HCM URBAN STREETS METHODOLOGY
OCTOBER 31, 2013

Bicyclist, Pedestrian, and Transit Passenger

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Learning Objectives

- Discuss the impacts of various inputs on the LOS of each mode
- Discuss recent case studies of how the methodology has been applied

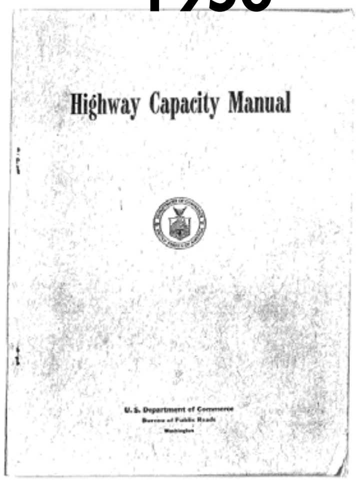
Agenda

- Brief history of HCM multimodal analysis
- Development of the HCM methodology
  - Pedestrian LOS model
  - Bicyclist LOS model
  - Transit Passenger LOS model
- Case Studies
  - General Plan & Specific Plan
  - Congestion Management Program
  - Traffic Impact Analysis
  - Road Diet Analysis
- Q&A

HCM Multimodal History

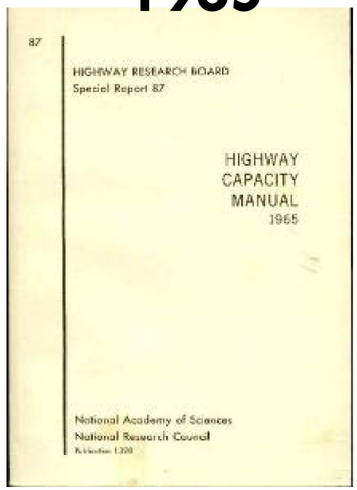
Brief History of Highway Capacity Manual (HCM) Multimodal Analysis

1950



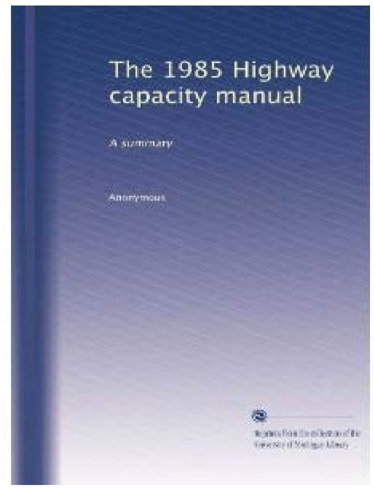
Transit and pedestrian impacts on motor vehicle capacity

1965



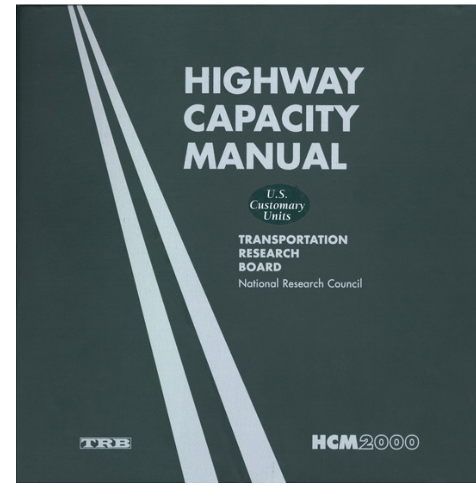
Level of Service concept and bus transit chapter

1985



Expanded bus transit chapter, new pedestrian chapter (density), and new bicycle chapter (vehicle hindrance)

2000

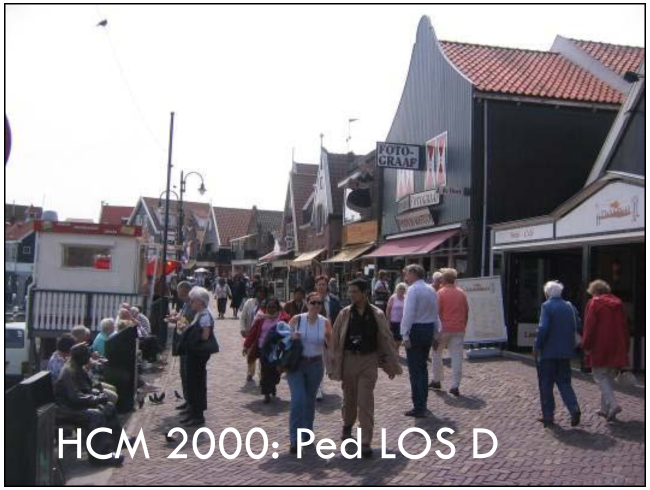


4 Transit LOS measures, expanded pedestrian and bicycle chapters

Brief History of Highway Capacity Manual (HCM) Multimodal Analysis

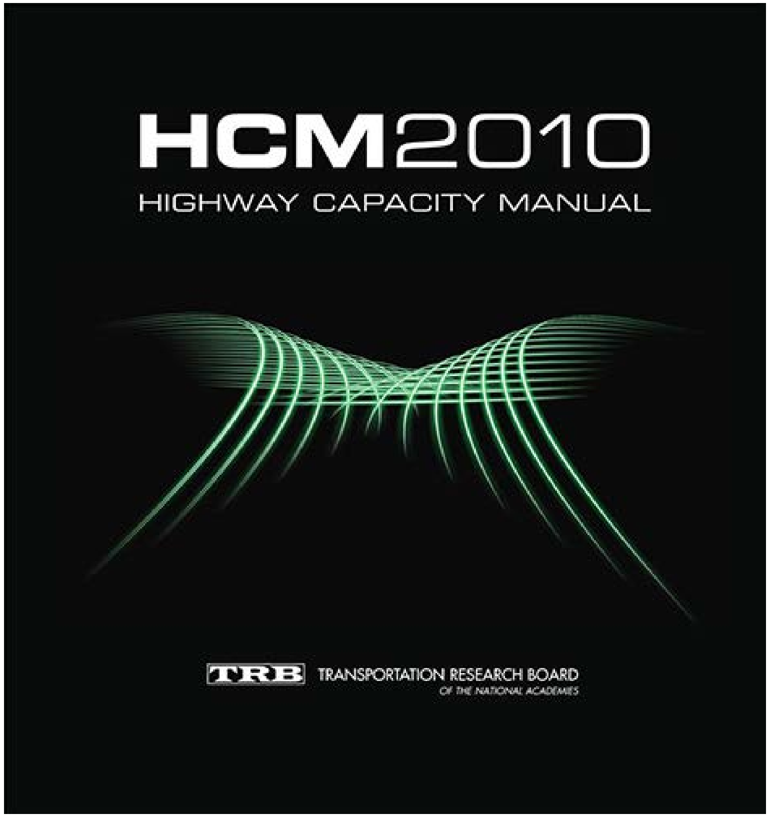
- Issues with HCM 2000:
  - Pedestrian and bicyclist LOS measures reflected a motorist perspective of density
  - Transit measures reflected a traveler's perspective, but the multiple LOS measures created issues with results interpretation

HCM 2000: Ped LOS A



HCM 2000: Ped LOS D

HCM 2010 Multimodal Philosophy

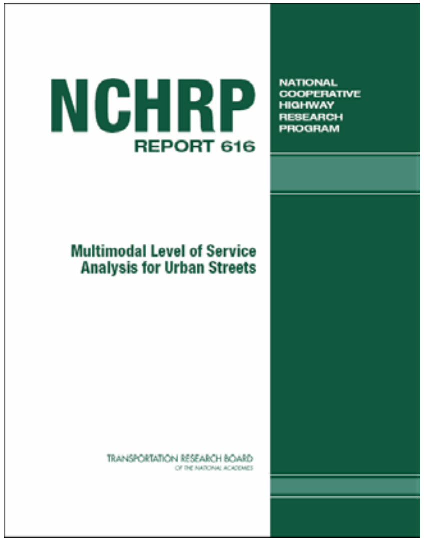


- Integrate multimodal analysis methods into appropriate chapters
  - Road user perspective
  - No separate bicyclist, pedestrian, or transit passenger chapters
    - Methodologies for all modes presented together and intertwined
  - Encourage software developers to add multimodal analysis features

Methodology Development

Methodology Selection

- NCHRP Report 616 method used in HCM 2010
  - Designed specifically for the HCM
  - LOS measures based on traveler perceptions
  - Modal LOS scores can be directly compared to each other and reflect average traveler satisfaction by mode
  - Model developed and tested based on national conditions



Methodology Development

- Pedestrian, bicyclist, motorist:
  - 90 typical street segments recorded
  - Video labs in four cities around the U.S.
  - 120 Participants rated conditions on an A-F scale

Methodology Development

- Transit passenger:
  - Video lab not feasible
  - On-board surveys conducted in 4 cities
    - However, results showed biased results
  - Final model was based on national traveler response data to changes in transit service quality
    - For example, when service frequency or travel time is improved, ridership increases

Methodology Characteristics

- All models generate an perception score that is generally in the range of 1 to 6 (A to F)
- All models have multiple service quality factors as inputs
  - Traditional HCM service measures are based on a single factor (e.g., delay)
- LOS thresholds are the same across models

LOS Score Interpretation

LOS	LOS Score
A	≤2.00
B	>2.00–2.75
C	>2.75–3.50
D	>3.50–4.25
E	>4.25–5.00
F	>5.00

- Motorist LOS is based on *travel speed as a percentage of base free-flow speed* instead of on the perception score developed in research

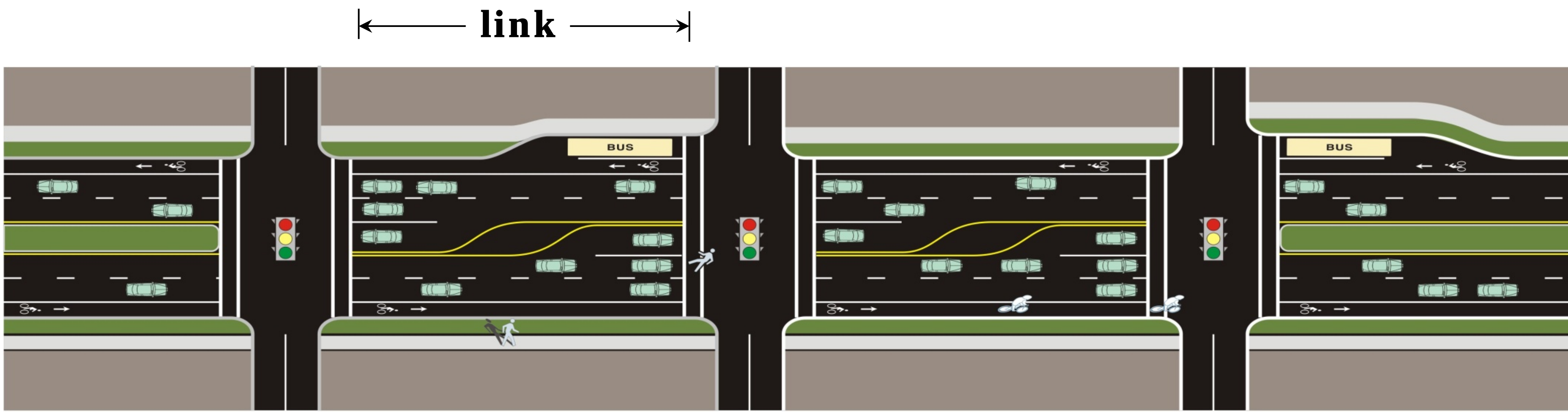
LOS Score Interpretation

- LOS is reported individually by mode and direction
- No combined LOS for the street
  - Vehicle volumes would typically dominate an LOS weighted by number of travelers
  - Combined LOS would potentially mask important deficiencies for a given mode
- Measures the degree to which urban streets meet the need of all users

Treatment of Safety in Multimodal LOS

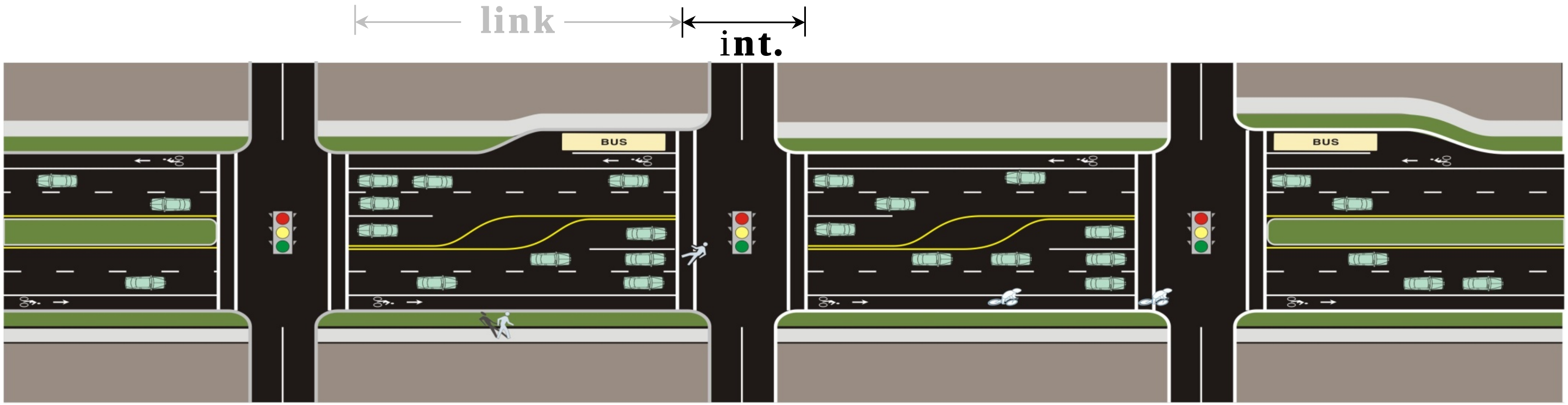
- HCM 2010 does not explicitly include safety in LOS calculations.
  - Collision history does not affect LOS
- However, HCM 2010 does include safety implicitly.
  - Traveler Perceived Safety
    - Speed of traffic
    - Percent heavy vehicles
    - Barriers between sidewalk and street
    - lateral separation between vehicle stream and bicyclists and pedestrians

Urban Street System Elements: Link



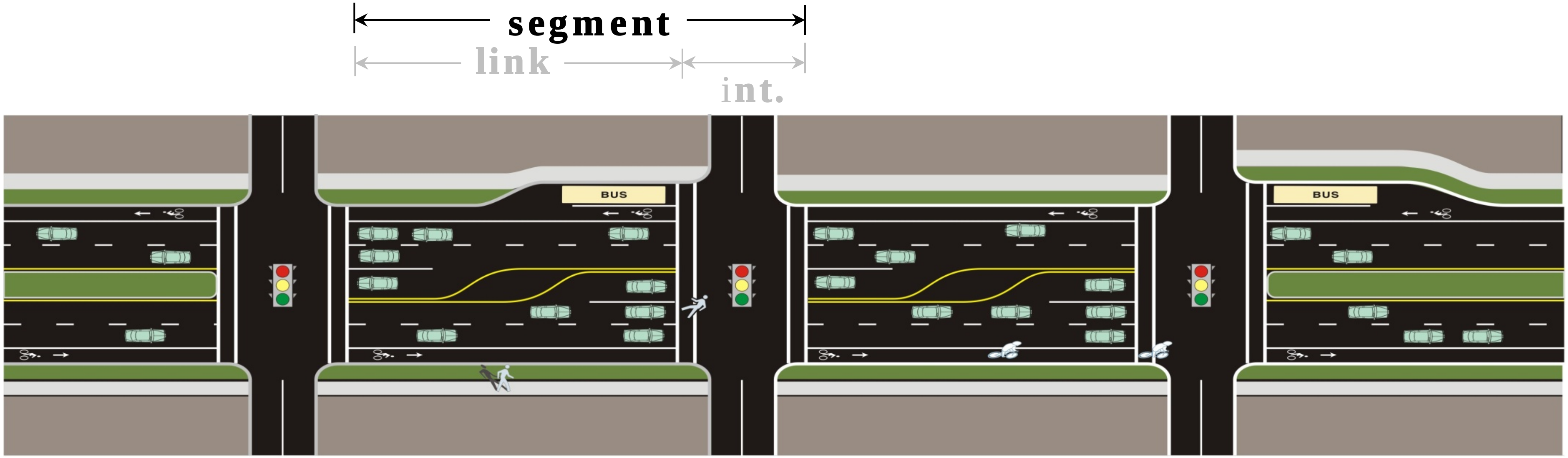
- Distance between two signalized intersections
  - Roundabout or all-way STOP could also be an end point
- Perception score for bicyclists and pedestrians

Urban Street System Elements: Intersection



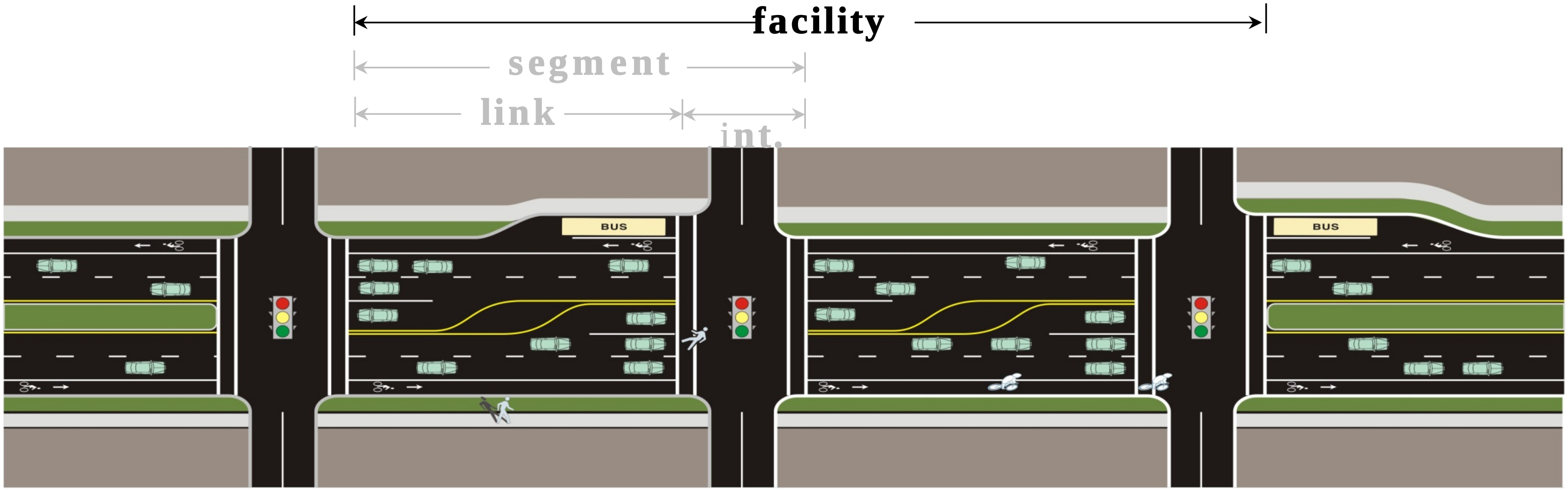
- Signalized intersection, roundabout, or all-way STOP that terminates a link
- Intersection scores only for pedestrians and bicyclists

Urban Street System Elements: Segment



- Segment = link + downstream intersection
- Perception scores available for all modes
  - Pedestrian/Bicyclist scores based on combination of link, intersection, and additional factor

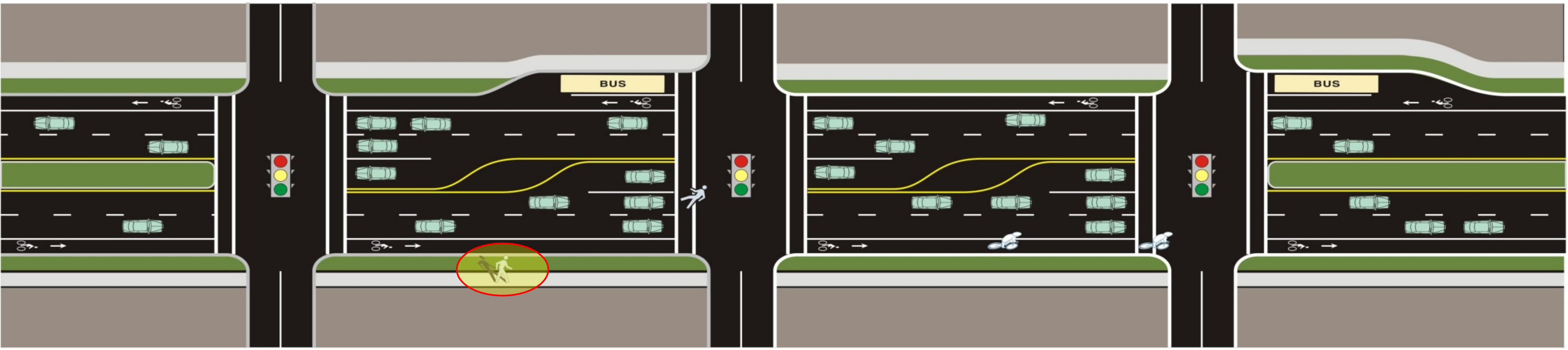
Urban Street System Elements: Facility



- Facility = 2 or more consecutive segments
- Perception scores available for all modes
  - Length-weighted average of the segment scores

Pedestrian LOS

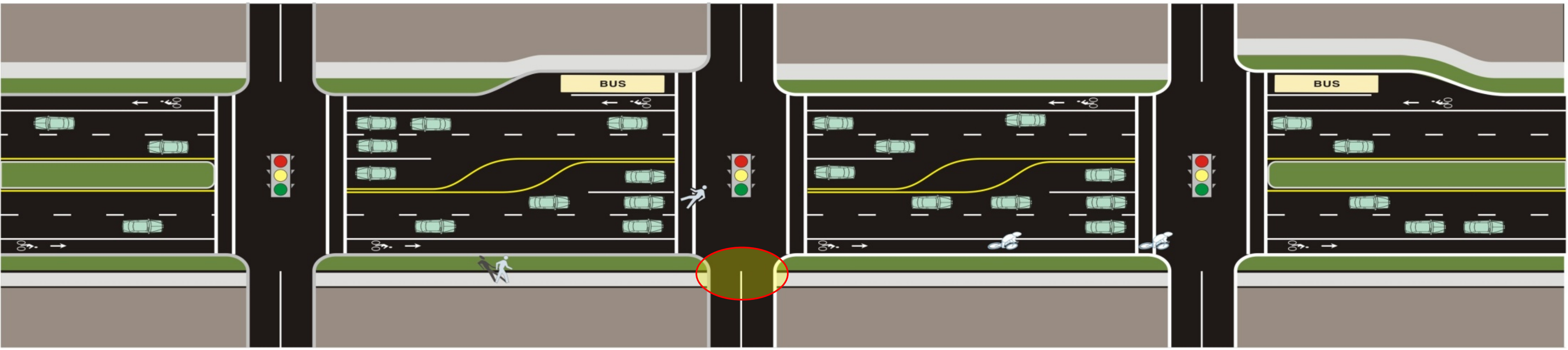
Pedestrian LOS: Links



Pedestrian LOS: Links
Model Factors

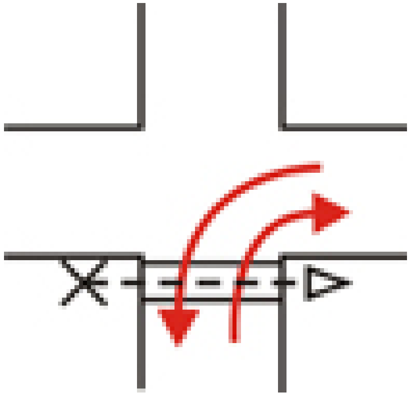
- Factors included:
  - Outside travel lane width (+)
  - Bicycle lane/shoulder width (+)
  - Buffer presence (e.g., on-street parking, street trees) (+)
  - Sidewalk presence and width (+)
  - Volume and speed of motor vehicle traffic in outside travel lane (–)
- Pedestrian density considered separately
  - Worse of (density LOS, link LOS score) used in determining overall link LOS

Pedestrian LOS: Signalized Intersections

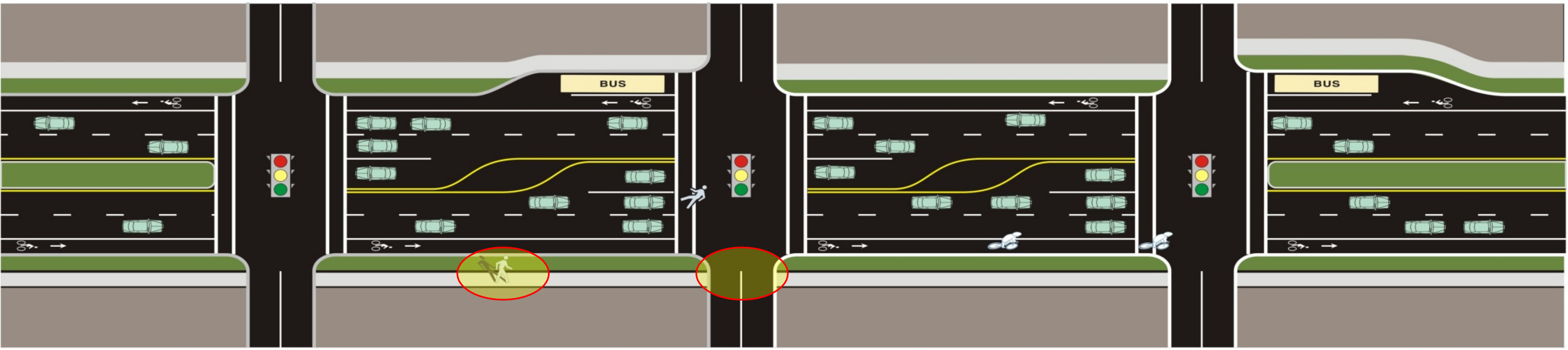


Pedestrian LOS: Signalized Intersections Model Factors

- Factors included:
  - Permitted left turn and right-turn-on-red volumes (–)
  - Cross-street motor vehicle volumes and speeds (–)
  - Crossing length (–)
  - Average pedestrian delay (–)
  - Right-turn channelizing island presence (+)



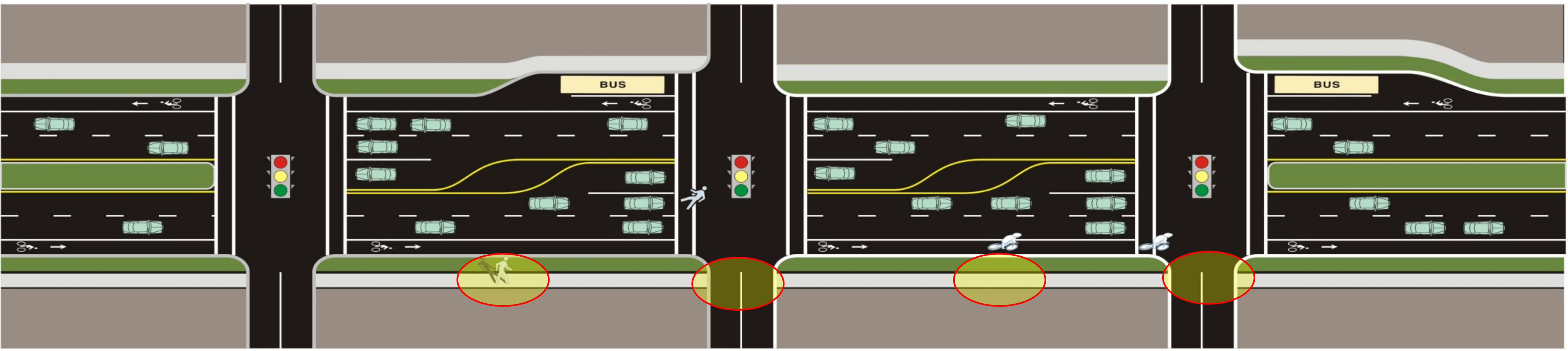
Pedestrian LOS: Segments



Pedestrian LOS: Segments Model Factors

- Factors included:
  - Pedestrian link LOS (+)
  - Pedestrian intersection LOS (+)
  - Street-crossing difficulty (–/+)
    - Delay diverting to signalized crossing
    - Delay crossing street at legal unsignalized location

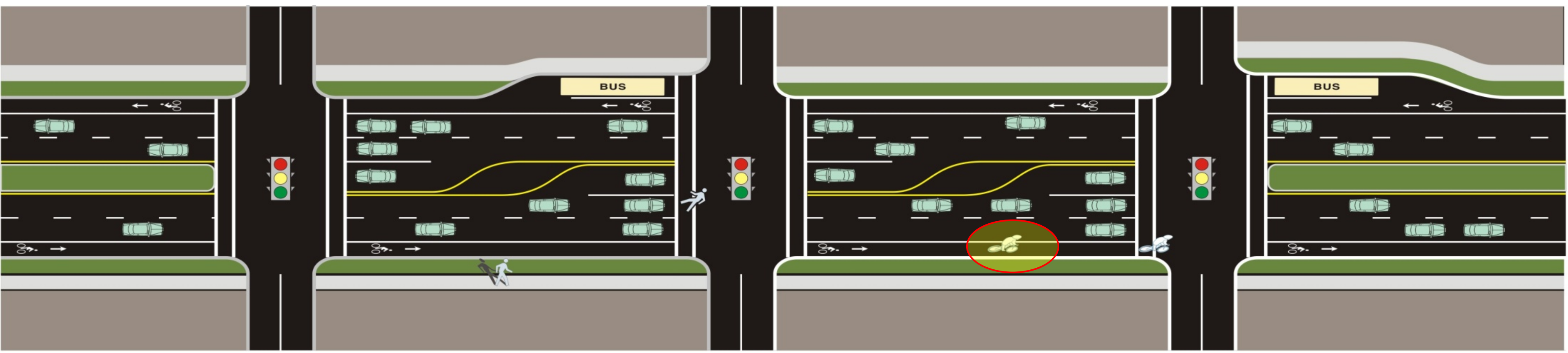
Pedestrian LOS: Facility



- **Length-weighted average of segment LOS scores**
  - Can mask deficiencies in individual segments
  - Consider also reporting segment LOS score for the worst segment in the facility

Bicyclist LOS

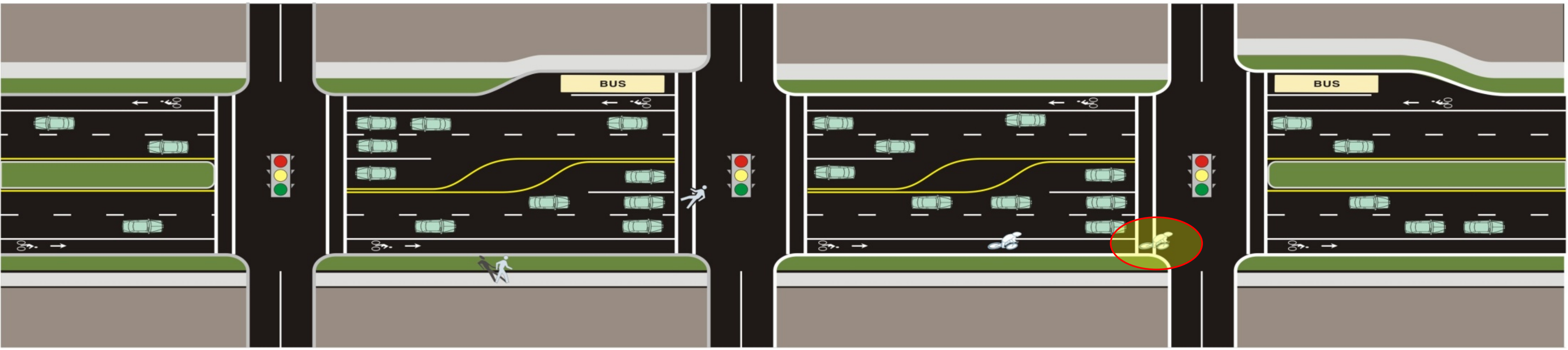
Bicyclist LOS: Links



Bicyclist LOS: Links
Model Factors

- Factors included:
  - Volume and speed of traffic in outside travel lane (–)
  - Heavy vehicle percentage (–)
  - Pavement condition (+)
  - Bicycle lane presence (+)
  - Bicycle lane, shoulder, and outside lane widths (+)
  - On-street parking utilization (–)

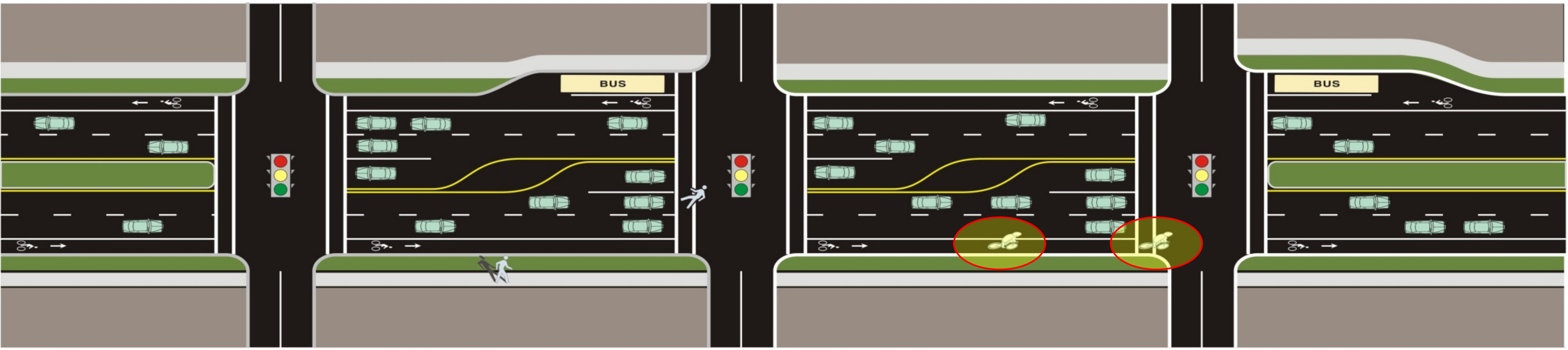
Bicyclist LOS: Signalized Intersections



Bicyclist LOS: Signalized Intersections Model Factors

- Factors included:
  - Width of outside through lane and bicycle lane (+)
  - Cross-street width (–)
  - Vehicle traffic volume in the outside lane (–)

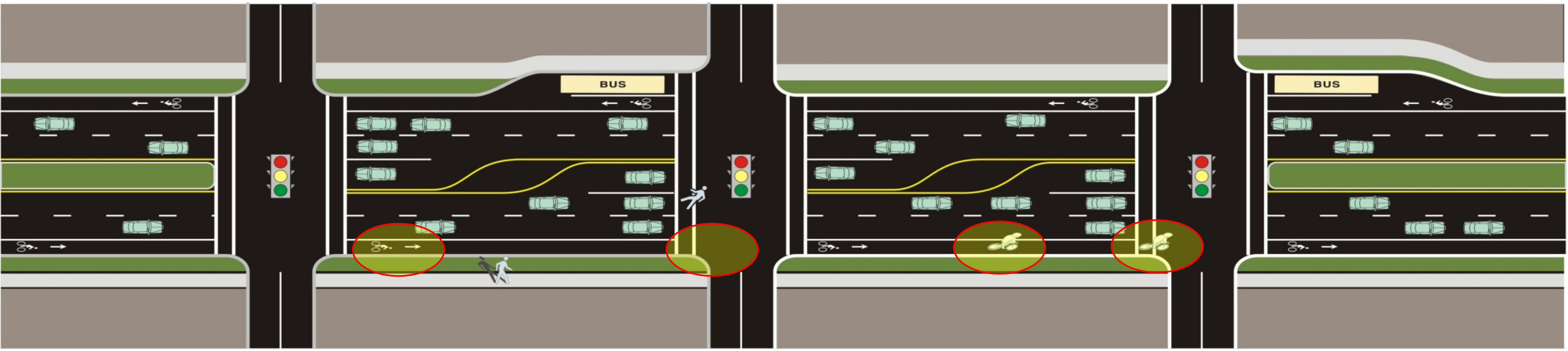
Bicyclist LOS: Segments



Bicyclist LOS: Segments Model Factors

- Factors included:
  - Bicycle link LOS (+)
  - Bicycle intersection LOS, if signalized (+)
  - Number of access points on right side (–)
    - Includes driveways and unsignalized street intersections
    - Judgment required on how low-volume residential driveways are treated

Bicyclist LOS: Facility



- **Length-weighted average of segment LOS scores**
  - Can mask deficiencies in individual segments
  - Consider also reporting segment LOS score for the worst segment in the facility

Transit Passenger LOS

Transit Passenger LOS: Overview

- Only segment and facility LOS models
- Transit facility LOS is a length-weighted average of segment LOS
- "Transit" includes buses, streetcars, and street-running light rail
- Three main model components:
  - Access to transit (pedestrian link LOS)
  - Wait for transit (frequency)
  - Riding transit (perceived travel time rate)

Transit Passenger LOS: Perceived Travel Time Components

- Factors included:
  - Actual bus travel speed (+)
  - Bus stop amenities (+)
  - Excess wait time due to late bus/train arrival (–)
  - On-board crowding (–)

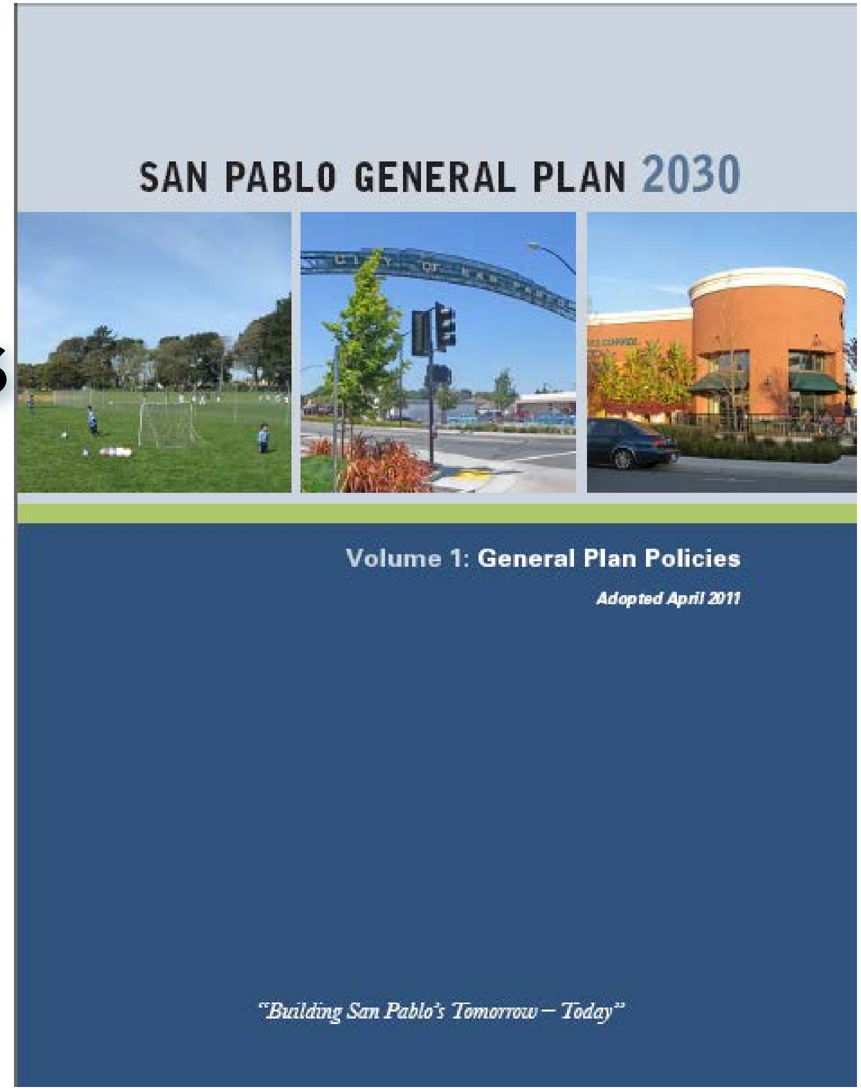
General Plan Case Study

San Pablo, California

CITY OF SAN PABLO
City of New Directions

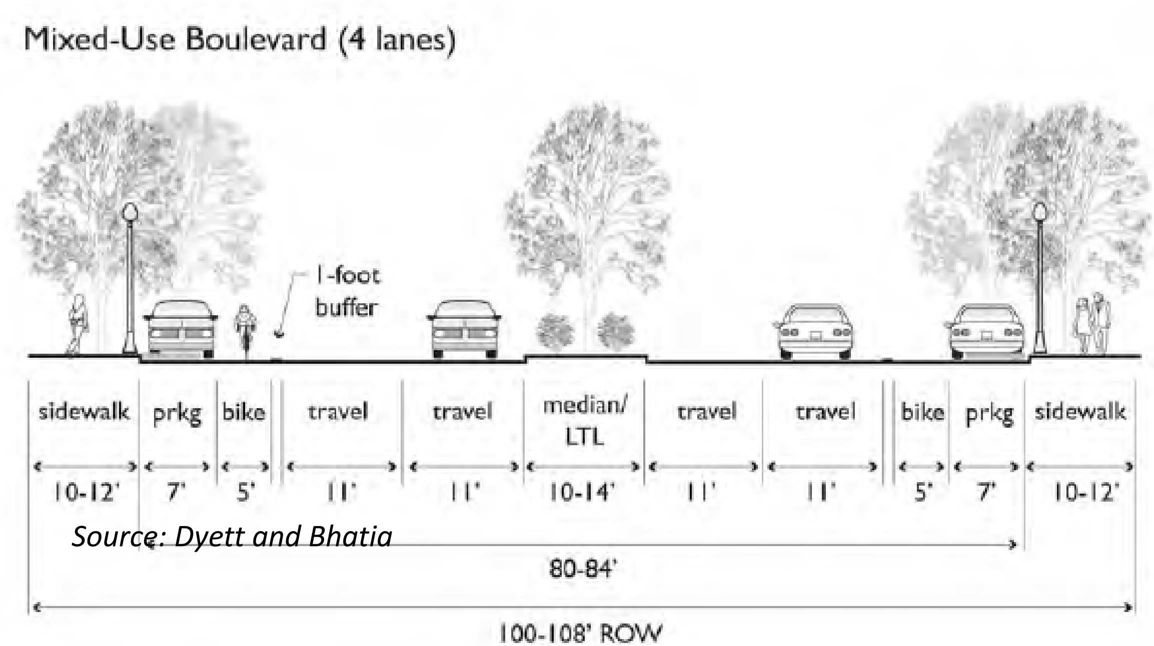
Case Study
General Plan (Comprehensive Plan)

- **Adopted 2011**
- **Dyett and Bhatia – Prime consultant**
- **How to incorporate MMLOS**



Case Study
General Plan (Comprehensive Plan)

- Complete Street general policies
- Designation of circulation system
  - Move away from motorist-only perceptions
  - Incorporate more multimodal designations



Source: Dyett and Bhatia

Case Study
General Plan (Comprehensive Plan)

CITY OF SAN PABLO
City of New Directions

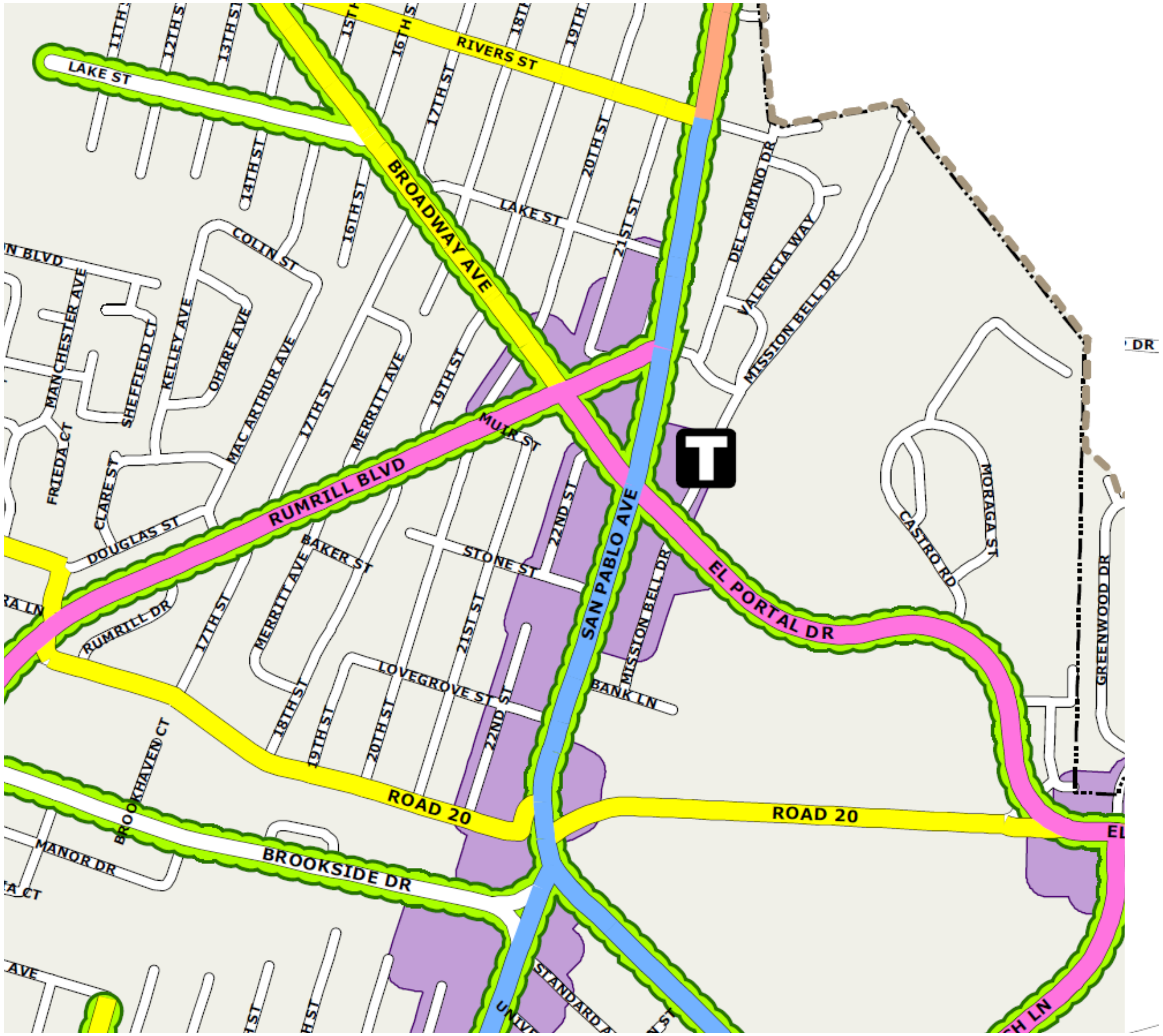


Figure 5-1
Proposed Roadway System

- State Highway
- Mixed Use Boulevard
- Urban Arterial
- Auto Arterial
- Avenue
- Local
- Major Transit Hub
- Pedestrian Priority Zone
- Green Street Overlay
- Planning Area
- City Limits
- Railroads

Case Study
General Plan (Comprehensive Plan)

CITY OF SAN PABLO
City of New Directions

Prioritization of different street types by mode

Table 5.2-1 Transportation Facilities Matrix

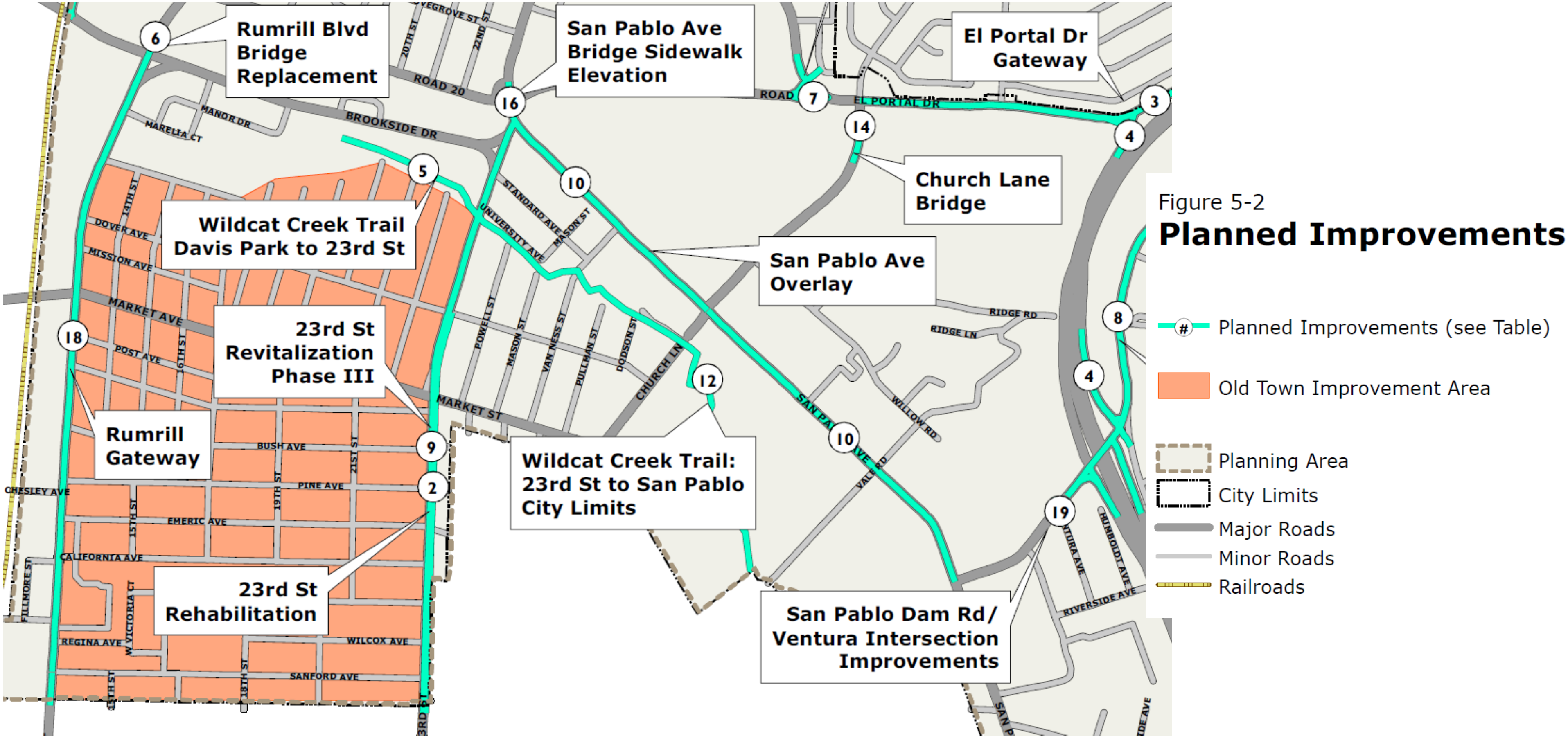
Facility	*Transit*	*Bicycles*	*Pedestrians*	*Trucks*	*Automobiles*
State Highway	□	X	X	□	□
Auto Arterial	□	□	○	■	■
Urban Arterial[1]	■	■	□	○	■
Mixed Used Boulevard	■	□	■	□	□
Avenue	○	□	□	○	□
Local	○	□	□	X	□

■ = Dominant
□ = Accommodated
○ = Incidental
X = Prohibited

[1] Transit has priority over bicycles on Urban Arterials, where conflicts exist.

Case Study
General Plan (Comprehensive Plan)

- **More robust determination of improvements**



Case Study
General Plan (Comprehensive Plan)

CITY OF SAN PABLO
City of New Directions

- MMLOS summary of factors for each mode

Table 5.2-4 Definition of Multi-modal Level of Service Indicators

LOS	*Transit*	*Bicycle*	*Pedestrian*
A	(Good walk access to bus stops, frequent service, good bus stop amenities.)	(Few driveway and cross street conflicts, good pavement condition, ample width of outside lane, including parking and bike lanes.)	(Low traffic volumes, wide buffer separating sidewalk from traffic, numerous street trees, and high parking occupancy.)
B	↓	↓	↓
C			
D			
E			
F	(Poor walk access to bus stops, infrequent service, poor schedule adherence, no bus stop amenities.)	(Poor pavement condition, narrow width of outside lane, frequent driveways and cross streets.)	(High traffic volumes, limited buffer separating sidewalk from traffic, few street trees, low parking occupancy.)

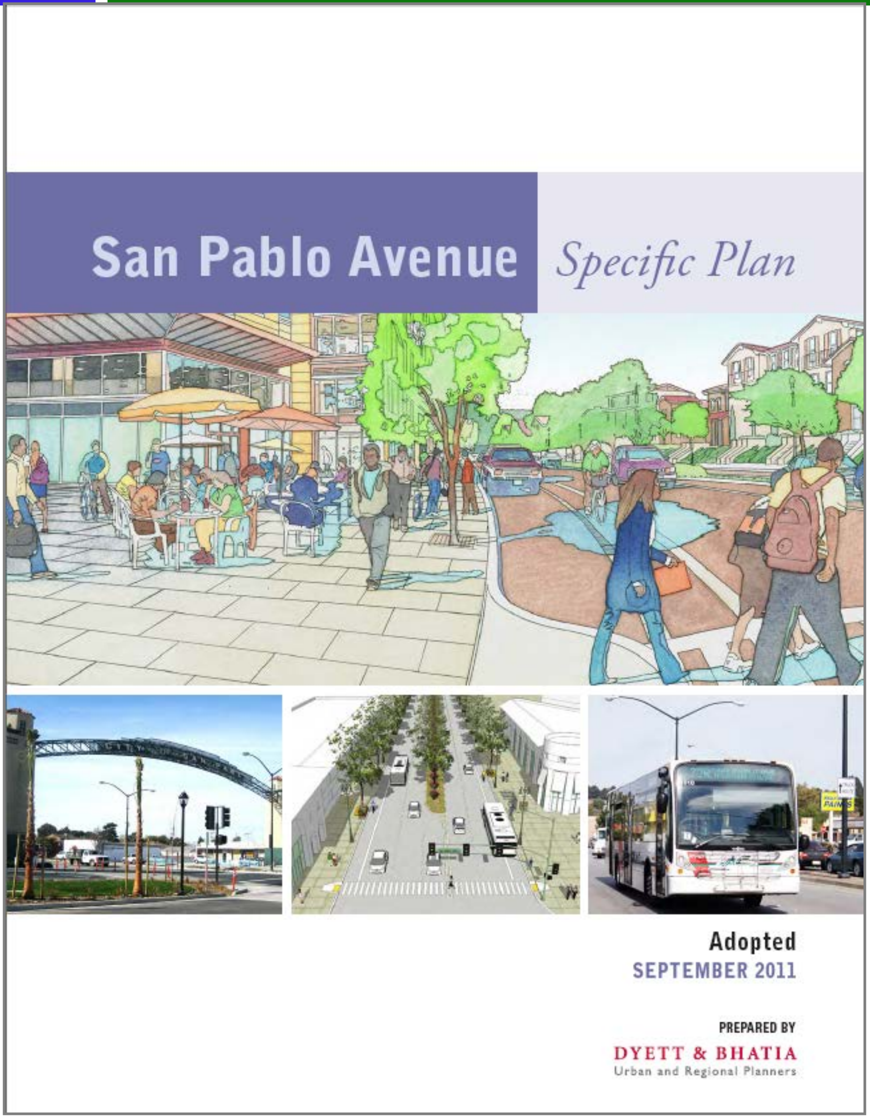
Source: Dowling Associates, 2010.

Specific Plan Case Study

San Pablo Avenue

San Pablo, California

Case Study
Specific Plan



- Adopted 2011
- Guide to revitalize in a sustainable manner
- MMLOS analysis
  - Existing
  - 2030 No Project
  - 2030 Specific Plan

Case Study
Specific Plan (Sub-Area Plan)

- MMLOS Analysis

AM Peak-Hour													
		Northbound						*Southbound*					
		Transit Passenger		*Bicyclist*		*Pedestrian*		*Transit Passenger*		*Bicyclist*		*Pedestrian*	
Corridor Section	*Scenario*	*Score*	*LOS*	*Score*	*LOS*	*Score*	*LOS*	*Score*	*LOS*	*Score*	*LOS*	*Score*	*LOS*
North	Existing	1.67	A	3.45	C	2.98	C	1.65	A	3.55	D	3.07	C
	2030 No Project	2.11	B	3.49	C	3.08	C	1.78	A	3.61	D	3.19	C
	2030 Specific Plan	2.07	B	3.18	C	2.84	C	1.76	A	3.29	C	3.04	C
Central	Existing	1.08	A	3.50	C	3.06	C	1.10	A	3.49	C	2.96	C
	2030 No Project	1.22	A	3.54	D	3.15	C	1.27	A	3.55	D	3.07	C
	2030 Specific Plan	1.20	A	3.48	C	3.03	C	1.23	A	2.95	C	2.83	C
South	Existing	0.91	A	4.13	D	2.87	C	0.80	A	3.60	D	2.83	C
	2030 No Project	1.07	A	4.22	D	2.99	C	1.06	A	3.65	D	2.96	C
	2030 Specific Plan	1.04	A	3.69	D	2.81	C	1.05	A	3.57	D	2.85	C

Dowling Associates, Inc., Multi-Modal Level of Service analysis using CompleteStreetsLOS version 2.1.8, November 2010

Legend

(red)	Worse than existing
(pink)	Worse than existing but better than 2030 No Project
(green)	Better than existing

Case Study
General and Specific Plan

CITY OF SAN PABLO
City of New Directions

- Benefits of MMLOS
  - Provided baseline LOS for all travel modes
    - Reasonableness of LOS standards
  - Tested MMLOS for Specific Plan scenario
  - Multimodal roadway designations
    - Provide guidelines for improvements
    - Inform mitigation requirements
    - Provide an analysis tool

Case Study
General and Specific Plan

CITY OF SAN PABLO
City of New Directions

- Lessons Learned
  - MMLOS works well analyzing fixed right-of-way
    - How to allocate space
    - Quantifies trade-offs between modes
  - Developing policy standards
    - Establish baseline
    - Conduct sketch what-if scenarios
    - May lead to prioritizing specific modes on streets

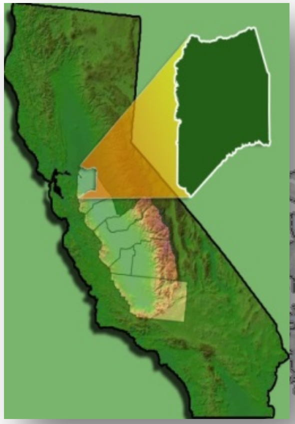
Congestion Management Program

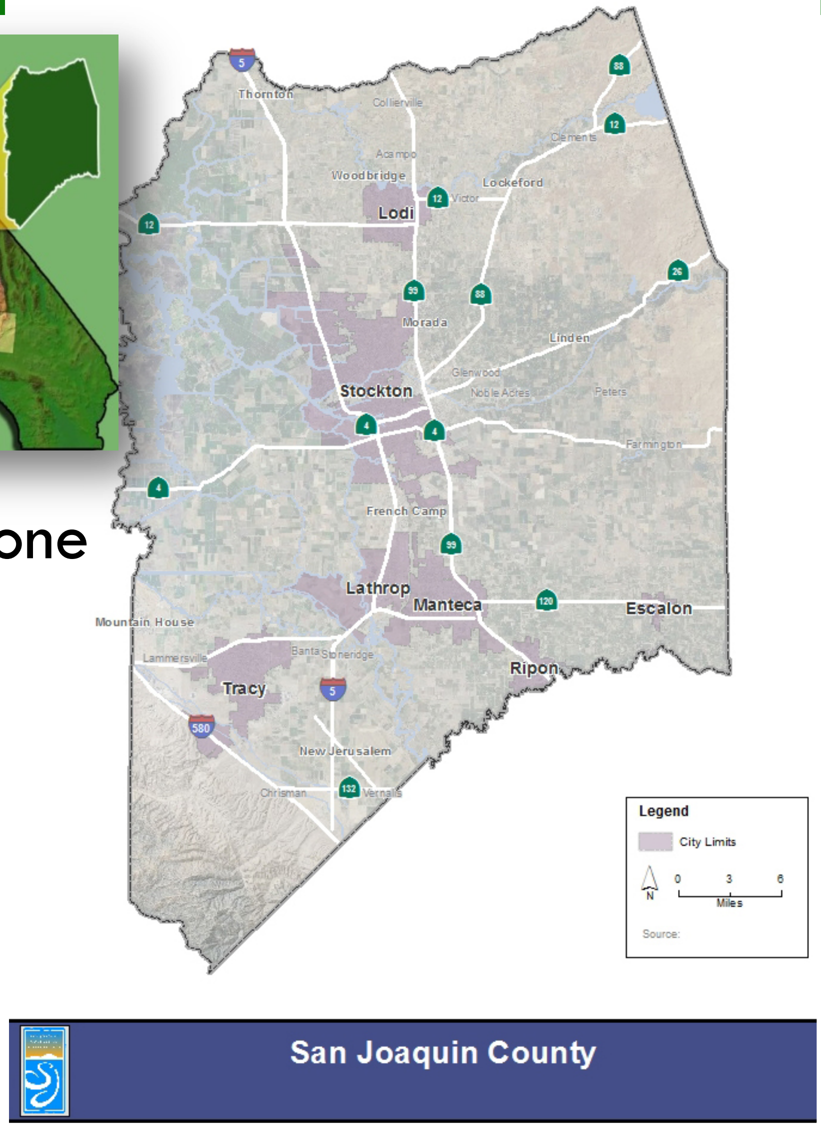
San Joaquin Council of Governments (SJCOG)

Regional Congestion Management Program (RCMP) Update 2012

San Joaquin Council of Governments (SJCOG)

- Local jurisdictions
  - 7 incorporated cities
  - San Joaquin County
- Federally designated:
  - Extreme non-attainment for ozone
  - Non-attainment for carbon monoxide
  - Non-attainment for PM 2.5



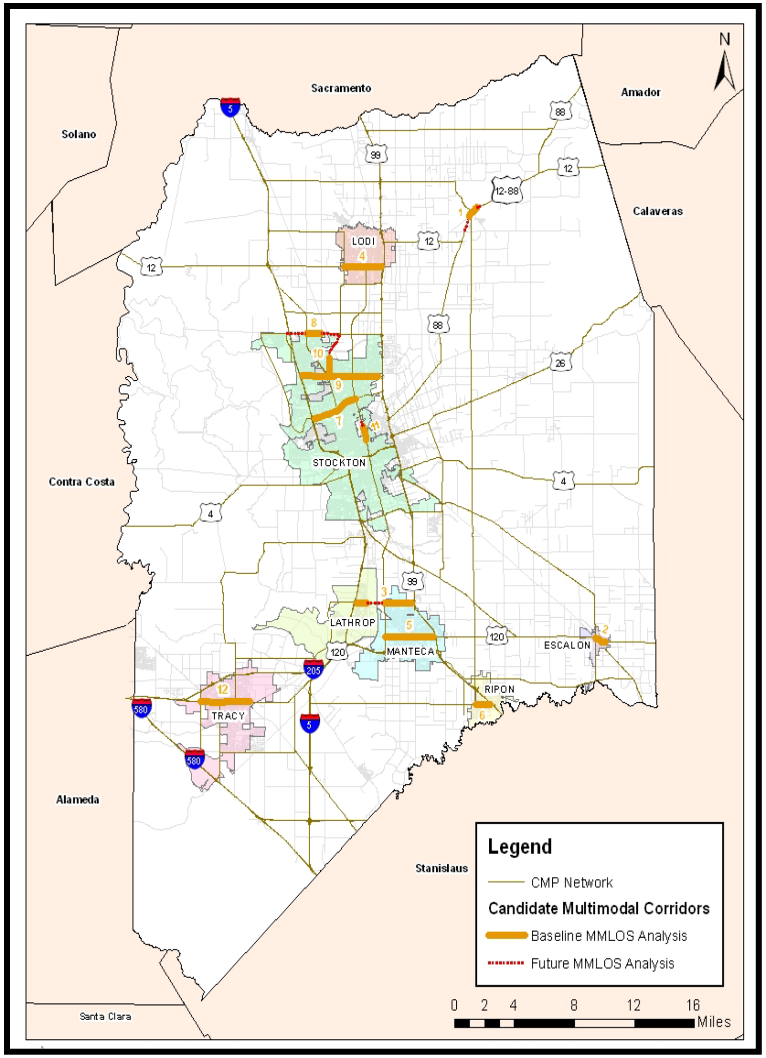


SJCOG RCMP Update 2012

- Multimodal Focus
  - Updated the CMP transportation network
    - Transit network
    - Bikeway system
  - Updated the regional data collection program
    - Bicyclist
    - Pedestrian
    - Transit
  - Developed multimodal objectives and performance measures
  - ***Designated Multimodal Corridors***

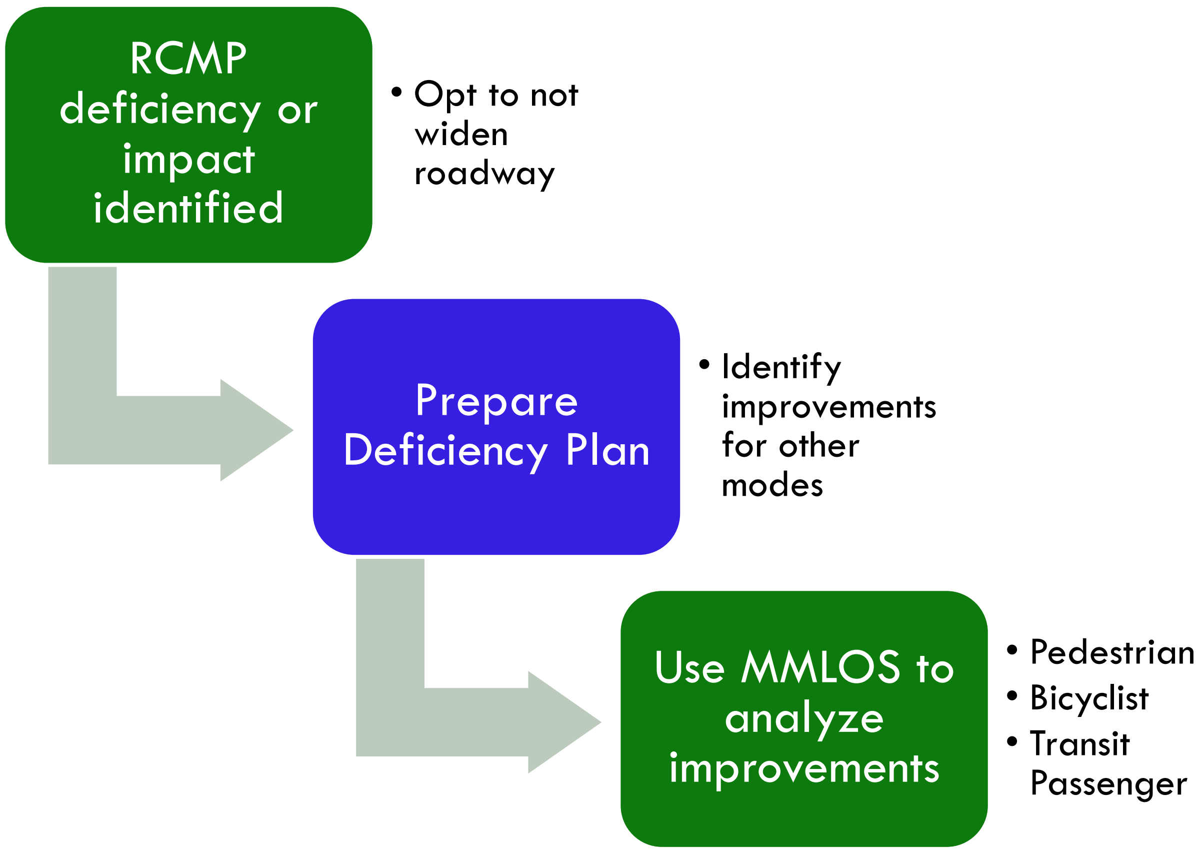
SJCOG RCMP Update 2012

- Multimodal Corridors
  - 13 designated corridors
  - No new significance standards
  - SJCOG provides data to local agencies
    - Baseline HCM 2010 MMLOS analysis
      - Pedestrian
      - Bicyclist
      - Transit Passenger
    - Data collection this year



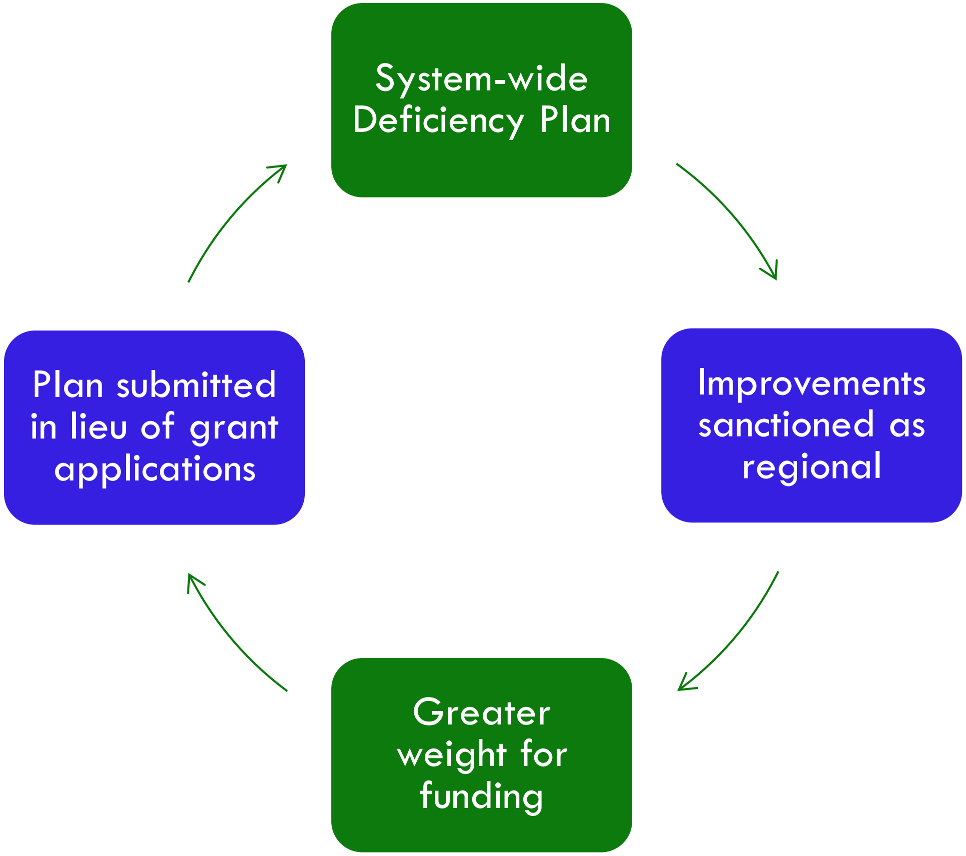
SJCOG RCMP Update 2012

- Multimodal Corridors
  - Options given to local agency



SJCOG RCMP Update 2012

- Multimodal Corridors



SJCOG RCMP Update 2012

- ## 2012 FHWA Certification Review Comments
  - *"The system monitoring program seems to be well documented as to how, when and where data collection activities are performed. The RCMP is multimodal in nature and identifies thirteen corridors applicable to a method to compute multimodal level of service (MMLOS)."*
  - *"SJCOG appears to have done a good job in developing a range of performance measures …. They are multimodal in nature which is an important federal requirement."*
  - *"The federal review team found SJCOG's CMP to be in compliance with Federal regulations."*

Development Impact Analysis

Pasadena, California

Traffic Impact Analysis

- Worked with the City of Pasadena to analyze multimodal impacts of a redevelopment project

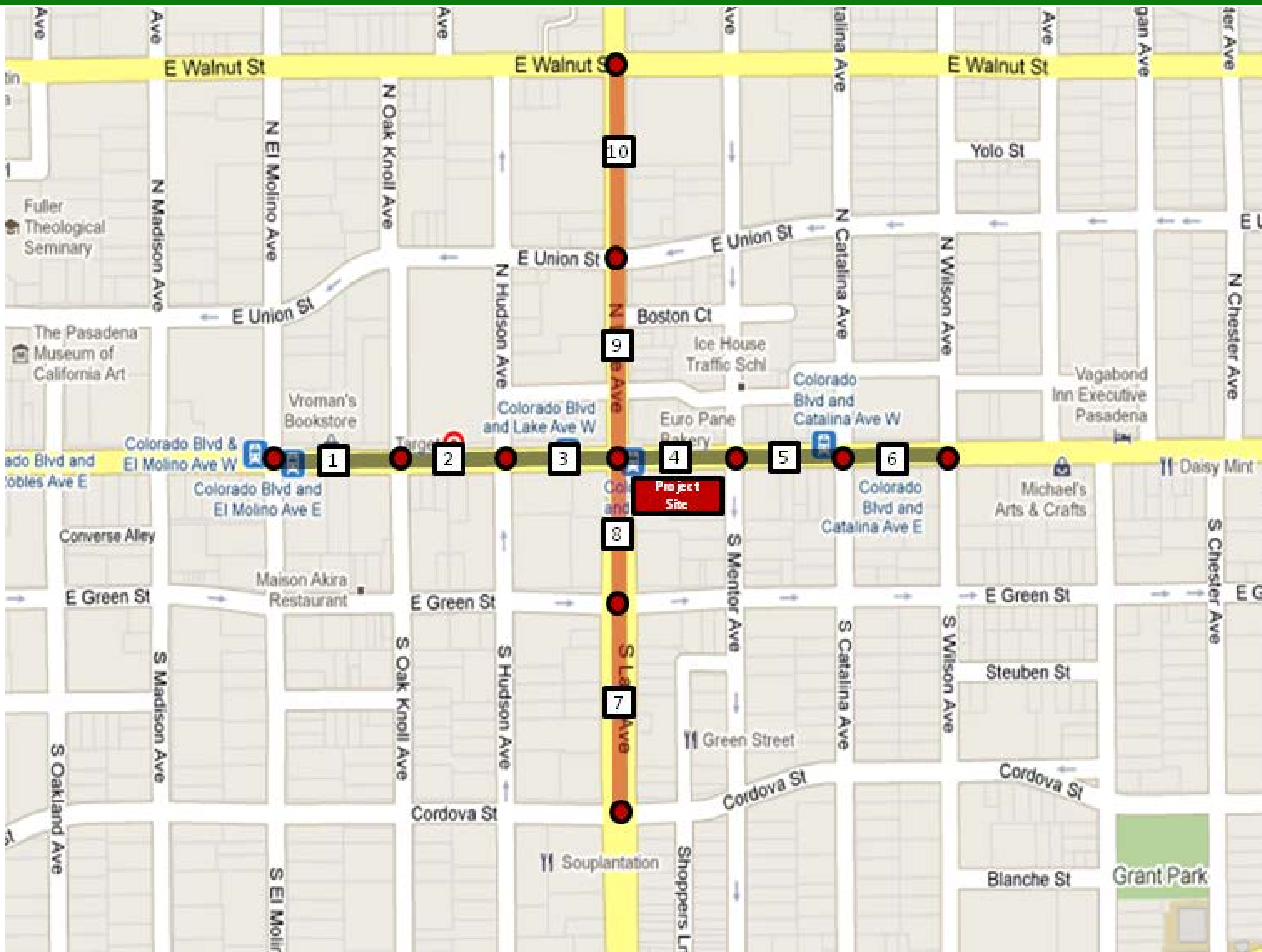
Traffic Impact Analysis

- Impact studies generally only consider auto
- Pasadena finding it difficult to mitigate certain areas
- How might MMLOS provide another tool
- A recent development project was selected to test multimodal LOS

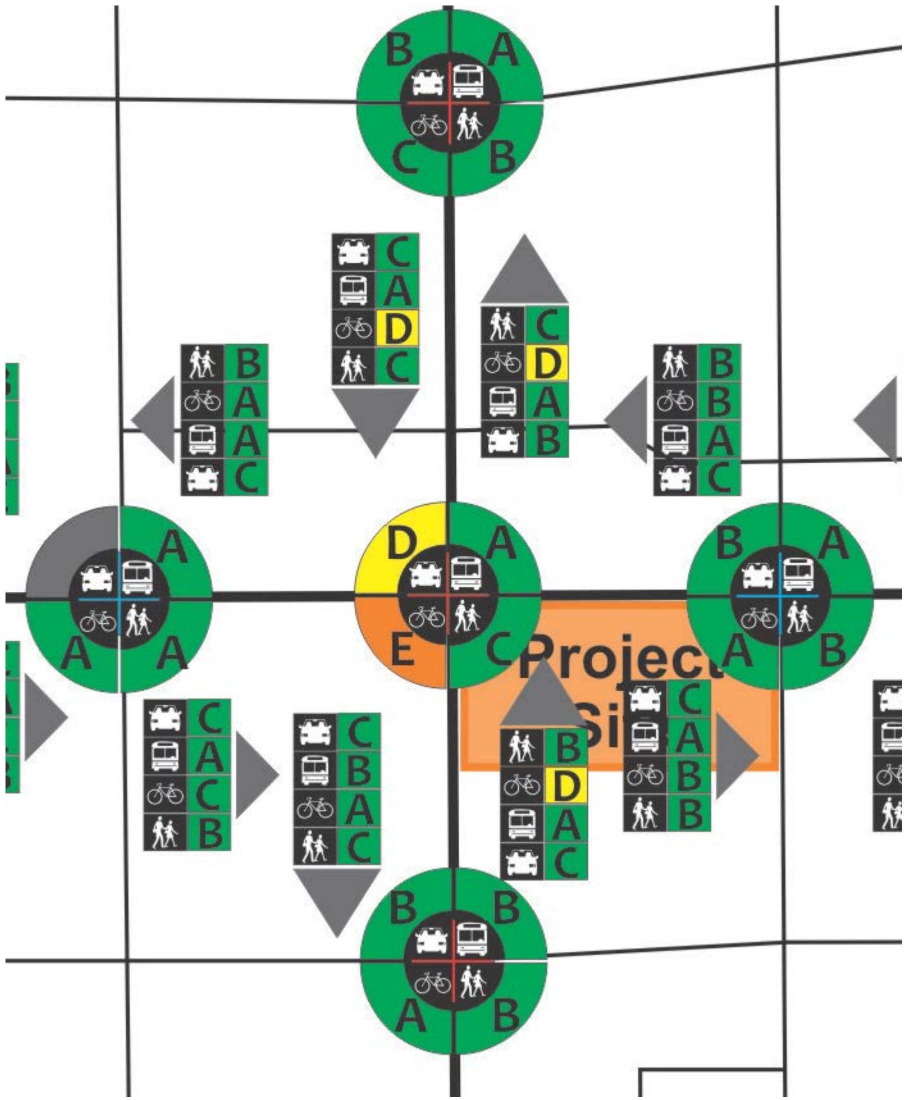
Traffic Impact Analysis

- Project consisted of:
  - **156 room hotel**
  - **38,000 ft^2 of dining**
  - **14,000 ft^2 retail**
  - **103,000 ft^2 office**
  - **8,000 ft^2 of bank**
- Generated 4,900 daily trips
- 289 trips in the AM peak hour
- 488 trips in the PM peak hour

Traffic Impact Analysis



Traffic Impact Analysis



Traffic Impact Analysis

Link results for Colorado Blvd.

Colorado Boulevard - Worst Direction PM Segment LOS							
Segment	Mode	Direction	Existing	2015	2015 + Proj	Diff.	% Change
El Molino Ave to Oak Knoll Ave	Auto	EB	2.88 (C)	2.90 (C)	2.91 (C)	0.01	0.3%
	Transit	WB	1.54 (A)	1.61 (A)	1.61 (A)	0.00	0.0%
	Pedestrian	EB	1.80 (A)	2.16 (B)	2.21 (B)	0.05	2.3%
	Bicycle	EB	2.98 (C)	3.10 (C)	3.12 (C)	0.02	0.6%
Oak Knoll Ave to Hudson Ave	Auto	EB	3.10 (C)	3.17 (C)	3.19 (C)	0.02	0.6%
	Transit	EB	1.44 (A)	1.53 (A)	1.54 (A)	0.01	0.7%
	Pedestrian	EB	1.83 (A)	2.19 (B)	2.24 (B)	0.05	2.3%
	Bicycle	EB	2.68 (B)	2.80 (C)	2.81 (C)	0.01	0.4%

Traffic Impact Analysis

- Transit Passenger
  - Minimal effect, transit speed slightly slower (-)
  - Pedestrian LOS slightly worse (-)
- Bicyclist
  - Slower auto speeds (+)
  - Increased volume (-)
- Pedestrian
  - More vehicles in lane nearest pedestrians (-)
  - Slower auto speeds (+)
- All impacts minor, volume has only small effect on LOS for non-auto modes

Traffic Impact Analysis

Conclusions

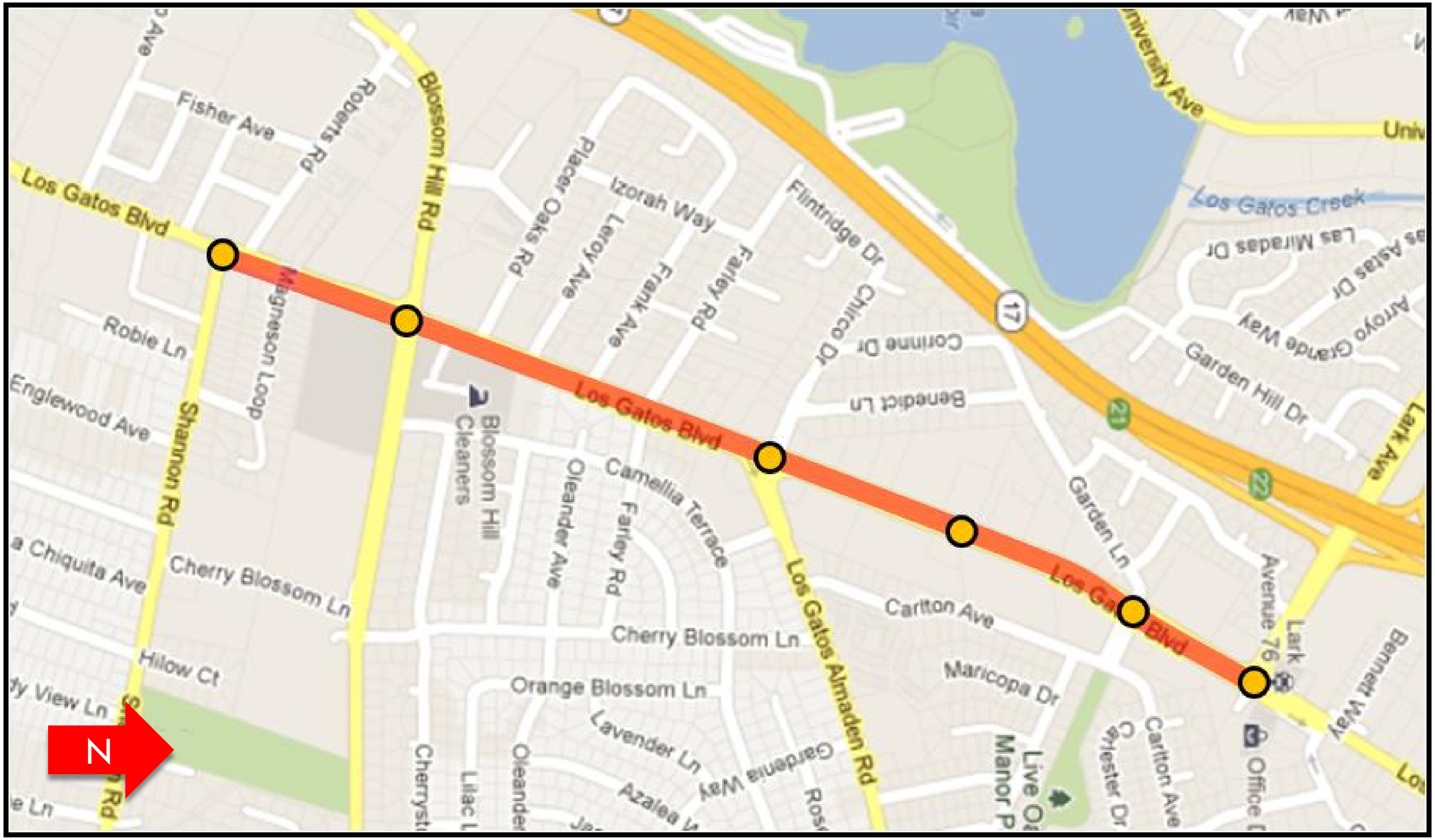
Lessons Learned:

- Multimodal LOS not very sensitive to volume changes
- Methodology much better at quantitatively showing impacts to all four modes resulting from physical attributes such as:
  - Cross section changes (Pedestrians/Bikes)
  - Trees or other buffers (Pedestrians)
  - Pavement condition (Bikes)

Road Diet Analysis

Santa Clara County, California

Road Diet Analysis Corridor



Road Diet Analysis Corridor

Direction	Segment	Sidewalk	Buffer*	Shoulder /Parking	Bike Lane	Outside Lane Width	Segment Length
Northbound	Shannon Rd. to Blossom Hill Rd.	5.5	2.5	0	5	11	1067
	Blossom Hill Rd. to Los Gatos Almaden Rd.	5.5	2.5	10	0	11	2096
	Los Gatos Almaden Rd. to Village Square	5.5	2.5	10	0	11	1208
	Village Square to Gateway Dr.	5.5	2.5	10	0	11	871
	Gateway Dr. to Lark Ave.	5.5	2.5	10	0	11	767

- Possible Road Diet Assumed:
  - Gateway to Lark would maintain lanes but remove parking
  - Remaining segments reduced from 3 to 2 lanes
  - Space allocated as follows:
    - 2.5 feet of additional sidewalk (8' total)
    - 5 feet of buffer with trees
    - 8 feet of parking
    - 5.5 feet of bike lanes

Road Diet Analysis Corridor

- Impact on the auto mode

Direction and Peak Hour	Percent of FF Speed
Existing Northbound AM	66%
Proposed Northbound AM	62%
Difference	4%
Existing Southbound PM	68%
Proposed Southbound PM	64%
Difference	4%

Road Diet Analysis Corridor

- Bicycle Intersection
  - Factors: Cross-Section, Volume
- Bicycle Link
  - Factors: Cross-Section, Volume, Speed, Pavement Condition
- Bicycle Segment
  - No change in the number of driveways

Segment	Existing NB AM			Proposed NB AM		
	Intersection	Link	Segment	Intersection	Link	Segment
Shannon Rd. to Blossom Hill Rd.	2.73 (B)	2.39 (B)	3.75 (D)	2.52 (B)	2.20 (B)	3.69 (D)
Blossom Hill Rd. to Los Gatos Almaden Rd.	3.25 (C)	3.73 (D)	3.91 (D)	2.43 (B)	2.04 (B)	3.48 (C)
Los Gatos Almaden Rd. to Shopping Center Dr.	3.49 (C)	4.07 (D)	4.01 (D)	2.73 (B)	2.01 (B)	3.49 (C)
Shopping Center Dr. to Gateway Dr.	3.93 (D)	4.11 (D)	4.28 (E)	3.15 (C)	2.04 (B)	3.65 (D)
Gateway Dr. to Lark Ave.	3.73 (D)	4.01 (D)	4.19 (D)	1.58 (A)	-0.24 (A)	3.11 (C)
Facility	3.99 (D)			3.50 (C)		

Road Diet Analysis Corridor

- Pedestrian Intersection
  - Factors: Cross-Section, Vehicle Volume, Speed, Ped. Delay
- Pedestrian Link
  - Factors: Cross-Section, Volume, Speed
  - Gateway Dr. to Lark Ave. became worse due to parking removal
- Pedestrian Segment
  - RCDF – No change from the maximum value

Segment	Existing NB AM			Proposed NB AM		
	Intersection	Link	Segment	Intersection	Link	Segment
Shannon Rd. to Blossom Hill Rd.	2.90 (C)	2.56 (B)	3.67 (D)	2.92 (C)	2.56 (B)	3.68 (D)
Blossom Hill Rd. to Los Gatos Almaden Rd.	2.73 (B)	2.66 (B)	3.66 (D)	2.57 (B)	2.48 (B)	3.55 (D)
Los Gatos Almaden Rd. to Shopping Center Dr.	1.96 (A)	2.78 (C)	3.51 (D)	1.96 (A)	2.69 (B)	3.47 (C)
Shopping Center Dr. to Gateway Dr.	2.40 (B)	2.64 (B)	3.57 (D)	2.18 (B)	2.53 (B)	3.47 (C)
Gateway Dr. to Lark Ave.	1.77 (A)	2.80 (C)	3.46 (C)	1.77 (A)	2.84 (C)	3.48 (C)
Facility	3.59 (D)			3.54 (D)		

Questions?

- Enter questions/comments in the Question Pod. Your question will be answered in the order it was received.