Multimodal Performance Measures Workshop
Pilot Applications of MMLOS in Santa Clara County and Beyond

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MOVING**FORWARD**THINKING

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TRANSPORTATION ENGINEERING/PLANNING

HCM 2010 METHODOLOGY OVERVIEW:
BICYCLE AND PEDESTRIAN LOS
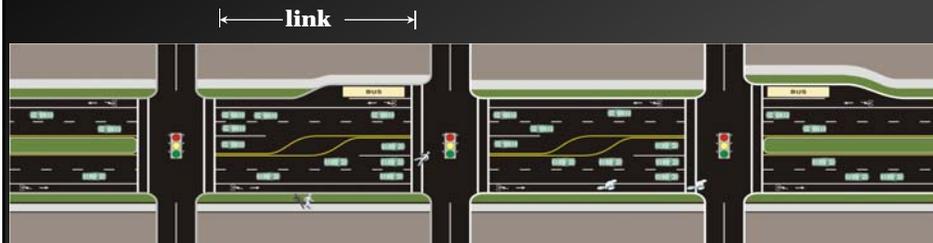
HCM2010
HIGHWAY CAPACITY MANUAL

TRB TRANSPORTATION RESEARCH BOARD
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2
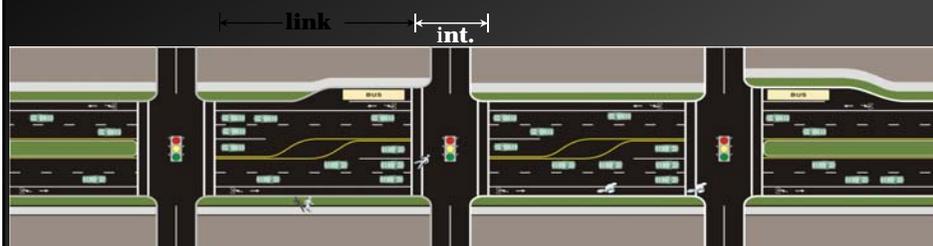
Urban Street System Elements: Segment
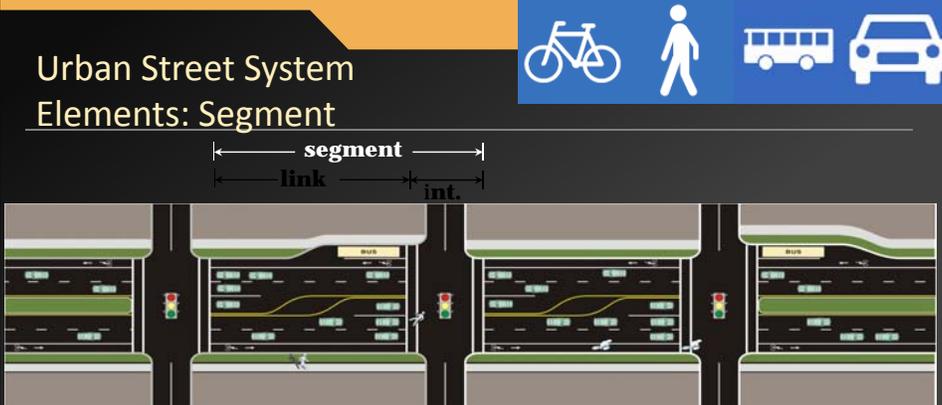
- Segment = link + downstream intersection
- Perception scores available for all modes
  - Ped & bike scores based on combination of link, intersection, and additional factor

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Urban Street System Elements: Facility

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

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Pedestrian LOS

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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

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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 (+/−)

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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

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Bicycle LOS

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Bicycle 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 (–)

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Bicycle LOS: Signalized Intersections
Model Factors

- Factors included:

    – Width of outside through lane and bicycle lane (+)

    – Cross-street width (–)

    – Motor vehicle traffic volume in the outside lane (–)

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Bicycle 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

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PILOT APPLICATIONS IN SANTA CLARA COUNTY

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Scope of Pilot Applications

- Analyzed 3 Corridors
  - El Camino Real (San Antonio Rd. to Rengstorff Ave.)
  - El Camino Real (Lawrence Expressway to Kiely Blvd.)
  - San Carlos Street (Market St. to 4th St.)
- Analyzed 6 Individual Intersections
  - De Anza Boulevard & Stevens Creek Boulevard (Cupertino, CA)
  - Saratoga Avenue & Highway 9 (Saratoga, CA)
  - Bascom Avenue & Hamilton Avenue (Campbell, CA)
  - Calaveras Boulevard & Milpitas Boulevard (Milpitas, CA)
  - Highway 9 & Santa Cruz Avenue (Los Gatos, CA)
 - Monterey Street & Leavesley Road (Gilroy, CA)

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El Camino Real (San Antonio to Rengstorff)

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El Camino Real (San Antonio to Rengstorff)

- Bicycle Intersection LOS - generally B or C;
- Bicycle Link LOS - ranges from B to E;
- Bicycle Segment LOS - generally D or E;
- Pedestrian Intersection LOS - generally A, few B/C;
- Pedestrian Link LOS - generally B or C;
- Pedestrian Segment LOS - generally C or D

Segment	Bicycle Westbound AM			Pedestrian Westbound AM		
	Intersection	Link	Segment	Intersection	Link	Segment
Rengstorff Avenue to Distel Drive	2.64 (B)	3.67 (D)	4.02 (D)	1.45 (A)	3.12 (C)	3.50 (D)
Distel Drive to Ortega Avenue	2.25 (B)	2.30 (B)	3.67 (D)	1.85 (A)	3.21 (C)	3.64 (D)
Ortega Avenue to Jordan Avenue	3.17 (C)	3.72 (D)	4.01 (D)	1.74 (A)	2.96 (C)	3.52 (D)
Jordan Avenue to Showers Drive	4.11 (E)	4.27 (E)	4.52 (E)	2.47 (B)	2.76 (C)	3.63 (D)
Showers Drive to San Antonio Road	3.73 (D)	4.02 (D)	4.40 (E)	3.07 (C)	3.26 (C)	3.98 (D)
Facility	4.12 (D)			3.71 (D)		

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El Camino Real (Lawrence Expressway to Kiely)

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El Camino Real (Lawrence Expressway to Kiely)

- Fairly similar to Corridor 1 except presence of an unsignalized mid-block pedestrian crossing and difference in cycle lengths causes difference in Roadway Crossing Difficulty Factor

Segment	Bicycle Westbound AM			Pedestrian Westbound AM		
	Intersection	Link	Segment	Intersection	Link	Segment
Kiely Boulevard to Calabazas Avenue	4.01 (D)	3.59 (D)	4.24 (D)	2.65 (B)	2.68 (B)	3.65 (D)
Calabazas Avenue to Pomeroy Avenue	2.30 (B)	2.74 (B)	3.61 (D)	1.99 (A)	2.52 (B)	3.30 (C)
Pomeroy Avenue to Nobili Avenue	2.99 (C)	2.90 (C)	3.90 (D)	1.77 (A)	2.55 (B)	3.37 (C)
Nobili Avenue to Flora Vista Avenue	3.14 (C)	3.21 (C)	3.92 (D)	2.04 (B)	2.70 (B)	3.46 (C)
Flora Vista Avenue to Lawrence Expressway NB Ramps	2.77 (C)	3.25 (C)	3.75 (D)	2.04 (B)	2.81 (C)	3.49 (C)
Facility	3.95 (D)			3.50 (C)		

Segment	Westbound AM	Westbound PM
Kiely Boulevard to Calabazas Avenue	1.20	1.20
Calabazas Avenue to Pomeroy Avenue	1.16	1.15
Pomeroy Avenue to Nobili Avenue	1.20	1.20
Nobili Avenue to Flora Vista Avenue	1.19	1.18
Flora Vista Avenue to Lawrence Expressway NB Ramps	1.18	1.19
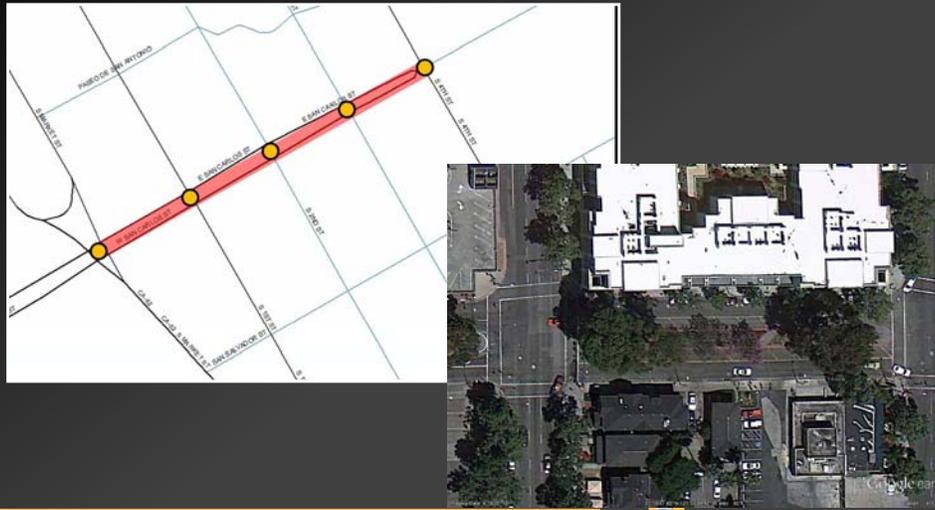
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San Carlos Street (Market to 4th)

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San Carlos Street (Market to 4th)

- Bicycle Intersection LOS - generally B or C;
- Bicycle Link LOS – generally B or C;
- Bicycle Segment LOS - generally C or D;
- Pedestrian Intersection LOS - generally A or B;
- Pedestrian Link LOS - generally A;
- Pedestrian Segment LOS - generally B or C

Segment	Bicycle Westbound PM			Pedestrian Westbound PM		
	Intersection	Link	Segment	Intersection	Link	Segment
Fourth Street to Third Street	3.30 (C)	3.63 (D)	3.73 (D)	2.34 (B)	1.00 (A)	2.57 (B)
Third Street to Second Street	2.98 (C)	2.69 (B)	3.50 (C)	1.94 (A)	0.98 (A)	2.81 (C)
Second Street to First Street	2.38 (B)	2.60 (B)	3.38 (C)	1.89 (A)	1.89 (A)	3.15 (C)
First Street to Market Street	3.58 (D)	2.74 (B)	3.68 (D)	2.68 (B)	1.90 (A)	3.36 (C)
Facility	3.58 (D)			2.98 (C)		

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Individual Intersections

De Anza Boulevard & Stevens Creek Boulevard
Cupertino

Saratoga Avenue & Highway 9
Saratoga

Bascom Avenue & Hamilton Avenue
Campbell

Calaveras Boulevard & Milpitas Boulevard
Milpitas

Highway 9 & Santa Cruz Avenue
Los Gatos

Monterey Street & Leavesley Road
Gilroy

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Individual Intersections

- Results are summarized by approach leg
- Bicycle LOS generally A to D
- Pedestrian LOS generally B and C

Intersection	Bicycle PM LOS				Pedestrian PM LOS			
	North Leg	South Leg	East Leg	West Leg	North Leg	South Leg	East Leg	West Leg
De Anza Boulevard & Stevens Creek Boulevard	2.90 (C)	2.99 (C)	2.76 (C)	3.48 (C)	3.43 (C)	3.54 (D)	3.13 (C)	3.25 (C)
Saratoga Avenue & Highway 9	2.47 (B)	2.99 (C)	2.02 (B)	2.29 (B)	2.64 (B)	2.74 (B)	2.42 (B)	2.40 (B)
Bascom Avenue & Hamilton Avenue	1.44 (A)	4.05 (D)	3.75 (D)	2.73 (B)	3.24 (C)	3.23 (C)	3.19 (C)	3.18 (C)
Calaveras Boulevard & Milpitas Boulevard	2.53 (B)	4.10 (D)	2.76 (C)	1.99 (A)	2.99 (C)	2.95 (C)	3.00 (C)	3.40 (C)
Highway 9 & Santa Cruz Avenue	1.10 (A)	2.53 (B)	4.04 (D)	3.58 (D)	2.35 (B)	2.38 (B)	2.80 (C)	2.80 (C)
Monterey Road & Leavesley Road	4.25 (E)	3.50 (D)	2.08 (B)	2.15 (B)	2.58 (B)	2.93 (C)	2.86 (C)	2.59 (B)

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Comparison Case Study
Improved Pedestrian Facilities on El Camino Real

- What is the impact of improving pedestrian facilities?
- San Antonio Center at El Camino Real and San Antonio Road is to be redeveloped.
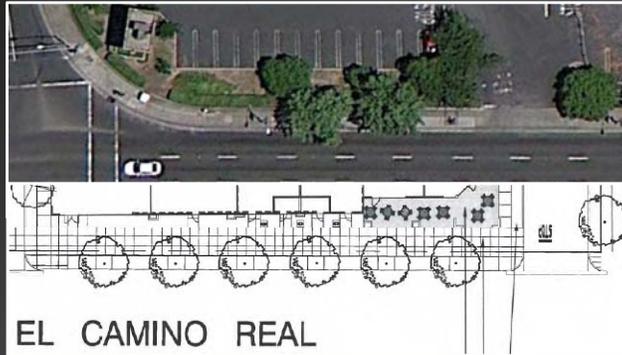
EL CAMINO REAL

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Comparison Case Study
Improved Pedestrian Facilities on El Camino Real

- Proposed changes only impact westbound analyses
- Does not affect pedestrian intersection LOS

Segment	Scenario	Westbound AM			Westbound PM		
		Intersection	Link	Segment	Intersection	Link	Segment
Jordan Avenue to Showers Drive	Existing	2.47 (B)	2.76 (C)	3.63 (D)	2.56 (B)	2.46 (B)	3.54 (D)
	Sidewalk Mods	2.47 (B)	2.76 (C)	3.63 (D)	2.56 (B)	2.46 (B)	3.54 (D)
	Percent Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Showers Drive to San Antonio Road	Existing	3.07 (C)	3.26 (C)	3.98 (D)	3.17 (C)	2.85 (C)	3.85 (D)
	Sidewalk Mods	3.07 (C)	2.46 (B)	3.68 (D)	3.17 (C)	2.06 (B)	3.55 (D)
	Percent Change	0.00%	-24.50%	-7.50%	0.00%	-27.70%	-7.80%
Facility	Existing	3.71 (D)			3.60 (D)		
	Sidewalk Mods	3.62 (D)			3.51 (D)		
	Percent Change	-2.60%			-2.60%		

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ADDITIONAL APPLICATIONS OF MULTIMODAL LEVEL OF SERVICE

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Applications of MMLOS

- **City of Oakland**
  - Community-based transportation plan
- **City of Pasadena**
  - Road diet (Orange Grove Blvd)
  - Traffic impact analysis
- **City of San Pablo**
  - General Plan – Roadway classifications
  - Specific Plan for San Pablo Avenue

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Applications of MMLOS

- **City of San Luis Obispo**
  - Baseline analysis for General Plan
- **City of Goleta**
  - Roadway redesign (Hollister Avenue)
- **SJCOG Regional CMP Update**
  - Designation of multimodal corridors
  - Baseline analysis for upcoming CMP

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Traffic Impact Case Study City of Pasadena

- Pasadena was looking for alternative tools to address the inability to mitigate certain facilities
- Worked with the City of Pasadena to analyze multimodal impacts of a new development

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Traffic Impact Case Study
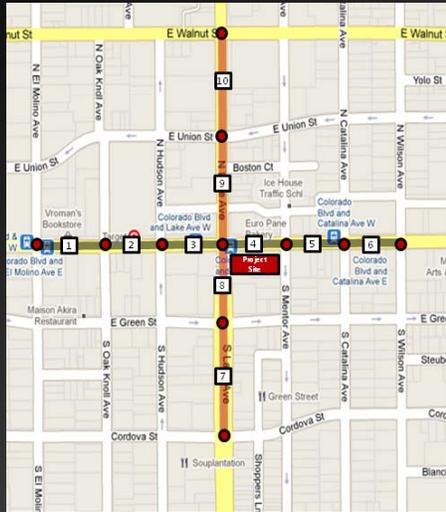
- A Development Project Consisted of:
  - 156 room hotel
  - 38,000 ft^2 of dining
  - 14,000 ft^2 retail
  - 103,000 ft^2 office
  - 8,000 ft^2 of bank
- Generated 4,900 daily trips
- 289 trips in the AM peak hour
- 488 trips in the PM peak hour

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Traffic Impact Case Study
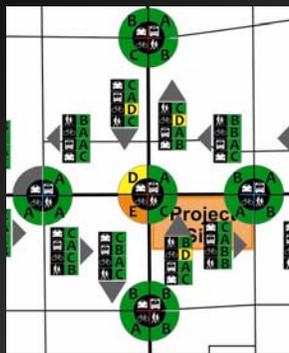
Direction	Mode	AM Peak			PM Peak		
		Existing	2015	2015 + Proj	Existing	2015	2015 + Proj
Eastbound	Auto	2.97 (C)	2.99 (C)	2.99 (C)	3.04 (C)	3.08 (C)	3.09 (C)
	Transit	1.29 (A)	1.32 (A)	1.32 (A)	1.36 (A)	1.43 (A)	1.44 (A)
	Pedestrian	2.46 (B)	2.52 (B)	2.54 (B)	2.65 (B)	2.77 (C)	2.79 (C)
	Bicycle	3.39 (C)	3.42 (C)	3.42 (C)	3.47 (C)	3.50 (C)	3.51 (D)
	Overall	2.53 (B)	2.56 (B)	2.57 (B)	2.63 (B)	2.70 (B)	2.71 (B)
Westbound	Auto	3.02 (C)	3.05 (C)	3.05 (C)	3.02 (C)	3.06 (C)	3.06 (C)
	Transit	1.26 (A)	1.32 (A)	1.33 (A)	1.47 (A)	1.54 (A)	1.54 (A)
	Pedestrian	2.58 (B)	2.67 (B)	2.68 (B)	2.61 (B)	2.71 (B)	2.72 (B)
	Bicycle	3.29 (C)	3.32 (C)	3.32 (C)	3.30 (C)	3.33 (C)	3.33 (C)
	Overall	2.54 (B)	2.59 (B)	2.60 (B)	2.60 (B)	2.66 (B)	2.66 (B)

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Traffic Impact Case Study

- Bicycle
  - 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

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Traffic Impact Case Study
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)

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Case Study
General Plan

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

SAN PABLO GENERAL PLAN 2030

Volume 1: General Plan Policies
Adopted April 2011

"Building San Pablo's Tomorrow – Today"
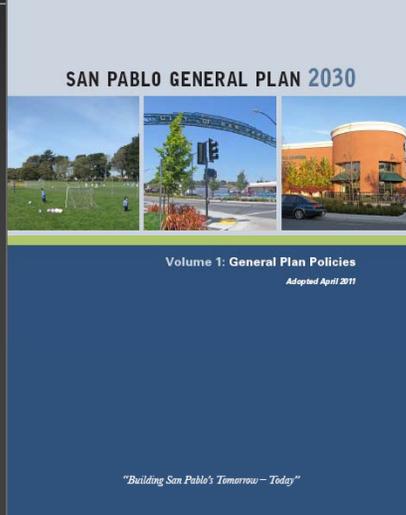
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Case Study
General Plan

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

Mixed-Use Boulevard (4 lanes)

sidewalk	prkg	bike	travel	travel	median/LTL	travel	travel	bike	prkg	sidewalk
10-12'	7'	5'	11'	11'	10-14'	11'	11'	5'	7'	10-12'

80-84'

100-108' ROW

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Case Study
General Plan

Figure 5-1
Proposed Roadway System
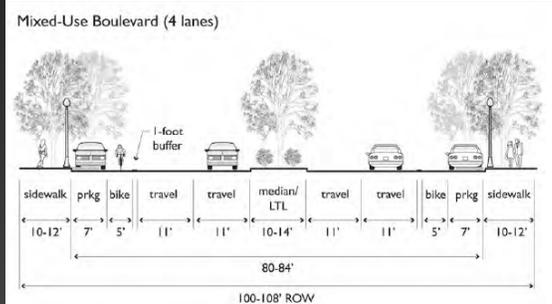
MOVING**FORWARD**THINKING
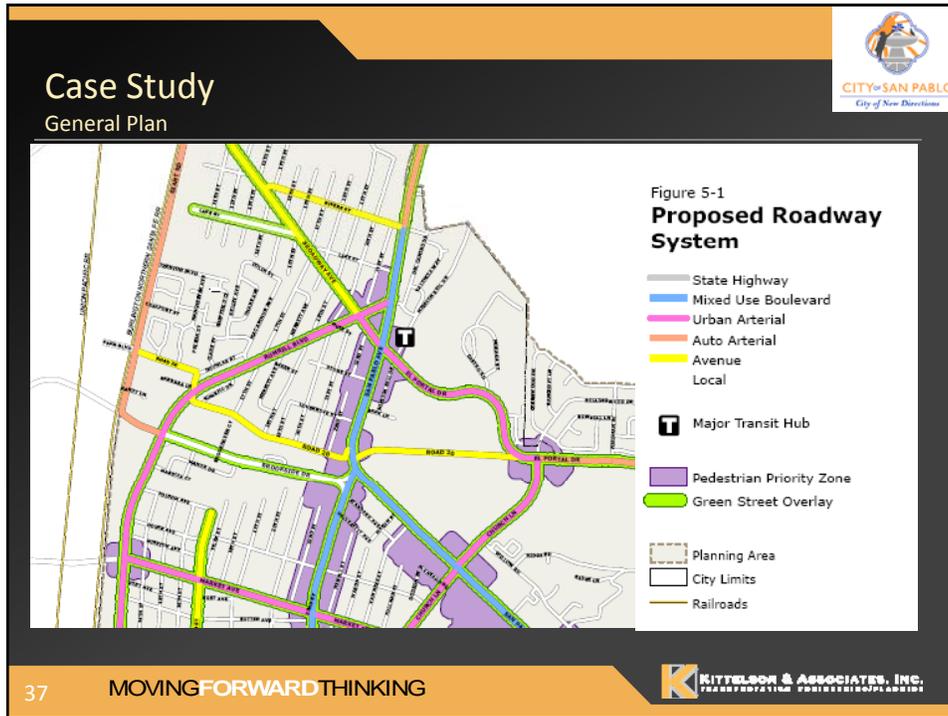
Case Study
General Plan

– Prioritization of different street types by mode

Table 5.2-1 Transportation Facilities Matrix					
Facility	Transit	Bicycles	Pedestrians	Trucks	Automobiles
State Highway	□	✕	✕	□	□
Auto Arterial	□	□	○	■	■
Urban Arterial[1]	■	■	□	○	■
Mixed Used Boulevard	■	□	■	□	□
Avenue	○	□	□	○	□
Local	○	□	□	✕	□

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

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

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Case Study
Specific Plan

San Pablo Avenue *Specific Plan*

Adopted
SEPTEMBER 2011

PREPARED BY
DYETT & BHATIA
Urban and Regional Planners

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

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Case Study
Specific 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	
	Worse than existing
	Worse than existing but better than 2030 No Project
	Better than existing

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Case Study
General and Specific Plan

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

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Big Picture Observations on MMLOS

- Methodology is most sensitive to physical attributes of an urban street
- Not always necessary to perform a full corridor MMLOS analysis
- Areas MMLOS Methodology is most useful:
  - Evaluation of alternative ROW's
  - Comparing existing vs. project conditions
  - Provides quantifiable way of creating bike/ped improvement priority lists
  - Analysis of intersection operations for peds/bikes

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