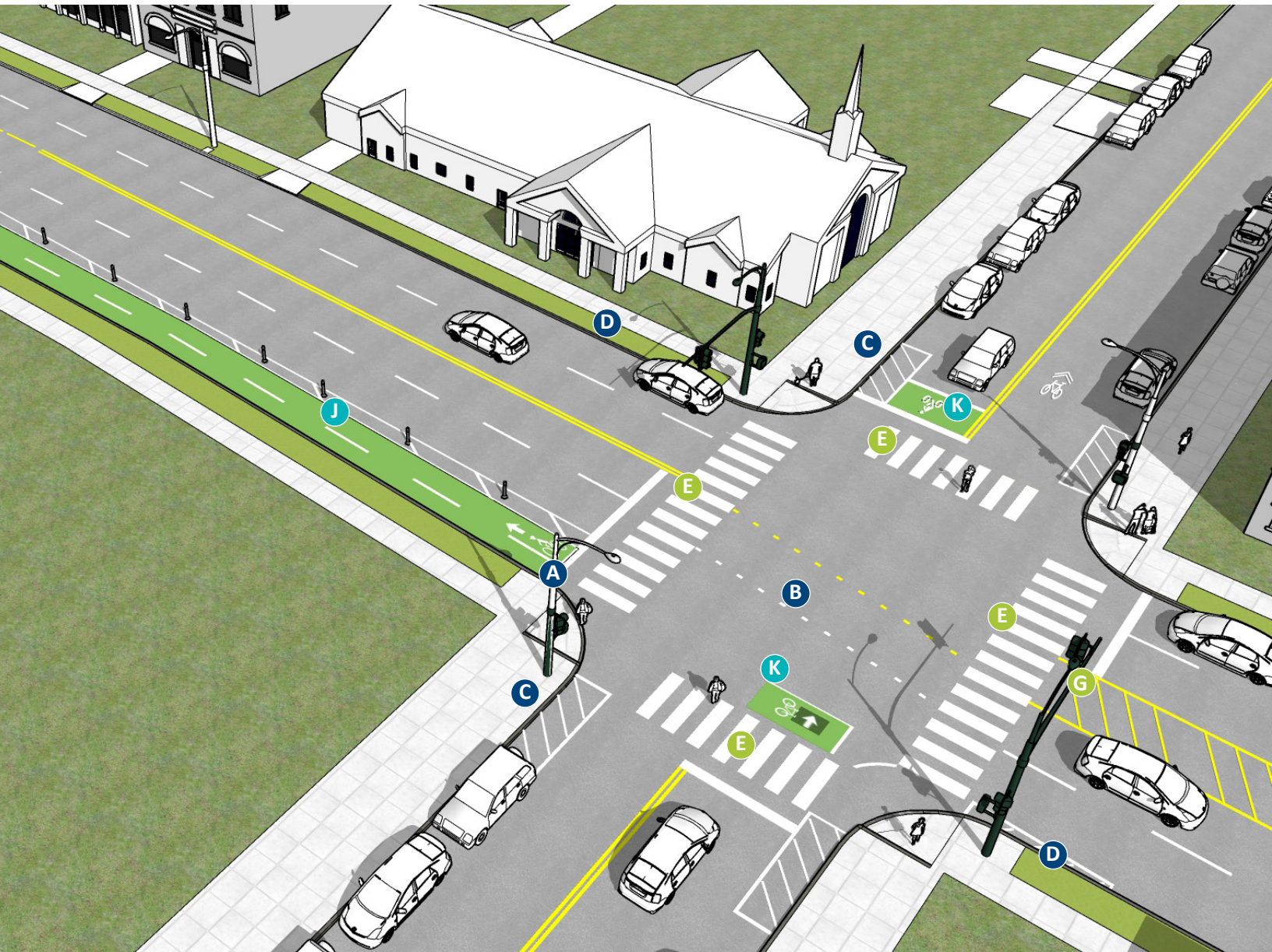


Existing Condition



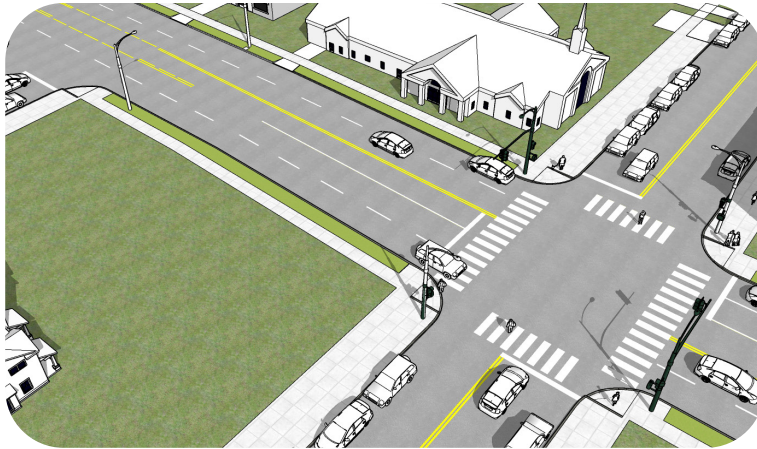
- | | | |
|------------------------------------|----------|------------|
| New Signal | A | ROADWAY |
| Vehicle Movement Striping | B | |
| Curb Extension / Sidewalk Widening | C | |
| Bus stop (if applicable) | D | PEDESTRIAN |
| High Visibility Crosswalks | E | |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | |
| Pedestrian-scale Lighting | H | |
| Landscape Area / Street Trees | I | BICYCLE |
| Dedicated Bicycle Facility | J | |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement

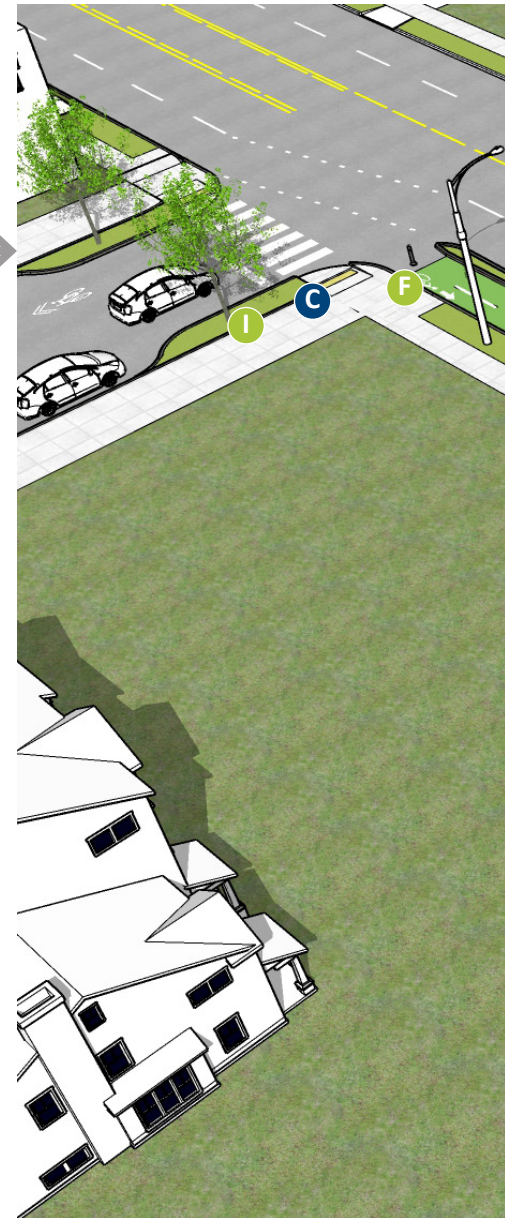


Off-Set Intersection 2

Phase 2 Intersection Design



Phase 1 Design

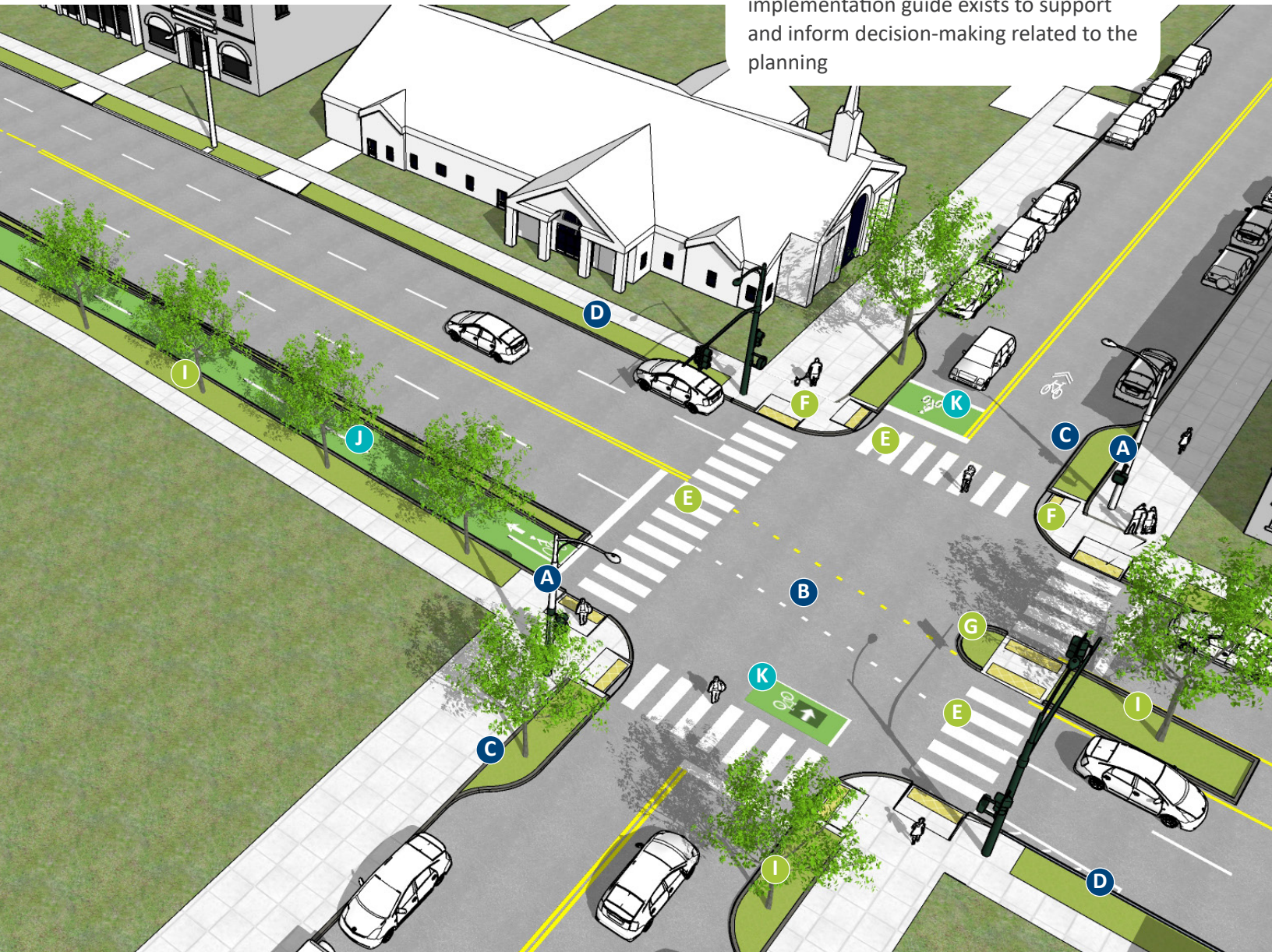


- | | | |
|------------------------------------|----------|------------|
| New Signal | A | ROADWAY |
| Vehicle Movement Striping | B | |
| Curb Extension / Sidewalk Widening | C | |
| Bus stop (if applicable) | D | |
| High Visibility Crosswalks | E | PEDESTRIAN |
| Directional ADA Ramps | F | |
| Pedestrian Refuge Island | G | |
| Pedestrian-scale Lighting | H | |
| Landscape Area / Street Trees | I | BICYCLE |
| Dedicated Bicycle Facility | J | |
| Bicycle Box | K | |
| Bicycle Street Markings | L | |

indicates optional improvement

Phase 2: Off-Set Intersection Improvement

The Stress Free Connections implementation guide exists to support and inform decision-making related to the planning



Opposed Signal Phasing

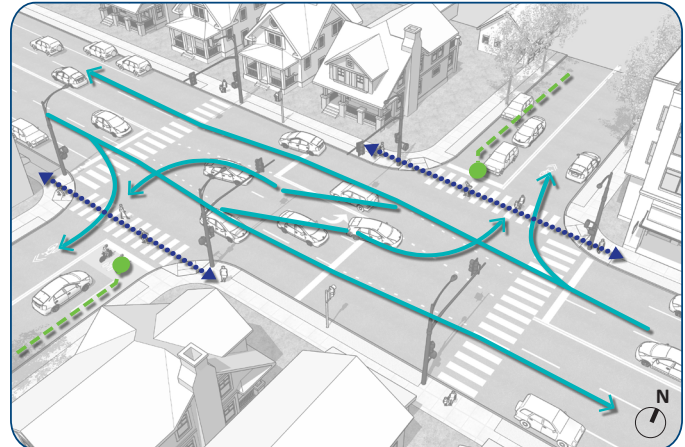
For off-set intersections

Opportunities / Improvements

- Where there are smaller off-set intersections at major street crossings along NEN corridors, providing a protected bicycle facility may not be necessary to provide continuity in comfort. In some cases, signal phasing can be adjusted to accommodate the time and space to safely and comfortably cross. This will require splitting a traffic signal cycle into three distinct phases.
- The first signal phase would provide a green light to traffic on the major arterial street to allow all right, left, and through movement.
- The second signal phase provides a dedicated green light for one side of the minor street but also provides a green light for traffic within the intersection. This effectively allows people bicycling from this leg of the intersection to make the necessary right and subsequent left turn motion to get to the other side of the street within a single signal phase.
- The third signal phase would mirror the second phase for the opposite side of the minor street.
- Opposed signal phasing should be implemented consistent with LADOT Manual of Policies and Procedures (MPP).

OPTION 1 Vehicles and bicycles share center left-turn lane

Signal Phase 1 - Major Street



from MAJOR STREET:

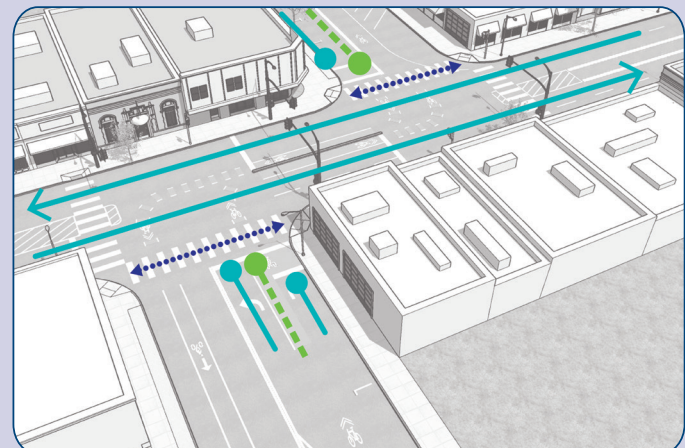
- **Eastbound Vehicles** Continue straight; can make right turn or left turn
- **Westbound Vehicles** Continue straight; can make right turn or left turn
- **Bicycles** N/A
- **Pedestrians** Cross minor street

from MINOR STREET:

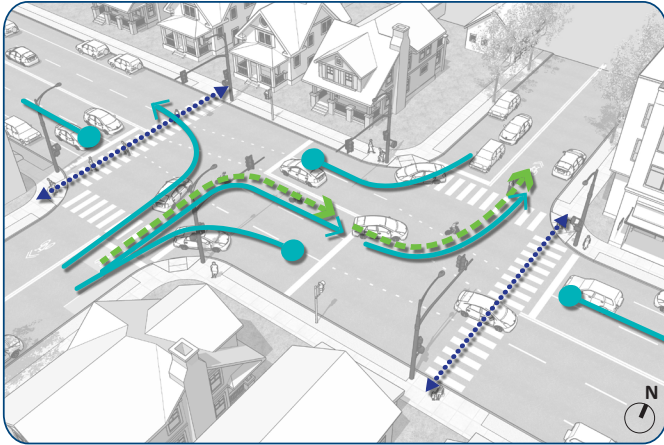
- **Vehicles** STOP
- **Bicycles** STOP
- **Pedestrians** STOP

OPTION 2 Vehicles restricted from center left-turn lane

Signal Phase 1 - Major Street



Signal Phase 2 - Minor Street (South)



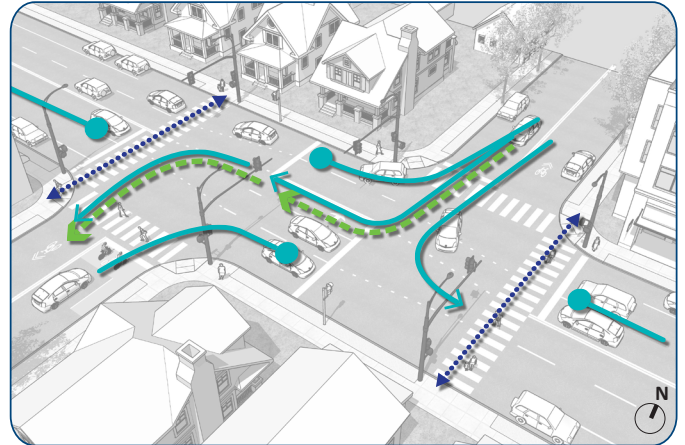
from MAJOR STREET:

- **Eastbound Vehicles** STOP at south street
- **Westbound Vehicles** STOP at north street
- **Bicycles** Make left turn onto minor street
- **Pedestrians** STOP

from MINOR STREET:

- **Northbound Vehicles** Move to left turn lane, make left turn onto minor street; can make left and right turn onto major street
- **Southbound Vehicles** Can make right turn
- **Bicycles** Move to left-turn lane
- **Pedestrians** Cross major street

Signal Phase 3 - Minor Street (North)



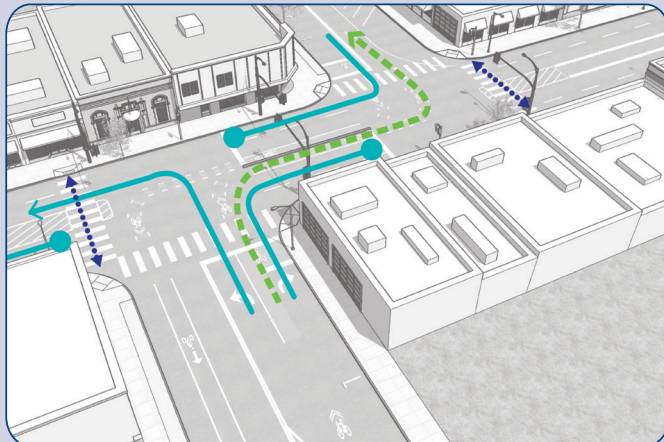
from MAJOR STREET:

- **Eastbound Vehicles** Can make right turn; STOP at north street
- **Westbound Vehicles** STOP at north street, can make a right turn if clear
- **Bicycles** N/A
- **Pedestrians** Cross west minor street

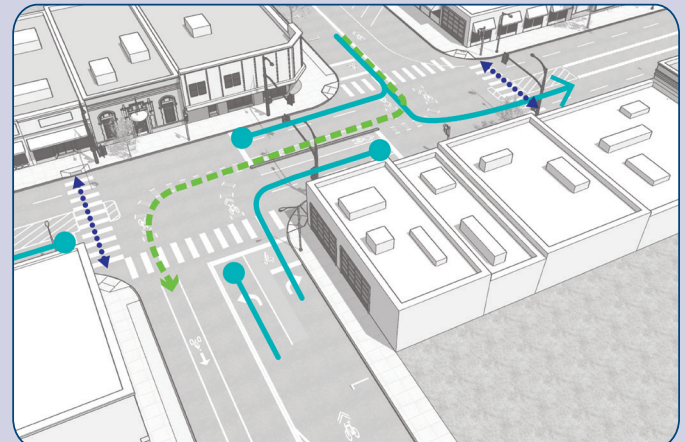
from MINOR STREET:

- **Northbound Vehicles** Can make right turn
- **Southbound Vehicles** Move to left turn lane, make left turn onto minor street; can make left and right turn onto major street
- **Bicycles** Move to left-turn lane
- **Pedestrians** Cross major street

Signal Phase 2 - Minor Street (South)



Signal Phase 3 - Minor Street (North)



5 Additional Considerations



Source: Flickr - Greg Raisman



Source: NACTO

Creating a stress-free NEN corridor begins with achieving the speed, volume, and access requirements outlined in this guide. When a corridor has retrofitted intersections to be comfortable and accessible, and reduced vehicle speeds and volumes mid-block to align with the a low LTS, there are additional elements that should be considered.

Wayfinding

Installing signage and road markings along NEN corridors is an important strategy to direct people on bicycles to and through a NEN network. Given the innate design of residential streets, traveling on NEN corridors sometimes involve making subtle right and left turns or traversing arterials at standard or jogged intersections. Wayfinding can take the form of signage to communicate proximity to major destinations and direct people at turns to remain along the NEN. Directional signage can be complemented with shared lane markings (sharrows) to provide clarity about navigating turns and indicating whether someone is on a NEN corridor. Lastly, wayfinding is an opportunity for LADOT to engage neighborhood groups and other community institutions to apply community character to the network corridors. LADOT has tested this strategy at the inaugural NEN corridor on Yucca Street, a model that could be replicated citywide. Wayfinding and shared lane markings should follow implementation of the traffic calming and accessibility measures to ensure the corridor is truly stress free and has first successfully

reduced volumes and speeds and bridged gaps at intersections. If wayfinding is implemented first or independent of complementary traffic calming and addressing barriers at major crossings, it can leave pedestrians and bicyclists stranded at busy intersections with upset expectations. Images to the right and previous page show how to effectively use wayfinding elements.

Improving Access

Access in the context of building out the NEN focuses attention on solving for barriers at major street crossing to facilitate development of a network. Additional measures that can be deployed to retrofit existing signalized and unsignalized intersections, include:

- Implementing Lead Pedestrian Intervals (LPis) as part of new or existing traffic signals along NEN corridors
- Striping crosswalks on all legs of an intersection that already has a crosswalk striped on at least one leg [insert before/after example]
- Converting 2-way stops into all-way stops
- Retrofitting existing signalized intersections to include bike boxes which allow people bicycling to easily and intuitively trigger green lights

Improving Comfort

When opportunities for resources and collaboration with partner agencies are available, NEN corridors can incorporate project components that enhance user comfort and perceived safety, including:

- Trees for shade
- Landscaping and stormwater capture
- Street lighting
- Smooth pavement conditions



Source: Longbeach.gov



Source: Madison.com, The Capital Times



Source: Greenfield Recorder



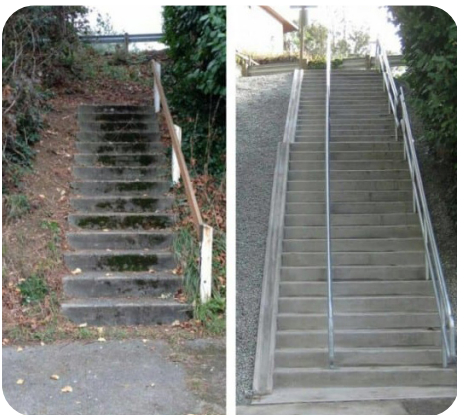
Source: Gothamist.com

Context Sensitive Barriers

In some cases, NEN corridors will have unique challenges, even after implementing measures to achieve the speed, volume, and access criteria defined in this guide. Such barriers can include and be solved for through the following:



Source: Joe Linton



Channel for bike wheels and second railing shown on image to right.

Source: Seattle Bike Blog

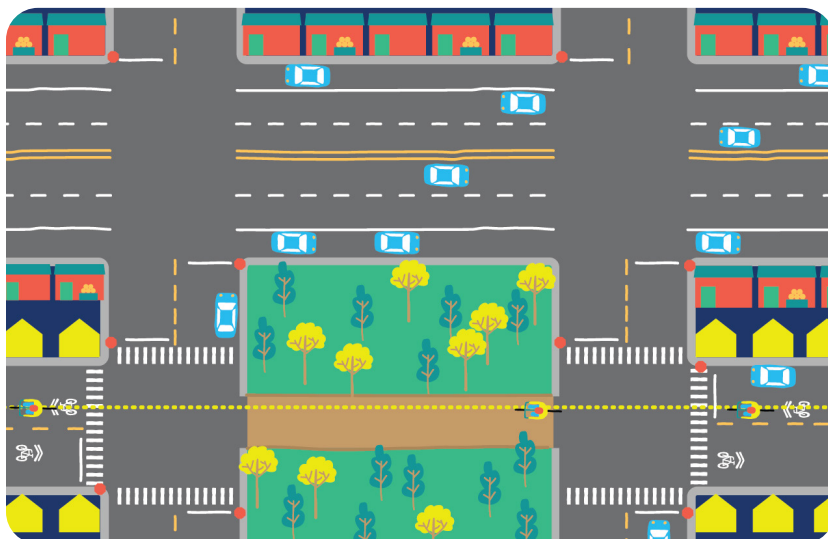
- **At-Grade Train Tracks:** Where a NEN corridor crosses at grade train tracks, the path of travel for a person on a bicycle should be designed so that bicycle tires cross train tracks at a perpendicular angle. This may require implementing a brief stretch of bike lane, bike path, or sharrows to gently direct the bicycle user so that when they reach the train tracks they are as perpendicular to the tracks as possible. This will reduce the likelihood of bicycle user's tires getting caught in the tracks and potentially falling off their bike.
- **Hills/Topography:** Although comfortable NEN networks should avoid inclines wherever possible, there may be unavoidable circumstances in which a bicycle user must navigate hilly terrain or prolonged inclines. When a street's grade is sufficiently steep, some bicyclists opt to dismount and walk their bicycle up a hill on an adjacent sidewalk if it is available. However, for bicycle users that want to continue riding on inclines, separate lateral space should be created so that bicyclists do not feel pressured to share a lane with vehicle traffic. This separation can take the form of a bike lane or protected path and be accommodated by narrowing travel lanes or repurposing road space. Where space is limited, uphill accommodations can be reserved to "bike turnouts" around bends to avoid situations where an uphill driver veers into oncoming traffic at a blind corner to overtake a bicyclist. For descending declines, separate space for bicycles can be provided but is not as necessary. If separate space is provided, it should be sufficiently wide so that bicyclists do not feel constrained or risk



Separate space for a bicycle as a "bike turnout" for uphill, bend section of a road.

striking their pedal on a curb. In the NEN context, most often an uphill or “climbing” bike lane and downhill sharrow should satisfy infrastructural needs and considerations.

- **Parks and Pedestrian Space:** On occasion, NEN corridors may have gaps due to the presence of parks or pedestrian spaces. Where possible and appropriate, a direct path of travel for people on bike and foot can be accommodated through the park. This can mean removing barriers such as closely spaced bollards to create enough space for bicycles to comfortably filter through while still prohibiting vehicle access or constructing curb ramps so that bicycles can transition from roadway to pedestrian space without needing to dismount. In some contexts, dedicated space for bikes can be delineated, striped, and signed for through a pedestrian space or park. Any path provided should be paved with concrete, asphalt, or decomposed granite while avoiding surfaces such as dirt or gravel which are less accessible. Every effort should be made to avoid requiring bicycles to take a detour around pedestrian spaces unless pedestrian volumes are so high that accommodating bicycles would adversely affect the pedestrian experience.
- **Stairs:** Although a connected network of neighborhood streets will generally travel along surface streets, there may be unique circumstances where a street briefly turns into a stairway or requires traveling a set of stairs to stay on a route (such as traversing an overpass) to overcome a barrier or reach a destination. In such cases, a bicycle-friendly ramp, runnel, or channel can be provided so that people can push their bicycles rather than carry their bicycles up or down a set of stairs.



Bicycle route continues straight through the park.



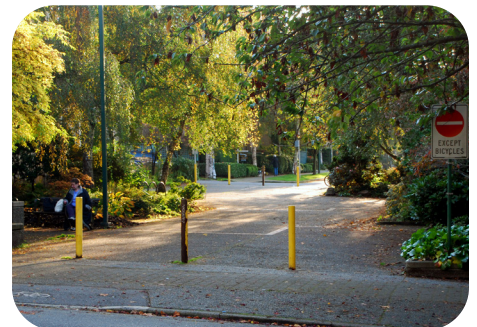
Overpass designed for bicycles

Source: Bicycle Dutch



Crosswalk and Bicycle Lane Mixing

Source: Bicycle Dutch



Bicycle/Pedestrian access between streets

Source: BeyondDC



Bicycle/Pedestrian path through park

Source: BeyondDC

Appendix

Investigating the Effectiveness of Traffic Calming Strategies on Driver Behavior, Traffic Flow and Speed⁶

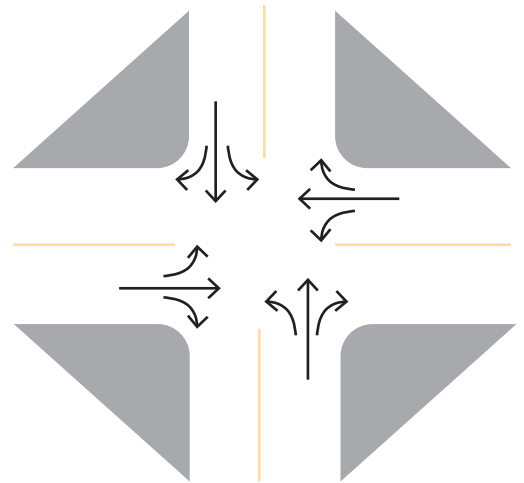
STRESS FREE CONNECTIONS TERMINOLOGY	SPEED REDUCTION	VOLUME REDUCTION	SPEED/VOLUME COMBINED	INCLUDING CRASH REDUCTION
SPEED HUMP	22%	18%	40%	53%
CHICANE	11%	20%	31%	
CURB EXTENSION	4%	10%	14%	
TRAFFIC CIRCLE	14%	5%	19%	47%
CHANNELIZED INTERSECTION	4%	35%	39%	
ENHANCED CURB EXTENSION	NO DATA	42%		
MEDIAN ISLAND	NO DATA	42%		

⁶Corkle, J., Giese, J., Marti, M. (2022). *Investigating the Effectiveness of Traffic Calming Strategies on Driver Behavior, Traffic Flow and Speed* (Report No. MN/RC-2002-02). Minnesota Local Road Research Board.

https://nacto.org/docs/usdg/investigating_effectiveness_of_traffic_calming_strategies_corkle.pdf

12 Intersection Movements

The diagram to the right shows the 12 intersection movements by vehicles at an intersection: straight through, left-turn, or right-turn from all four directions.



LADOT Assigned Value - Effectiveness

EFFECTIVENESS	<5%	5-10%	10-20%	20-30%	30-40%	40%+
ASSIGNED VALUE	1	2	3	4	5	6

LADOT Assigned Value - Behavior Change

BEHAVIOR CHANGE	NO CHANGE	SLOWS DOWN	REQUIRES CAREFULLY NAVIGATING AROUND TRAFFIC MEASURE	MAINTAINS AT LEAST 66% OF 12 INTERSECTION MOVEMENTS*	MAINTAINS AT LEAST 50% OF 12 INTERSECTION MOVEMENTS	MAINTAINS AT LEAST 33% OF 12 INTERSECTION MOVEMENTS
ASSIGNED VALUE	1	2	3	4	5	6

LADOT Traffic Calming Ratings

SPEED CONTROL MEASURES	EFFECTIVENESS		BEHAVIOR CHANGE	
	EFFECTIVENESS	BEHAVIOR CHANGE	EFFECTIVENESS	BEHAVIOR CHANGE
SPEED HUMP	3	2	5	6
CHICANE	2	3	6	4
CURB EXTENSION	1	3	6	5
TRAFFIC CIRCLE	3	3	5	6
			5	6



This Implementation Guide provides the criteria that need to be addressed and corresponding design solutions to consider in order to build out the Mobility Plan's Neighborhood Enhanced Network (NEN). While the Guide is comprehensive and covers a wide range of conditions and elements to consider, there may be additional factors that should be accounted for when developing stress free neighborhood corridors. Creating comfortable, safe, and inviting neighborhood corridors is a context-sensitive process and the means of achieving such conditions can vary street by street.



Los Angeles Department of Transportation



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