MTC
Arterial Operations
Committee
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Utilizing Innovative Technology for Lowering the Cost of Traffic Signal Synchronization Projects - A Case Study of Beach Boulevard

Presented by:
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Presentation Agenda

- OCTA's TLSP Program
- Beach TLSP Project
- Project Objectives
- Project Elements
- Special Features
- Timing Optimization
- Results and Summary of Benefits

Traffic Light Synchronization Program

- Traffic Light Synchronization Program (TLSP)
- Proposition 1B TLSP Component = $250M
  - First $150M allocated to LADOT by law
  - Last $100M competitive across California
- Funding Match is Key Leverage in Competition
  - $4M – Measure M Signal Improvement Program 50% Match
  - $4M – Prop. 1B TLSP Match
  - Number 1 project in competitive bid
- Project – 10 Interjurisdictional Corridors
  - 153 centerline miles – 533 signalized intersections
  - 3 years – last 3 projects now entering final phase

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Traffic Light Synchronization Program

- Corridors length range from 11 to 21 miles in length
- All have 6 – 9 agencies participating

1st year Corridors

- Alicia Parkway
- Beach Boulevard
- Chapman Avenue

Budget - $3.1 Million

2nd year Corridors

- Brookhurst Street
- Edinger/Irvine Center/ Moulton/Golden Lantern
- El Toro Road
- Orangethorpe Avenue

Budget - $2.9 Million

3rd year Corridors

- Katella Avenue
- La Palma Avenue
- Yorba Linda Boulevard

Budget - $2.0 Million

Traffic Light Synchronization Program

- Project Purpose –
  - Demonstration of large scale inter – agency cooperative efforts in traffic signal coordination providing superior results in reduction of:
    - Travel Time
    - Delay
    - Fuel Consumption
    - Emissions
- Driver Perception –
    - *“Improvement in overall quality of drive”*

Beach Boulevard TLSP Project

- Beach Boulevard is State Route 39
- 21 centerline miles
- Six to eight-lane facility
- 70 existing signals – Type 170 Control Systems
- 8 cities (La Habra, La Mirada, Buena Park, Anaheim, Stanton, Garden Grove, Westminster, Huntington Beach)
- 4 freeway interchanges (I-5, SR-91, SR-22 & I-405)

Background and Characteristics

- 60,000 ADT
- Over 2,500 vehicles per hour each direction during peak hours
- Twisted pair copper interconnect cable installed 20 years ago
- Last Synchronization completed in Year 2000
  - ❖ AM, MD, PM, weekend plans
  - ❖ 120 second cycle

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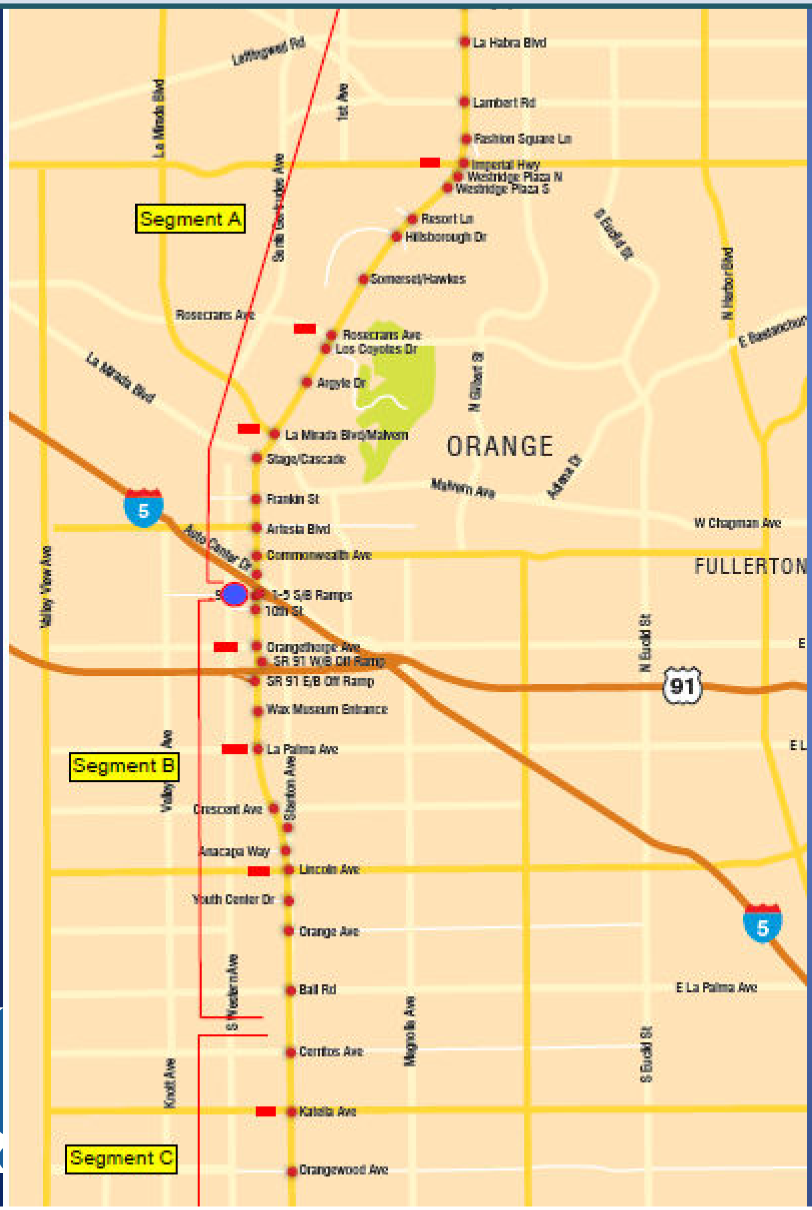
Project Map



Segment A
Segment B
Segment C
La Habra Blvd
Lambert Rd
Fashion Square Ln
Imperial Hwy
Westridge Plaza N
Westridge Plaza S
Resort Ln
Hillsborough Dr
Somerset/Hawkes
Rosecrans Ave
Los Coyotes Dr
Argyle Dr
La Mirada Blvd/Malvern
Stage/Cascade
Franklin St
Artesia Blvd
Commonwealth Ave
I-5 S/B Ramps
10th St
Orangethorpe Ave
SR 91 W/B Off Ramp
SR 91 E/B Off Ramp
Wax Museum Entrance
La Palma Ave
Crescent Ave
Anacapa Way
Lincoln Ave
Youth Center Dr
Orange Ave
Ball Rd
Cerritos Ave
Katella Ave
Orangewood Ave
ORANGE
FULLERTON
W Chapman Ave
E La Palma Ave
Leffingwell Rd
La Mirada Blvd
1st Ave
Santa Gertrudes Ave
Rosecrans Ave
N Gilbert St
N Euclid St
S Euclid St
N Harbor Blvd
Malvern Ave
Valley View Ave
Stanton Ave
S Western Ave
Knott Ave
Magnolia Ave
Auto Center Dr
5
91

Segment D
Segment E
Lampson Ave
Village Center/Stanford
Acacia Ave
Garden Grove Blvd
SR 22 W/B Off Ramp
SR 22 E/B Off Ramp
Trask Ave
Westminster Blvd
18th St
Hazard Ave
Bolsa Ave
McFadden Ave
Edinger Ave
Stark St
MacDonald Ave
Heil Ave
Terry Dr
Warner Ave
Slater Ave
Newman Ave
Talbert Ave
Main St/ Ellis Ave
Garfield Ave
Yorktown Ave
Utica Ave
Adams Ave
Indianapolis Ave
Atlanta Ave
Pacific View
Pacific Coast Hwy
GARDEN GROVE
FOUNTAIN VALLEY
HUNTINGTON BEACH
Newland St
Springdale St
Golden West St
Brookhurst St
Euclid St
S Harbor Blvd
N Harbor Blvd
Main St/ Elis Ave
17th St
Victoria St
22
405

Prop. 1B TLSP Grant and Measure M

- In 2009, Beach Boulevard received for TLSP:
- 50% Prop. 1B and 50% O.C. Measure "M"

Project Elements

- NEW CCTV cameras at 14 locations
- Upgrade communications network
- NEW Type 2070 control systems at 68 locations
- NEW Type 170E Field Master Controllers – 6
- NEW GPS time-base units – 6
- NEW Optimized Timing Analysis entire corridor
- NEW timing implementation & fine-tuning
- Continuous Field Monitoring – 9 months

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Project Objectives

- Reduce travel time, stops, fuel consumption
- Increase travel speeds
- Improve air quality
- Provide real-time video transmission to Caltrans District 12 (D-12) Traffic Management Center
- Enable remote monitoring & control of traffic signals from D-12 TMC
- Enhance controller functionalities

Leveraging Existing Infrastructure

- Caltrans originally desired upgrade to fiber optic cable
- Determined infeasible due to high cost
- Solutions:
  - ❖Reuse existing 12 pair#19 Copper I/C
  - ❖Implement Ethernet-over-Copper technology
  - ❖Proof that good quality video image can be provided at a lower cost
  - ❖Results = over $500,000 savings

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Issues and Solutions

- Issues with Infrastructure
  - ❖Conditions of existing cables and conduits
    - ❖Damaged and/or broken
  - ❖Quality of video transmitted over copper cable
- Solutions:
  - ❖Field Inspection of infrastructure conduit and cable
  - ❖Audio/Tone, Electronic, Magnetic Time Domain Reflectometry
- CCTV & Communications Bench Test
  - ❖5000 Lineal Foot Spool
  - ❖Emulate Field Conditions

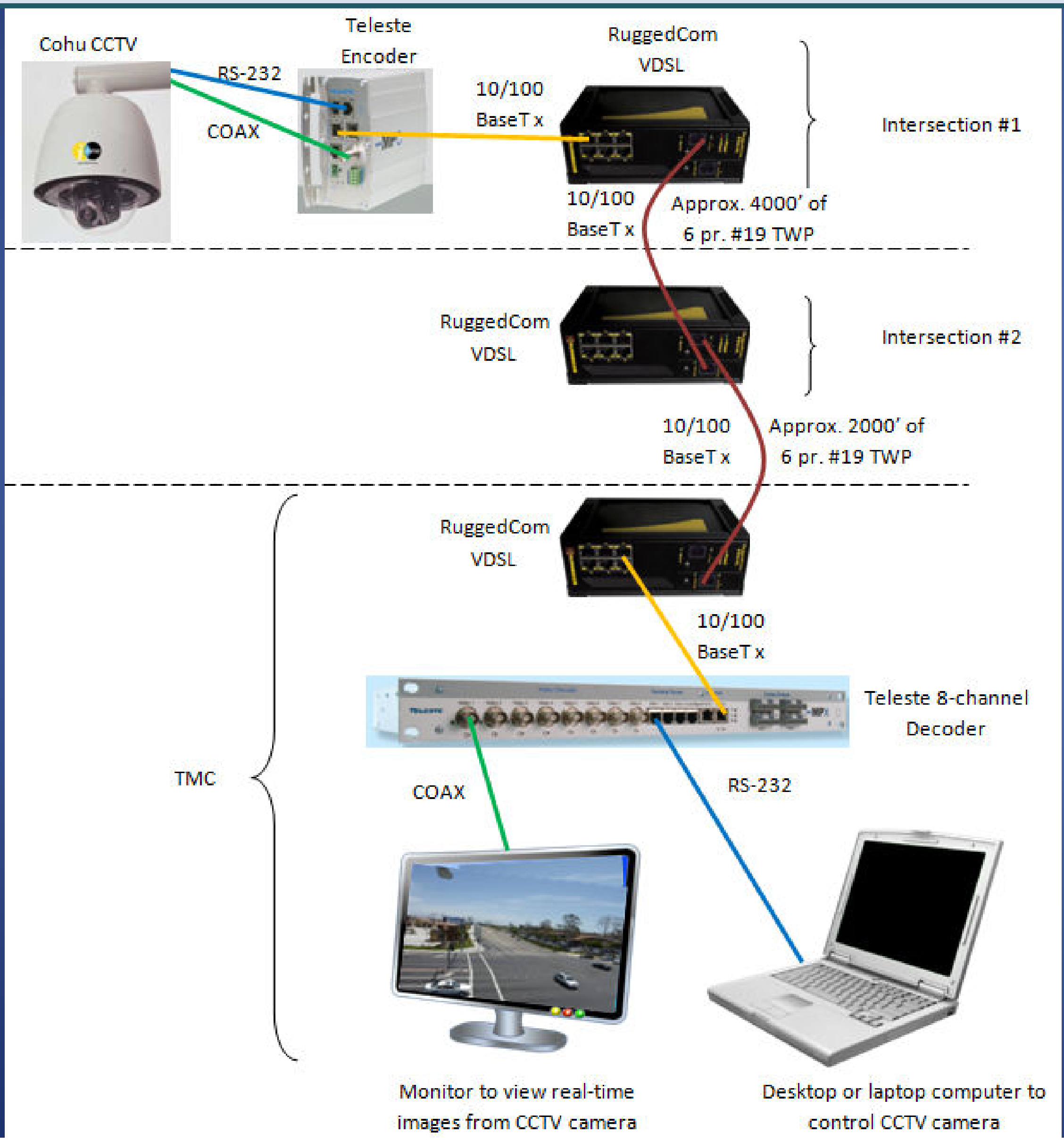
Conductivity Test

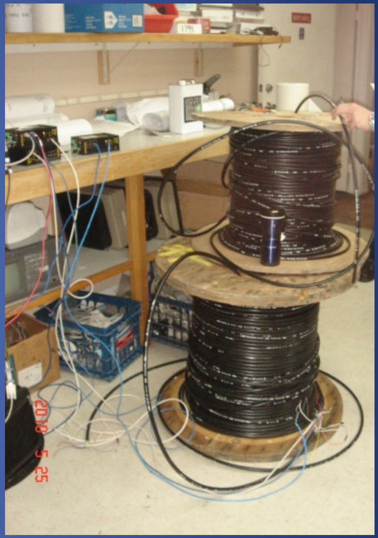
- Tested entire corridor, segment by segment
- All but one segments passed - Interconnect conduits damaged
- Replaced 2,000 feet of the damaged I/C cable and repaired the conduits at 2 break points

CCTV Bench Test

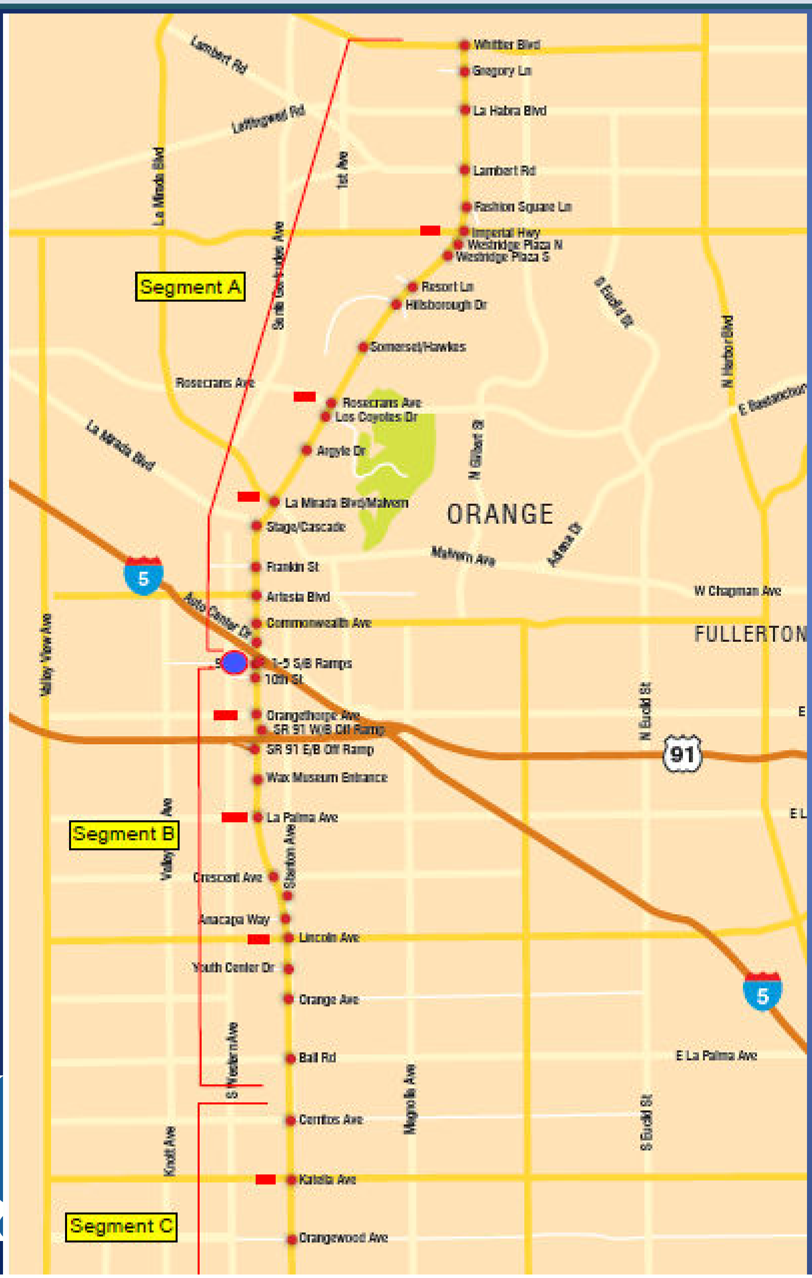
- Bench test to simulate field conditions
- Utilize actual field devices, and over one mile of copper cable
- Results
  - ❖ Good video quality from 500 kbps to 3Mbps speeds
  - ❖ Negligible latency in video transmission

CCTV Bench Test - Setup





Communications Network



CCTV Camera Installation

- Constraint
  - ❖ CEQA = No ground-disturbance (hence no new pole or conduits)
- Solutions
  - ❖ Install CCTV camera on existing pole
  - ❖ Install CCTV cable in existing conduits
  - ❖ Utilize existing Controller Assemblies for New Video Equipment

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CCTV Pole Selection Criteria

- Clear field-of-view in all directions
- Proximity to controller cabinet
- Percentage fill of conduits

Beach Boulevard and Westminster Avenue – Line of Sight for East Leg

Beach Boulevard and Westminster Avenue – View of East Leg


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Traffic Light Synchronization Phase

- Data Collection
  - Traffic Counts
  - 24/7 ADT
  - Intersection Turning Movement Counts
  - Auto, Pedestrian, Bicycle
  - “Floating Car” Before Study (AM, MD & PM peaks)
- Analysis and Optimization of signal timing
- Implementation / finetuning

Before Study Results

Parameters	AM Peak		Mid-Day Peak		PM Peak		Weekend Peak	
	NB	SB	NB	SB	NB	SB	NB	SB
Travel Time (Mins.)	43	45	43	45	53	49	48	52
Delay (time below 30 mph - mins.)	15	17	17	17	26	20	20	24
No. of Stops	18	20	19	19	27	23	25	31

New Performance Metric – Why?

Reductions in Emissions? GHG, CO, NO_X, VOC?
That's nice

Reduction in Overall delay? Stops/Vehicle, Number of Stops, Overall Delay Hours
That's nice

Intersection Capacity Utilization? ICU LOS A – H Capacity Reserve/Deficit Based
That's nice

Highway Capacity Manual Method? HCM LOS A – H Delay Based
That's nice

New Performance Metric – Why?

- **What does all this mean to us?**
- **??? Do the Elected Officials and Public Get it ???**

NO!

New Performance Metric – Why?

- What do people understand?
  - Faster = Average Speed
  - Getting Stopped at Every *"Bleep' n"* STOP Light = Greens/Reds
  - Getting Stopped for No Apparent Reason = Stops/Mile
  - Corridor Synchronization Performance Index (CSPI)
  - Travel Time, Fuel Consumption, and Emissions are Reduced

- Equates to **$ $ $ $ $ $** Saved
  - Elected Officials and Public Understand (GET IT!)

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YES!!!

Corridor Synchronization Performance Index (CSPI)

- New Rating System for all TLSP and OCTA sponsored TSS Projects
- Index based on additive scores of average speed, number of greens per red and number of stops per mile
- CSPI < 70 indicates a need for improvement

Speed (mph)	Score	Green/ Red	Score	Stops per Mile	Score
34	36	5.0	40	0.7	33
32	33	4.5	36	0.9	31
30	30	4.0	32	1.1	29
28	27	3.5	28	1.3	27
26	24	3.0	24	1.5	25
24	21	2.5	20	1.7	23
22	18	2.0	16	1.9	21
20	15	1.5	12	2.1	19
15	8	1.0	8	2.3	17

CSPI grading scale:
90-109 = A
80-89 = B
70-79 = C
60-69 = D
<59 = F

CSPI

Corridor Synchronization Performance Criteria

Performance Level	Description	CSPI Score
Optimal Signal Synchronization ●●●●●	Operations with very few numbers of stops at signalized intersections occurring with favorable progression and travel speeds along the corridor. Vehicles get through most of signalized intersections without stopping. Corridor has very good signal synchronization.	>=80
Good Signal Synchronization ●●●●	Operations with few numbers of stops at signalized intersections occurring with good progression and travel speeds along the corridor. Vehicles get through many signalized intersections without stopping. Corridor has good signal synchronization.	>= 70 to 80
Average Signal Synchronization ●●●	Operations with average numbers of stops at signalized intersections occurring with fair progression and travel speeds along the corridor. Vehicles get through above average numbers of signalized intersections without stopping. Corridor has an above average level signal synchronization.	>= 60 to 70
Below Average Signal Synchronization ●●	Operations with many numbers of stops at signalized intersections occurring with limited progression and slower than desired travel speeds. Many vehicles experience delay and vehicles get through fewer numbers of signalized intersections without stopping than expected. Corridor has a below average level signal synchronization. Local agencies along the corridor should consider applying for Measure M2 Project P signal synchronization funds.	>= 50 to 60
Needs Improvement to the Signal Synchronization* ●	Operations with delays and number of stops unacceptable to most drivers occurring with over-saturated conditions, poor progression, and low travel speeds. Most vehicles experience high delay and low travel speeds, and vehicles get through very few numbers of signalized intersections without stopping. Corridor needs improvement to the signal synchronization. Local agencies along the corridor should **strongly** consider applying for Measure M2 Project P signal synchronization funds.	< 50

Source: OCTA, 2011.

* Signal synchronization may not solve capacity problems. Capital improvements may also be required.

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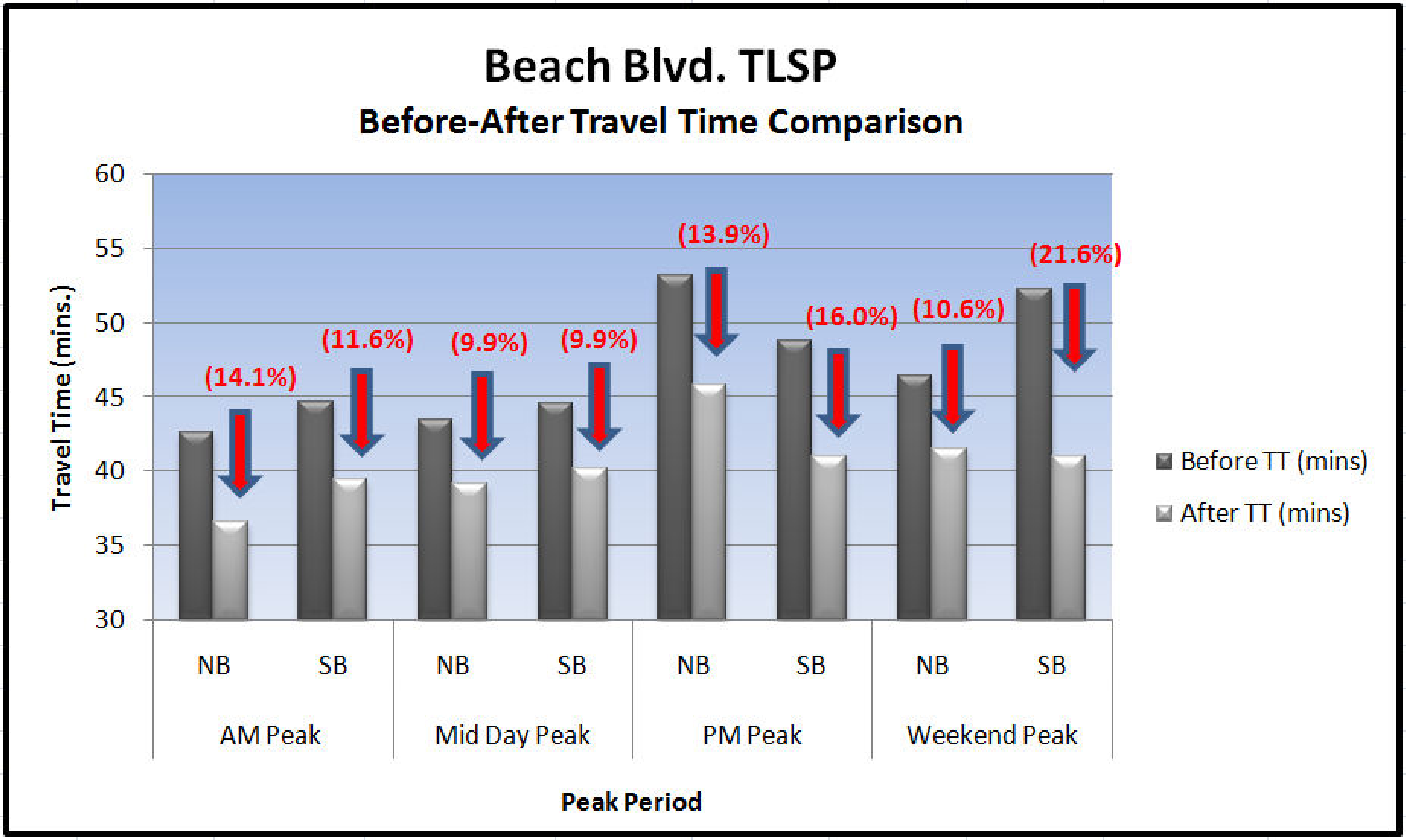
New Minimum or Initial Green

- First corridor in Orange County to have new minimum green implemented
- Changes affect all left-turns and side streets
- New min green increased by 5 to 10 seconds over existing
- Increase of 30% to 200% from the previously implemented minimum green timing

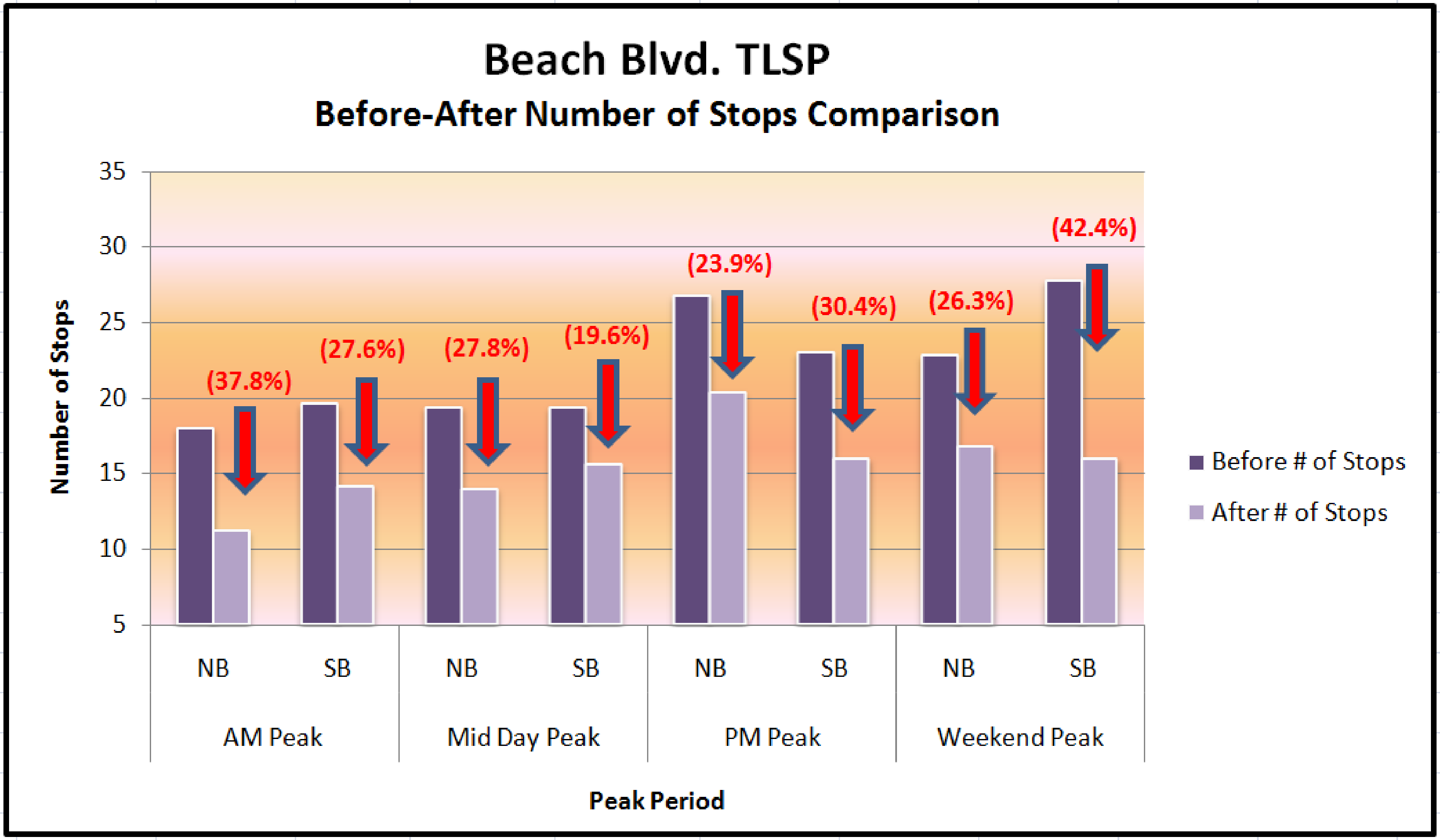
MUTCD – CA MUTCD Pedestrian Timing

- Significant pedestrian activity throughout the corridor.
  - Several Large Generators – Amusement Parks, Malls, Beach
- Existing ped clearance time is insufficient at most locations (old ≥ 4.0/fps – new = 3.5 fps)
- Average increase = 5 seconds

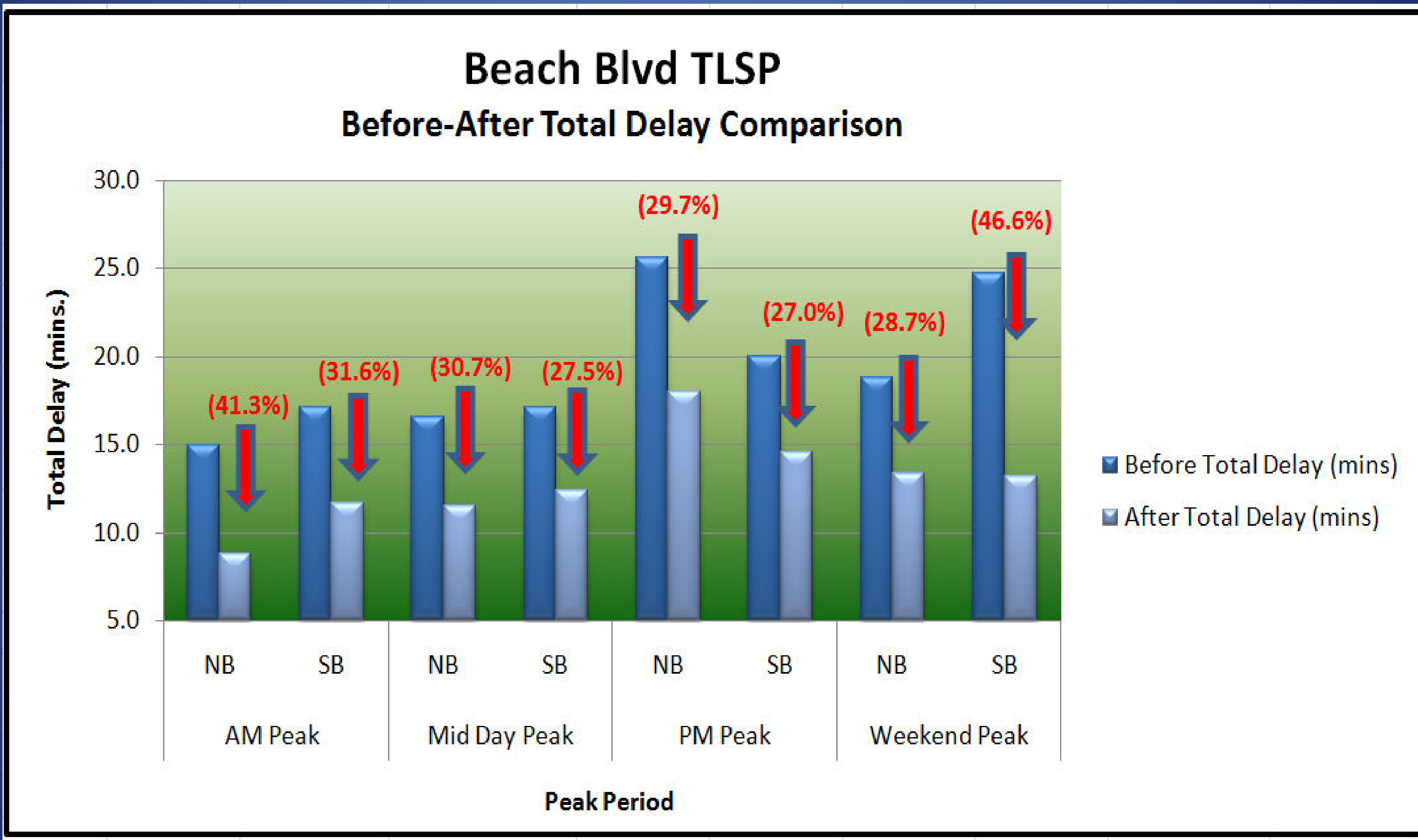
Reduction in Travel Time



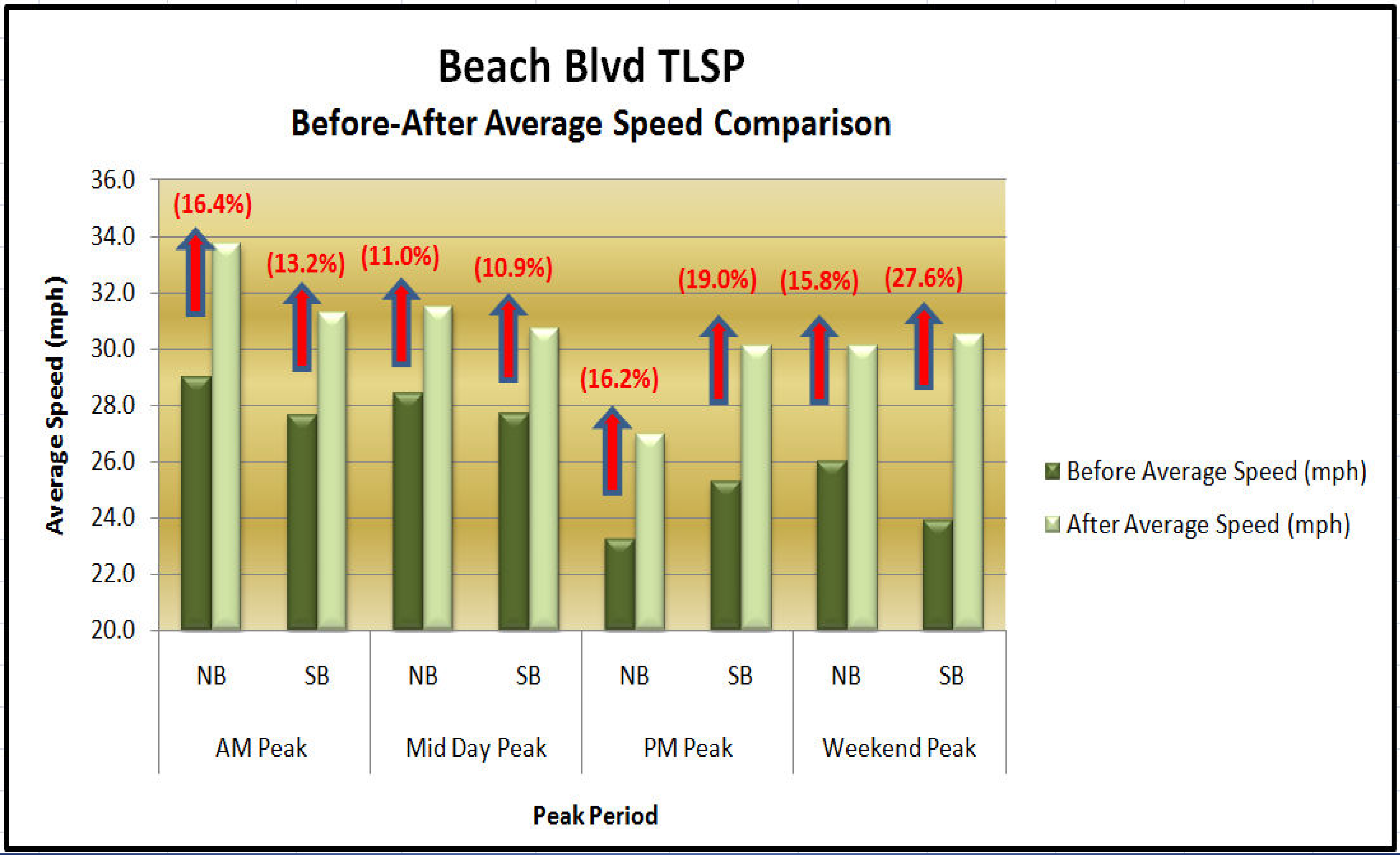
Reduction in Number of Stops per Mile



Reduction in Total Delay



Increase in Average Speed



Beach Boulevard TLSP
Before and After Comparison - CSPI

'Before' Condition

	AM Peak				MD Peak				PM Peak				Weekend Peak			
	NB		SB		NB		SB		NB		SB		NB		SB	
Parameters		score		score		score		score		score		score		score		score
Avg Speed	26	24.0	27	25.5	26	24.0	29	28.5	20	15.0	26	24.0	26	24.0	24	21.0
Green/Red	2.9	23.2	2.6	20.8	2.6	20.8	2.6	20.8	1.6	12.8	2.0	16.0	2.1	16.8	1.5	12.0
Stops per Mile	0.9	31.0	1.0	30.0	0.9	31.0	0.9	31.0	1.3	27.0	1.1	29.0	1.1	29.0	1.3	27.0
CSPI	**78.2**		**76.3**		**75.8**		**80.3**		**54.8**		**69.0**		**69.8**		**60.0**	
CSPI Grade	**C**		**C**		**C**		**B**		**F**		**D**		**D**		**D**	

'After' Conditions

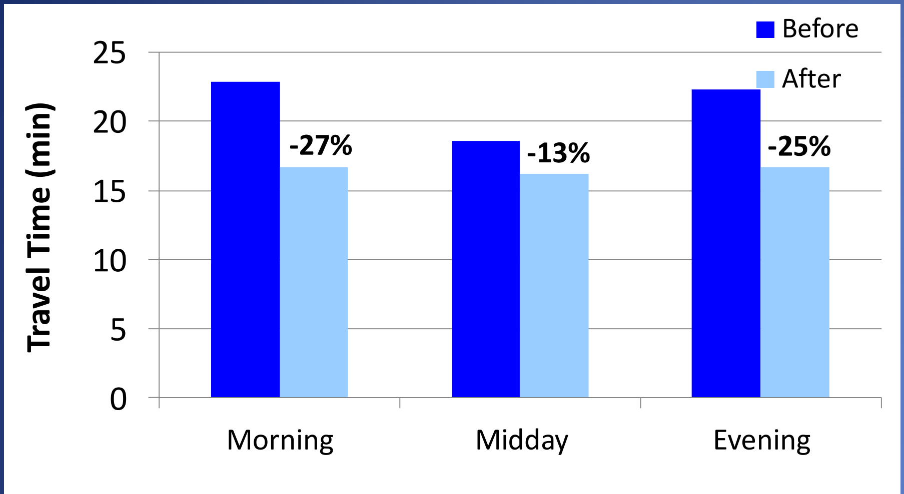
	AM Peak				MD Peak				PM Peak				Weekend Peak			
	NB		SB		NB		SB		NB		SB		NB		SB	
Parameters		score		score		score		score		score		score		score		score
Avg Speed	34	36.0	32	33.0	32	33.0	31	31.5	27	25.5	29	28.5	30	30.0	31	31.5
Green/Red	5.3	40.0	3.9	31.2	4.0	32.0	3.5	28.0	2.4	19.2	3.4	27.2	3.2	25.6	3.4	27.2
Stops per Mile	0.5	33.0	0.7	33.0	0.7	33.0	0.8	32.0	1.0	30.0	0.8	32.0	0.8	32.0	0.8	32.0
CSPI	**109.0**		**97.2**		**98.0**		**91.5**		**74.7**		**87.7**		**87.6**		**90.7**	
CSPI Grade	**A**		**A**		**A**		**A**		**C**		**B**		**B**		**A**	

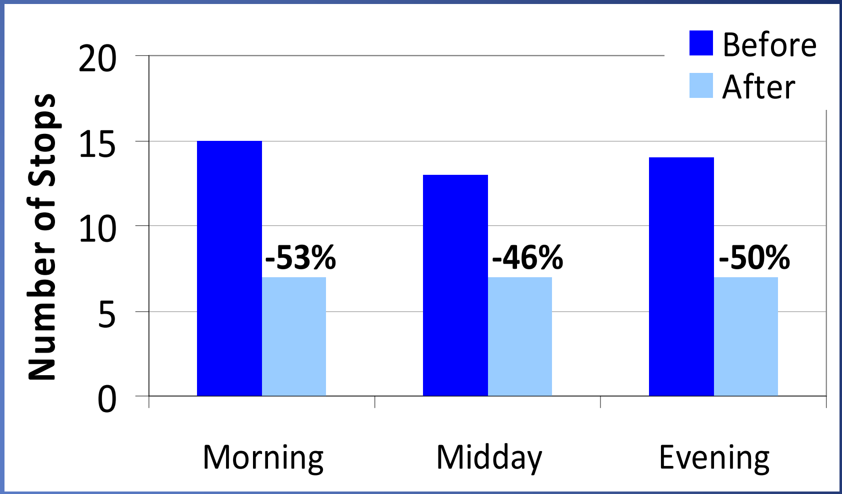
Project Benefits

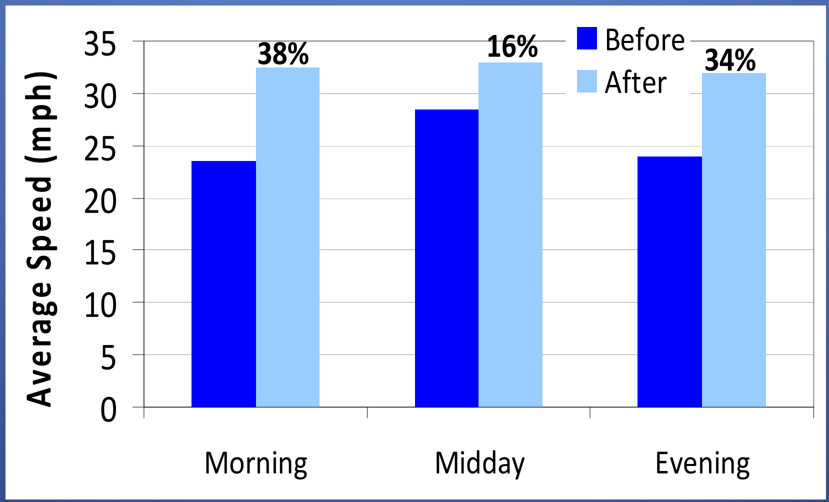
- Annual Savings = $27.5 million/year
- Benefit to Cost Ratio = 21:1 in first year
- Reduction in GHG's emissions:
  - 67,000 tons annually BEFORE PROJECT
  - 48,000 tons annually AFTER PROJECT
  - 19,000 tons or 28% REDUCTION!!!

Questions ???

TLSP – Typical Improvements
Travel Time, Stops/Mile, and Average Speed







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CSPI for Beach Boulevard - Before

Parameters	AM Peak			Mid-Day Peak			PM Peak			Weekend		
	NB	SB	Average	NB	SB	Average	NB	SB	Average	NB	SB	Average
Avg Speed	26.42	27.24	27	26.14	29.44	28	20.08	25.64	23	25	26.77	26
Green/Red	2.89	2.57	2.7	2.61	2.61	2.6	1.61	2.04	1.8	1.86	1.62	1.7
Stops per Mile	0.87	0.95	0.9	0.94	0.94	0.9	1.30	1.12	1.2	1.19	1.48	1.3
CSPI	80.5 (B)			82 (B)			63.5 (D)			65 (D)		

CSPI grading scale:
90-109 = A
80-89 = B
70-79 = C
60-69 = D
<59 = F

Special Feature
MUTCD's New Bicycle Policy Directive

- Mandates provision of Bicycle and Motorcycle Detection on all approaches to traffic-actuated signals in CA

- Incorporated in the new optimized timing plans for AM, Mid-Day, PM and Weekend peak hours

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Special Feature
MUTCD's New Bicycle Policy Directive

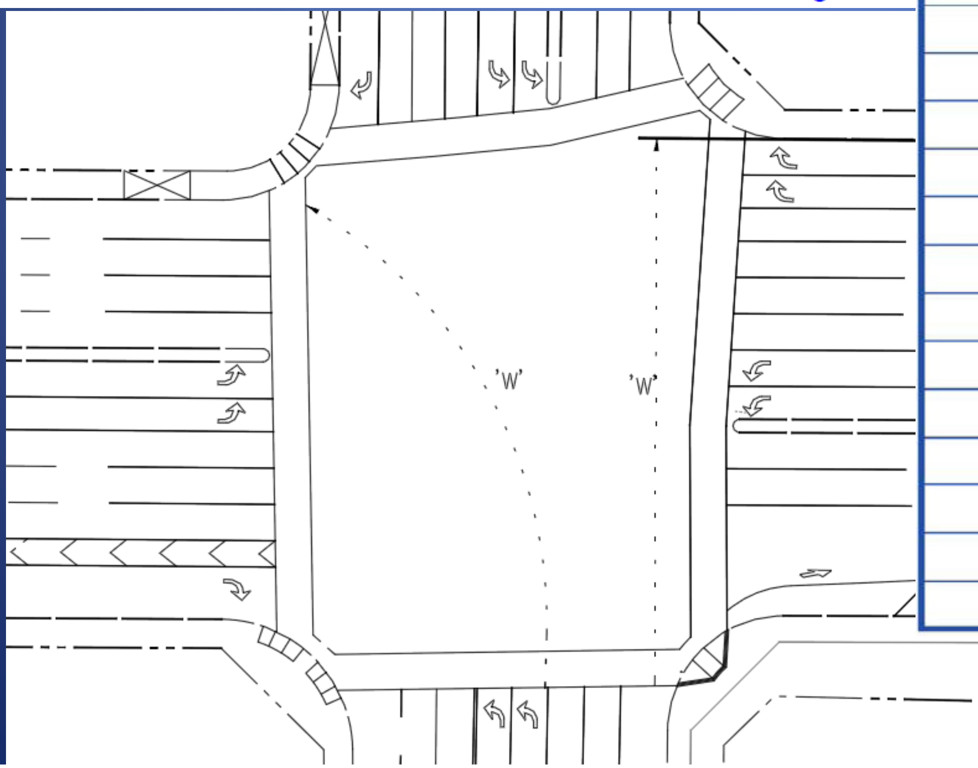
For all phases, the sum of the minimum green, plus the yellow change interval, plus any red clearance interval should be sufficient to allow a bicyclist riding a bicycle 6 ft long to clear the last conflicting lane at a speed of 14.7 ft/sec plus an additional effective start-up time of 6 seconds, according the formula

$G_{min} + Y + R_{clear} \geq 6 \text{ sec} + (W+6 \text{ ft})/14.7 \text{ ft/sec}$,

where

- Gmin = Length of minimum green interval (sec)
- Y = Length of yellow interval (sec)
- Rclear = Length of red clearance interval (sec)
- W = Distance from limit line to far side of last conflicting lane

Distance from limit line to far side of last conflicting lane	Minimum phase length (minimum green plus yellow plus red clearance)
Feet	Seconds
40	9.1
50	9.8
60	10.5
70	11.2
80	11.9
90	12.5
100	13.2
110	13.9
120	14.6
130	15.3
140	15.9
150	16.6
160	17.3
170	18.0
180	18.7



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Optimal Timing Implementation

- Incorporated new bicycle minimum green and ped clearance time
- Accommodated heavy left turns
- Preserved "Smart Street" concept by providing good progression in both directions
- New peak hour cycle lengths:
  - ❖ 120s, 130s, & 140s depending on the traffic conditions

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