Multi-modal performance measures: Are we getting an A?

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Webinar 9/16/14

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Agenda

- Why measure the street for walking and bicycling?
- Measures / tools available
- Comparison results
- Variable breakdown
  - Question break
- In-depth HCM breakdown
  - Question break
- Sensitivity case study
- Conclusions

Why Do We Have Measures for Walking and Biking Quality?

Auto Level-of-Service

6. DETERMINATION OF IMPACTS

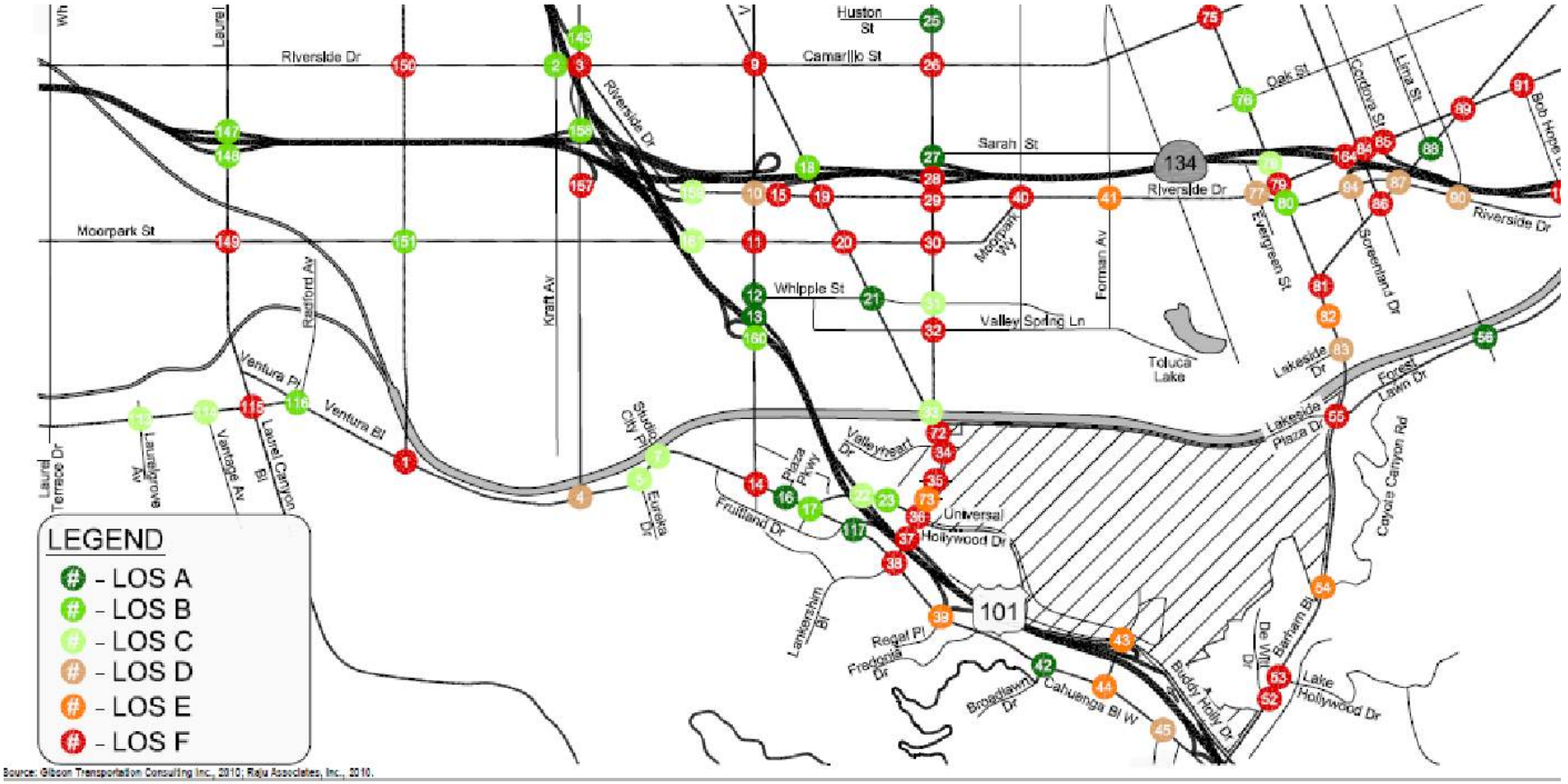
The following criteria shall be used to determine if the addition of project traffic should be considered to have a significant impact and feasible measures must be identified to mitigate the impacts.

6.1 Signalized Intersections

Any study intersection that is operating at a LOS 'A', 'B', 'C' or 'D' for any study scenario without project traffic in which the addition of project traffic causes the intersection to degrade to a LOS 'E' or 'F' shall mitigate that impact so as to bring the intersection back to at least LOS 'D'.

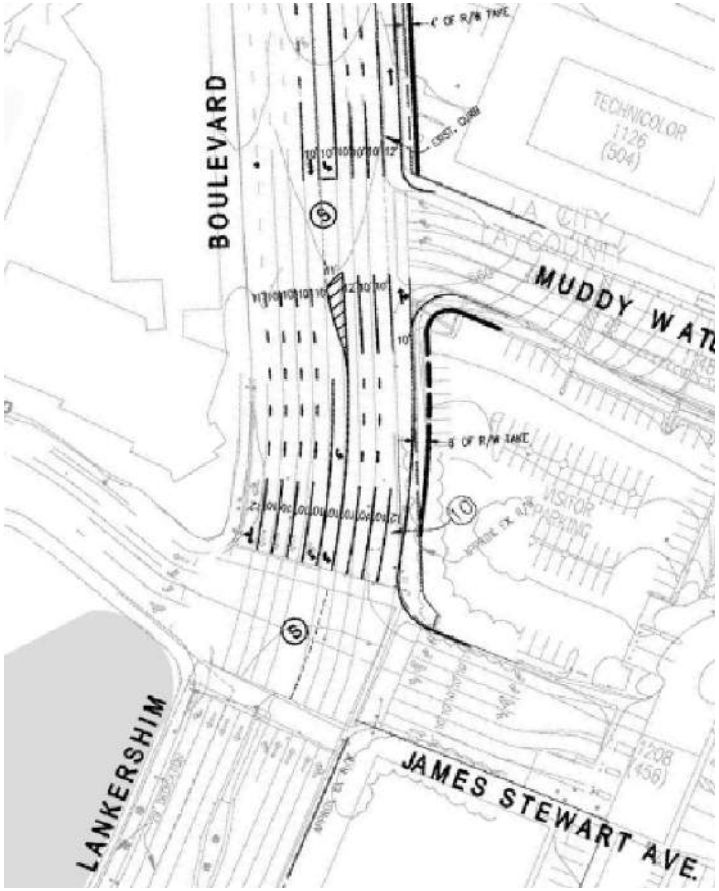
Any study intersection that is operating at a LOS 'E' or 'F' for any study scenario without project traffic shall mitigate any impacts so as to bring the intersection back to the overall level of delay established prior to project traffic being added.

Auto Level-of-Service



Source: Gibson Transportation Consulting Inc., 2010; Raju Associates, Inc., 2010.

Auto Level-of-Service



(d) Lankershim Boulevard Corridor Improvements

Mitigation Measure B-6: The Project Applicant or its successor shall implement or contribute toward the implementation of the following Lankershim Boulevard Corridor improvements:

a. Widen northbound Lankershim Boulevard at its intersection with Cahuenga Boulevard to provide three through lanes and dual right-turn lanes;

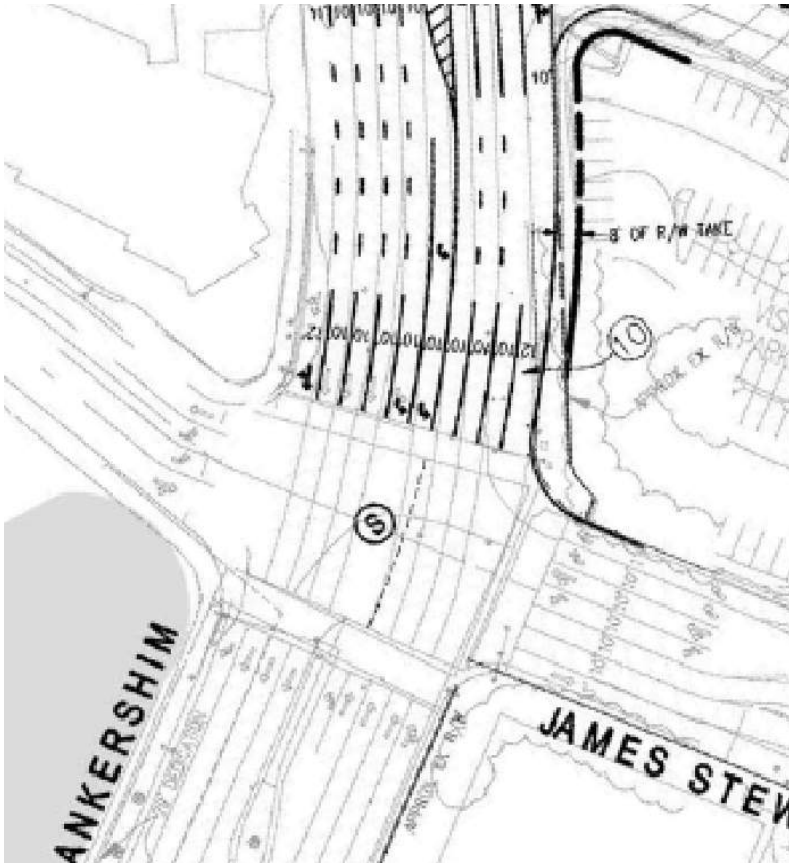
b. Widen Valleyheart Drive at its intersection with Lankershim Boulevard to provide dual left-turn lanes and a shared through/right lane in the eastbound direction;

c. Restripe James Stewart Avenue at its intersection with Lankershim Boulevard to provide one left-turn, one shared through/left-turn, and dual right-turn lanes in the westbound direction;

d. Widen southbound Lankershim Boulevard at its intersection with Valleyheart Drive/James Stewart Avenue to provide an additional southbound left-turn lane;

e. Widen Main Street at its intersection with Lankershim Boulevard to improve ingress/egress to/from the Project Site;

Improvements for Whom?



How is LOS used?

- Assess current situations
- Understand the effect of future development
  - Assess developer mitigation fees
  - Traffic impact analyses in environmental review
- Understand differences between improvement scenarios

Measures in our analysis

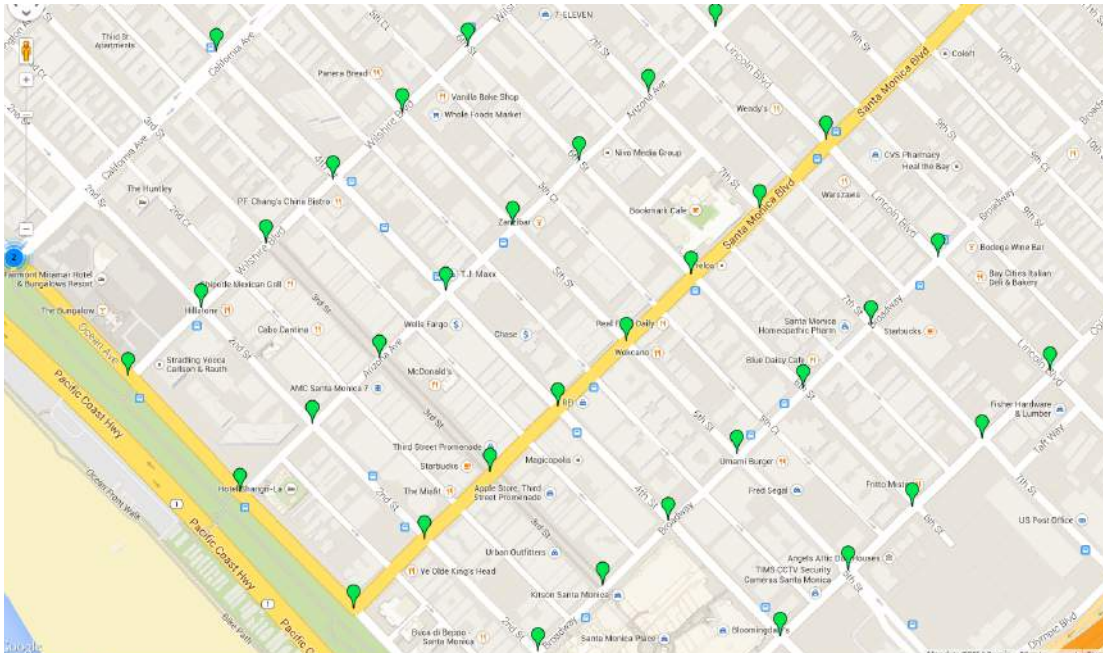
1. BEQI/PEQI
2. City of Charlotte Urban Street Design Guidelines performance measures
3. Highway Capacity Manual 2010

Other similar measures

- City of Fort Collins multi-modal performance measures
- Level of Traffic Stress
- Danish Bicycle Level of Service
- Others?

Applying These Measures to Real Streets

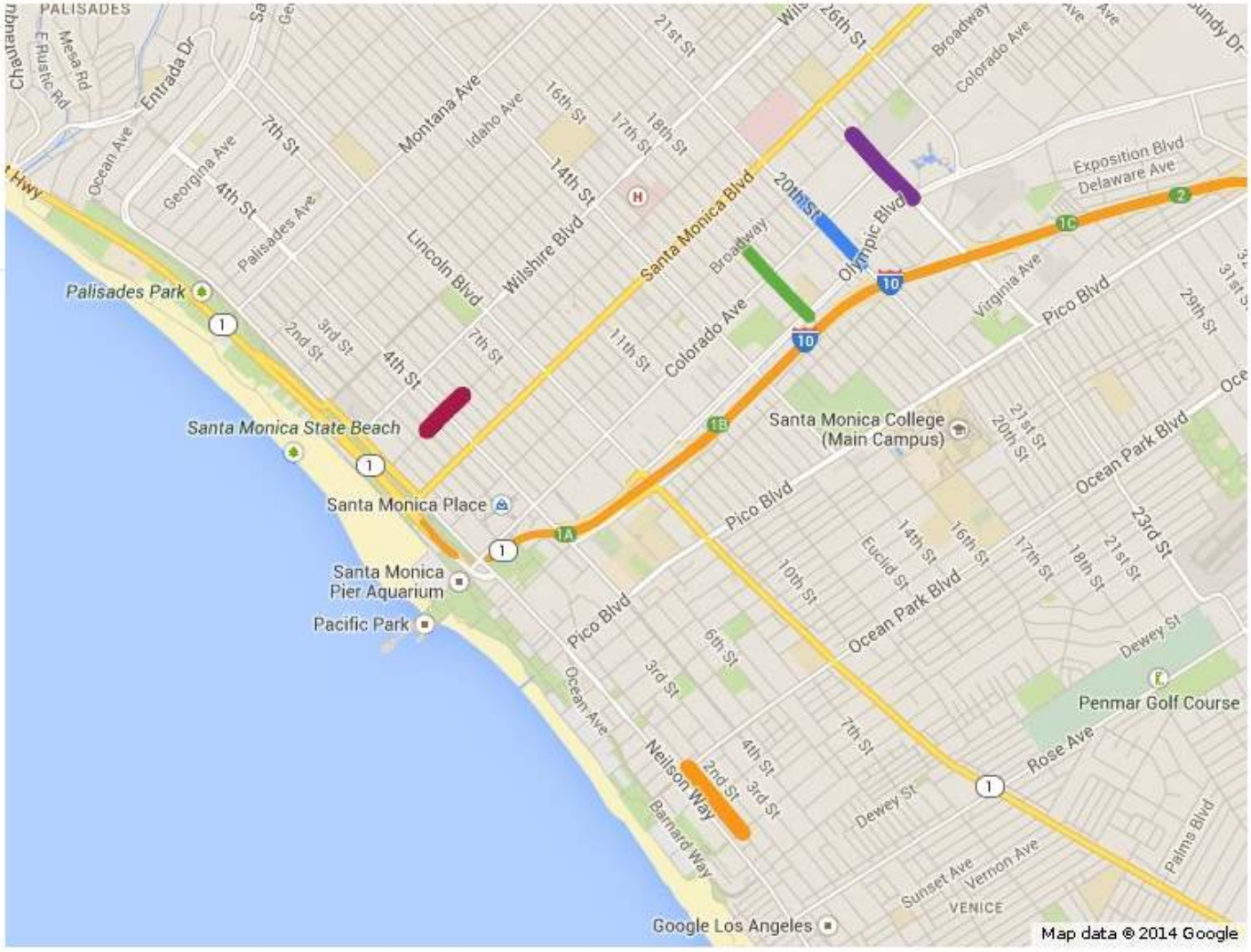
- Compared the different measurement tools to each other
- Selected 5 street segments in the City of Santa Monica
    - Arizona Ave
    - Main Street
    - 17th Street
    - 20th Street
    - Cloverfield Blvd
- Some tools have a lot of data needs including turning volumes



Are we getting an A?

Analysis Routes

- 17th Street
- 20th street
- Cloverfield Blvd
- Arizona Ave
- Main Street



Comparison results from 3 of 5 routes - all 5 in paper and report

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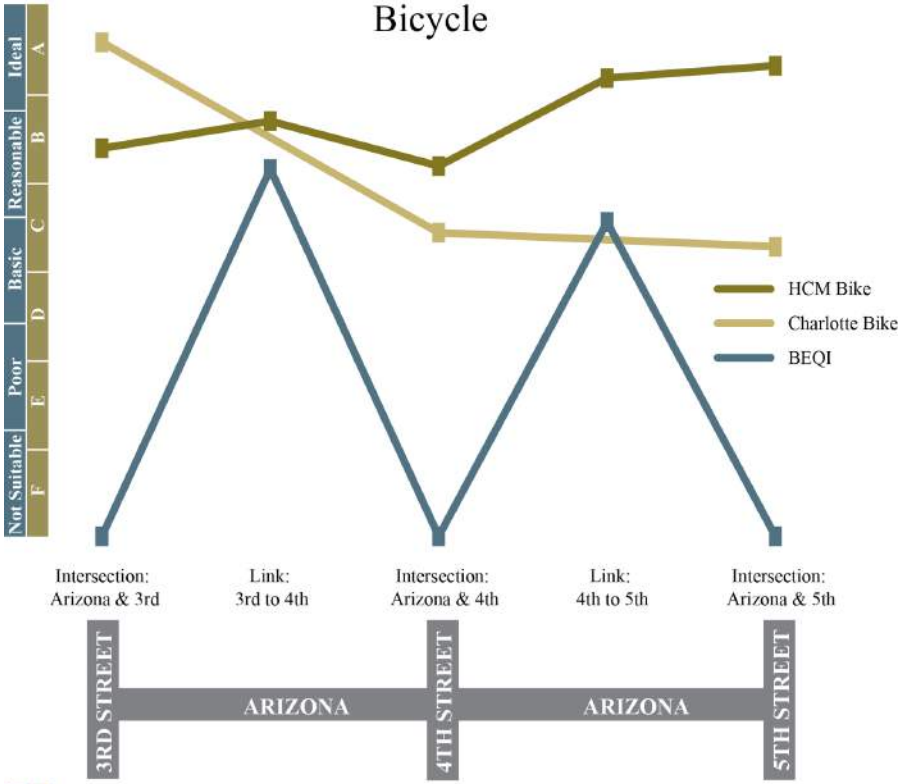
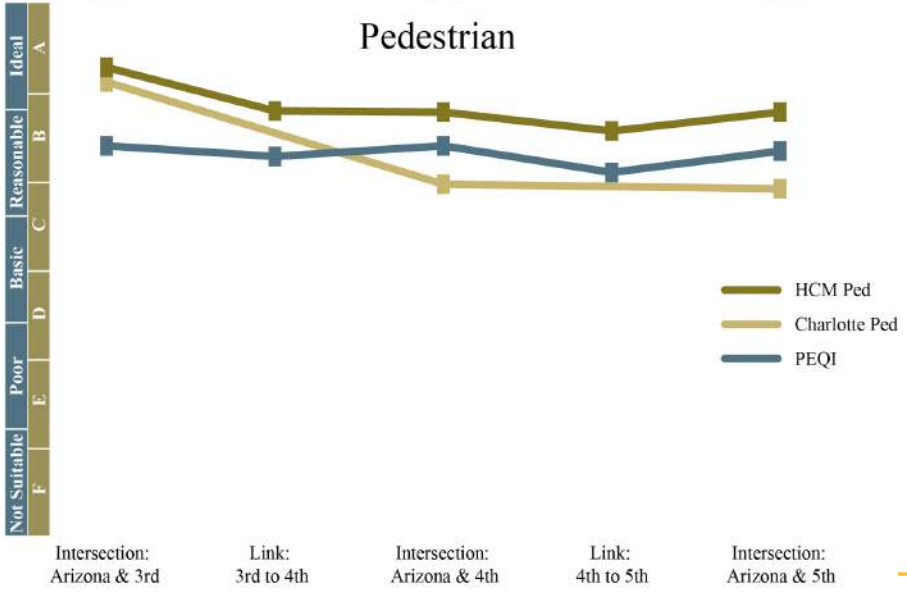
Arizona Ave





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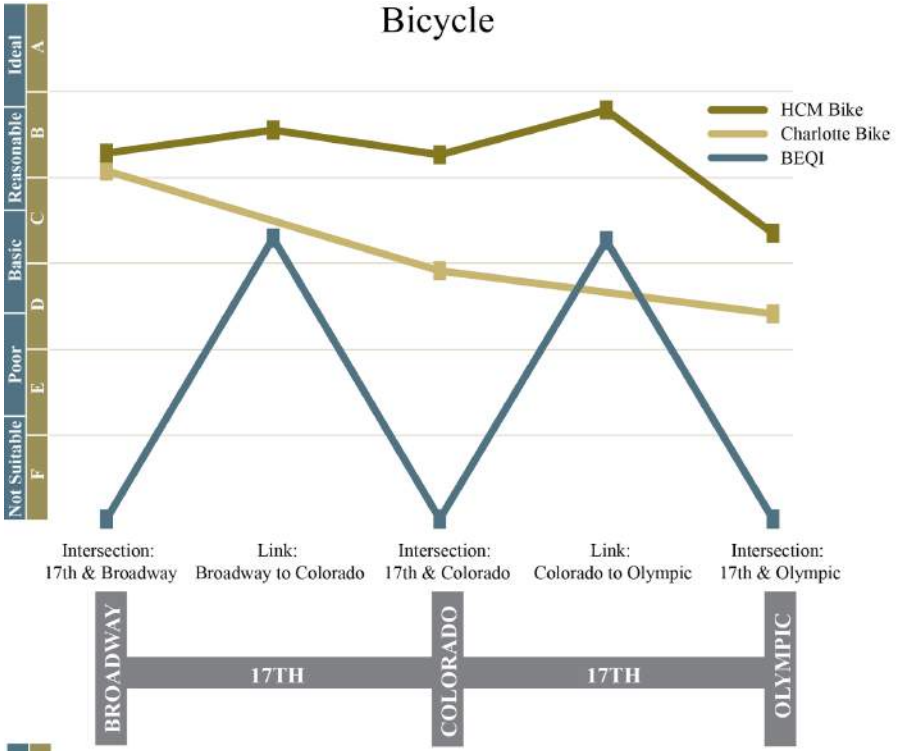
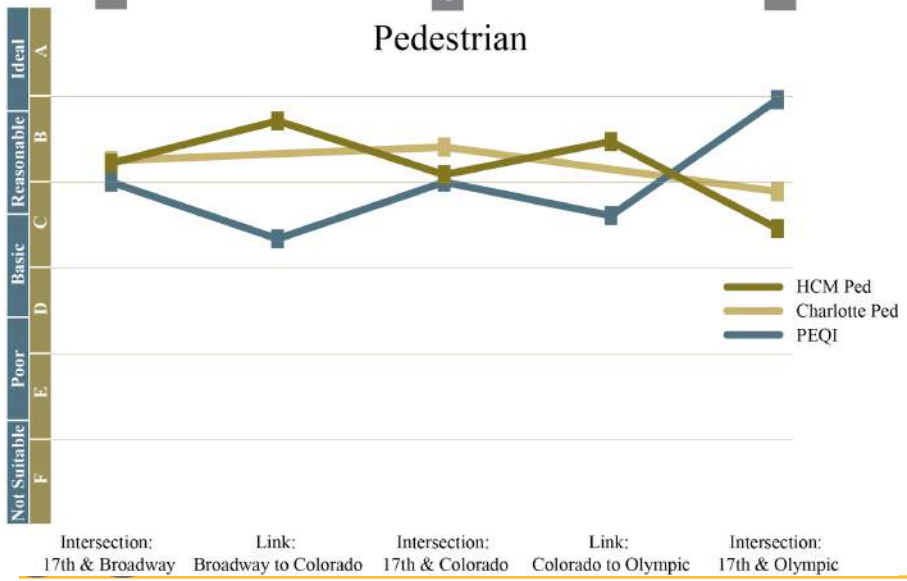
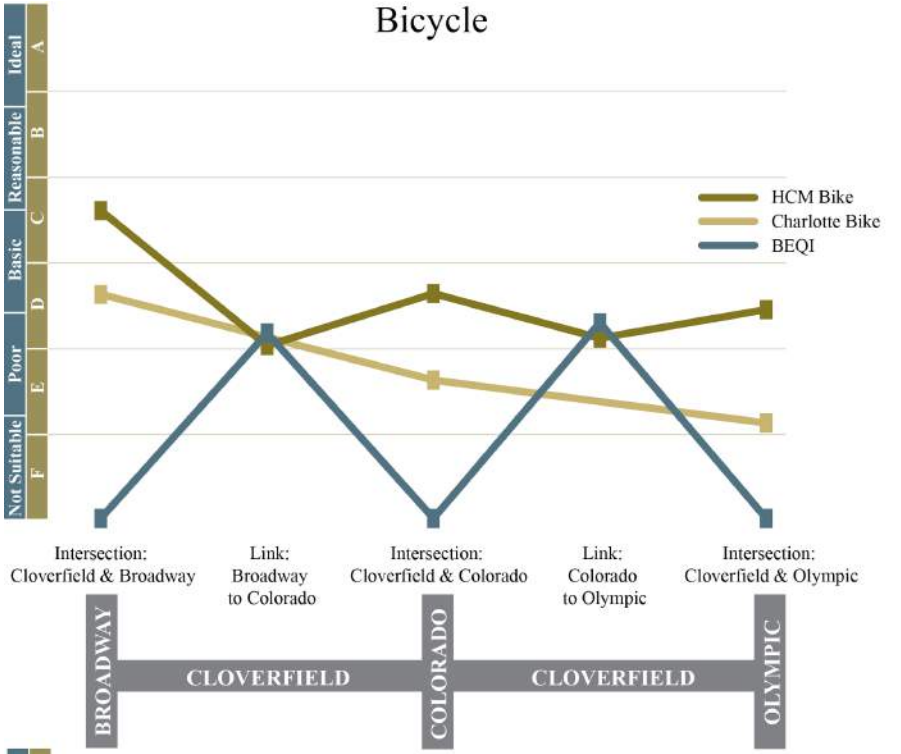
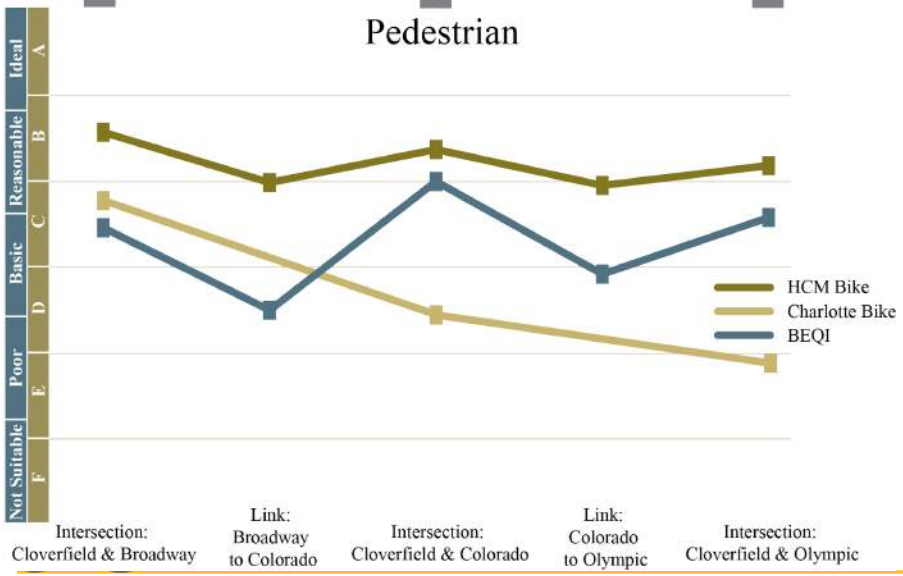
17th Street


Bicycle
Ideal
A
Reasonable
B
Basic
C
D
Poor
E
Not Suitable
F
HCM Bike
Charlotte Bike
BEQI
Intersection: 17th & Broadway
Link: Broadway to Colorado
Intersection: 17th & Colorado
Link: Colorado to Olympic
Intersection: 17th & Olympic
BROADWAY
17TH
COLORADO
17TH
OLYMPIC


Pedestrian
Ideal
A
Reasonable
B
Basic
C
D
Poor
E
Not Suitable
F
HCM Ped
Charlotte Ped
PEQI
Intersection: 17th & Broadway
Link: Broadway to Colorado
Intersection: 17th & Colorado
Link: Colorado to Olympic
Intersection: 17th & Olympic

Cloverfield Blvd

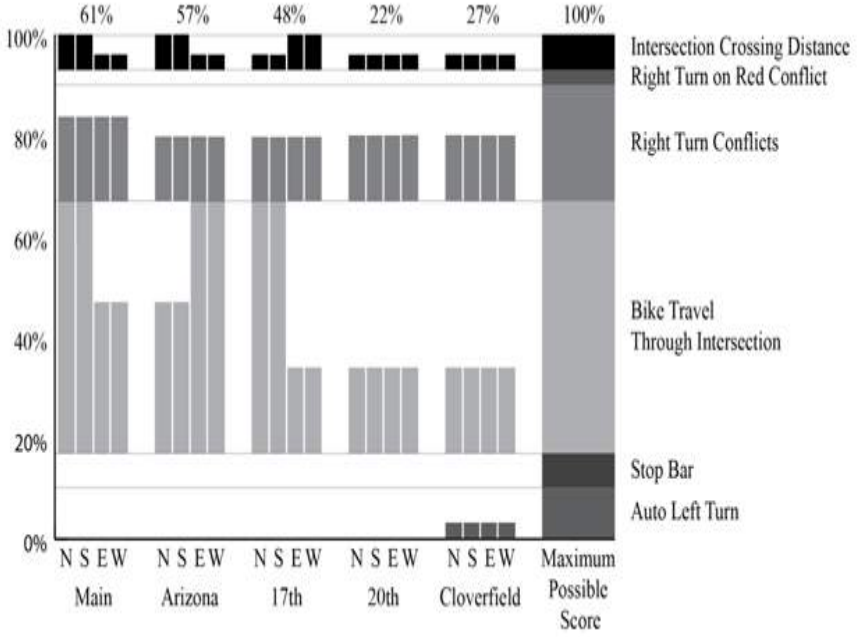




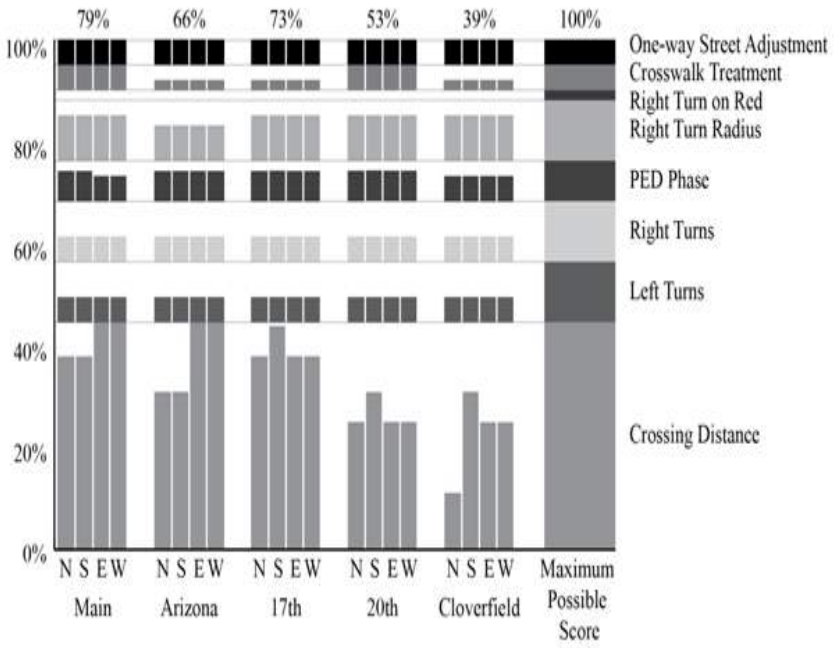
Why do we see such variation in the scores?

Each tool takes in *different inputs, scored differently*.

Charlotte intersection*



Bicycle



Pedestrian

*charlotte methodology only measures intersections and takes all 4 approaches into account

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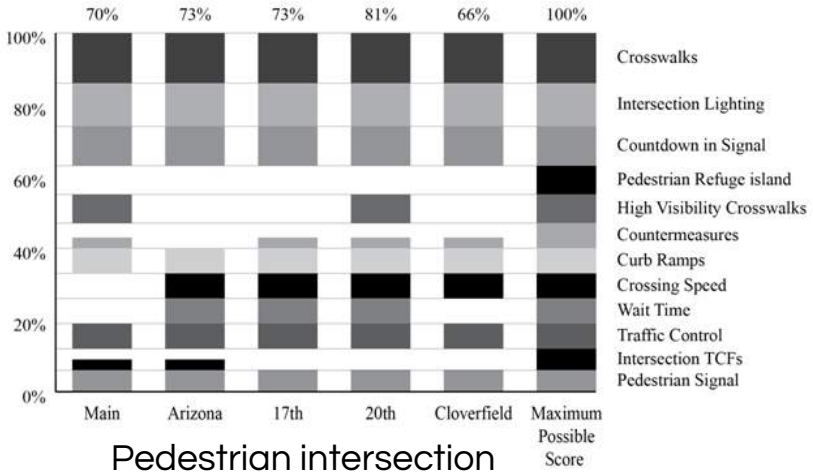
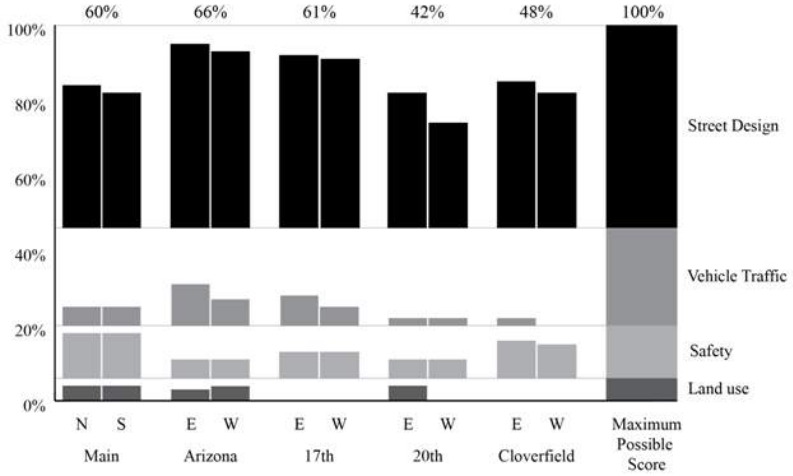
BEQI/PEQI Link & Intersection



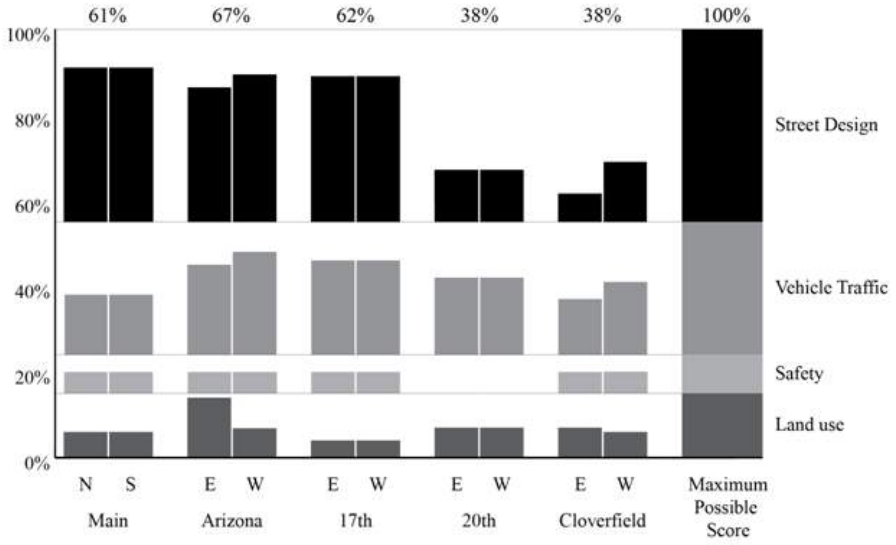
Pedestrian intersection



Pedestrian link

Bicycle intersection:

- Right turn on red restrictions
- Bike lane striping through the intersection
- Availability of left-turn bike lane



Bicycle link

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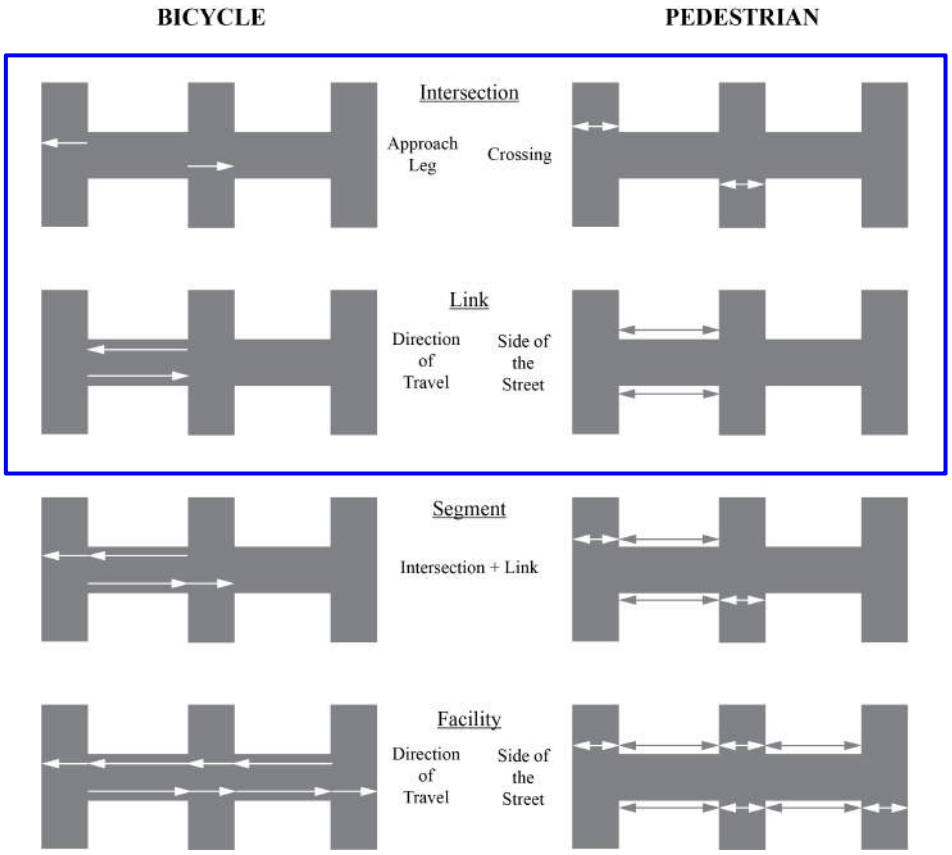
Question Break

What is HCM MMLOS?

- A *model* for bicycle and pedestrian quality of service (BLOS and PLOS)

Grade	Numerical Range
A	$x \leq 2.00$
B	$2.00 < x \leq 2.75$
C	$2.75 < x \leq 3.50$
D	$3.50 < x \leq 4.25$
E	$4.25 < x \leq 5.00$
F	$x > 5.00$



What is HCM MMLOS?

- A *complex formula...*

$$I_{p,ltnk} = 6.0468 + F_w + F_v + F_s$$

where

$$F_w = -1.2276 * \ln(W_v + 0.5 * W_1 + 50 * p_{pk} + W_{buf} * f_b + W_{aA} * f_{sw})$$

$$F_v = 0.0091 \frac{v_m}{4 * N_{th}}$$

$$F_s = 4 * \left(\frac{S_r}{100}\right)^2$$

Example: Link PLOS

Fw = Width Factor
Fv = Volumes Factor
Fs = Speed Factor

What is HCM MMLOS?

- … drawing on an exhaustive list of data

Name	Variable	Units
effective total width of outside vehicle lane, bike lane, and shoulder	W_v	feet
effective width of combined bicycle lane and shoulder	W_1	feet
proportion of on-street parking occupied	p_{pk}	none
buffer width between roadway and sidewalk	W_{buf}	feet
buffer area coefficient	f_b	none
adjusted available sidewalk width	W_{aA}	feet
sidewalk width coefficient	f_{sw}	feet
midblock demand flow rate	v_m	veh / hr
number of through lanes on the street in the direction of travel being considered	N_{th}	lanes
vehicle running speed	S_R	miles / hr

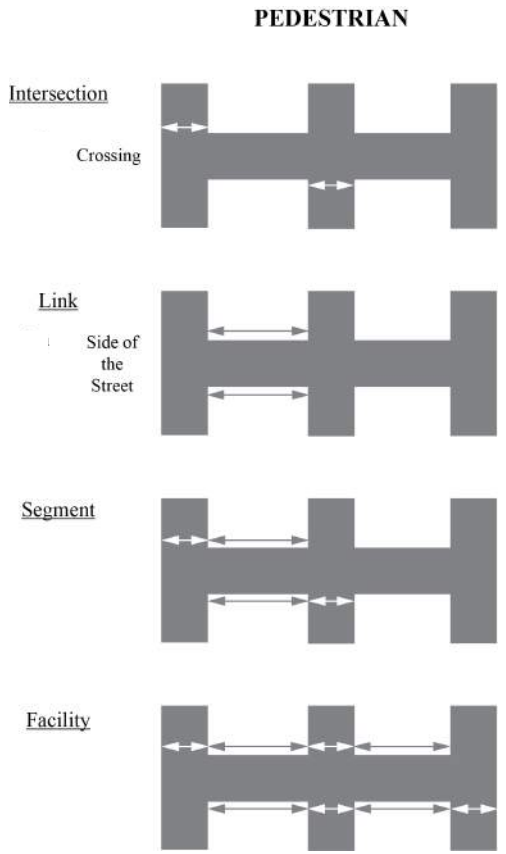
Example: Link PLOS

Where did HCM MMLOS come from?

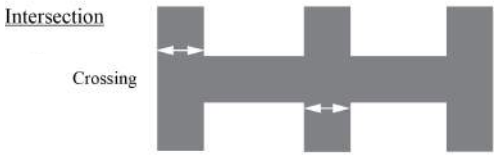
Source	Focus of study	Location	Number of participants	ADT Roadway Variety
(Landis, et al., 1997)	Bicycle link	Tampa, Florida	145	550 – 36,000 mean of 12,000
(Landis, et al., 2001)	Pedestrian link	Pensacola, Florida	~75 (no exact number listed)	200 – 18,500
(Landis, et al., 2003)	Bicycle intersection	Orlando, Florida.	59 (66% male)	800 – 38,000 mean of 25,600
(Petritsch, et al., 2005)	Pedestrian intersection	Sarasota, Florida.	46 (67% female)	Not noted.

Pedestrian LOS (PLOS): Overview

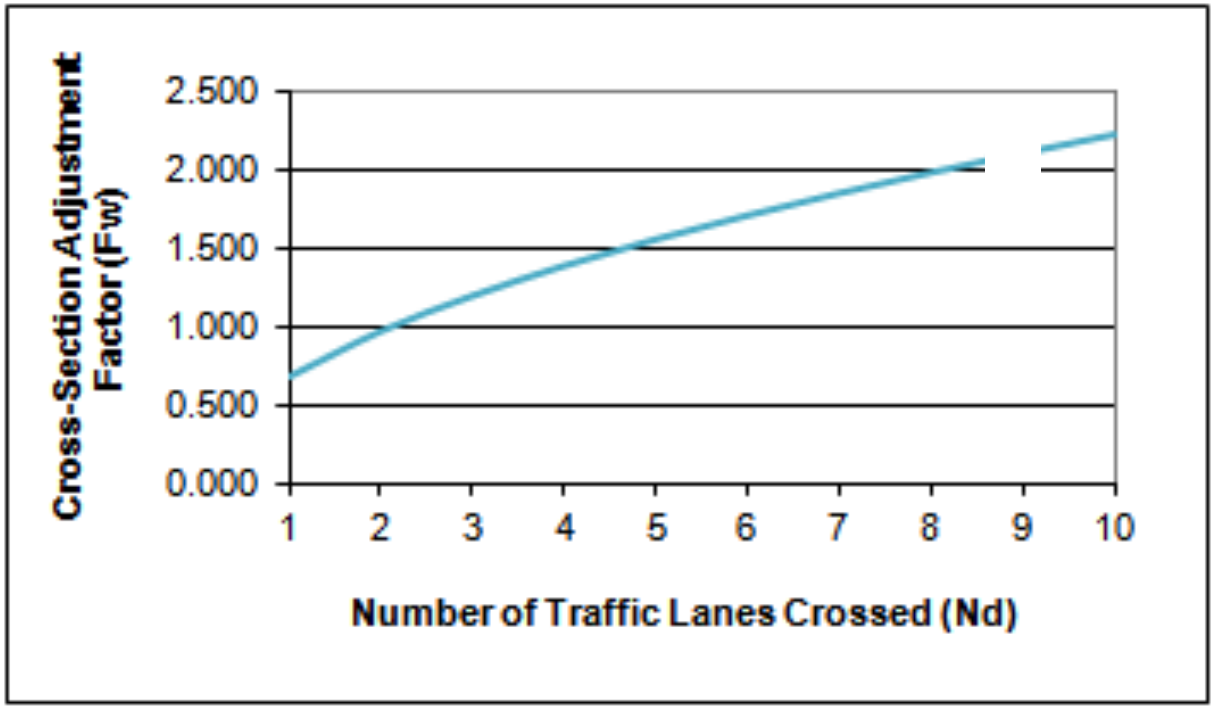
- Specific to a side of the street
- Intersection PLOS: # of lanes crossed
- Link PLOS: width of walking area
- Segment PLOS includes a crossing delay factor



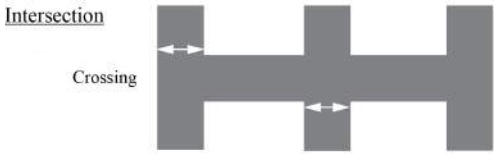
Intersection PLOS: Highlights



- Lanes crossed: lose about a half grade per additional lane

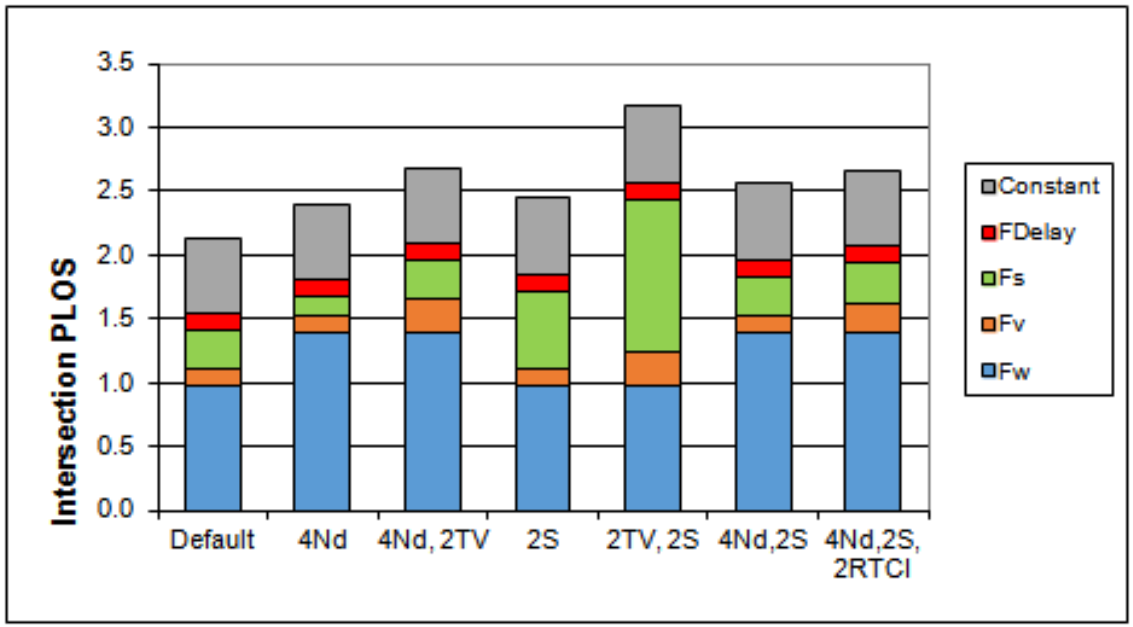


Intersection PLOS: Highlights



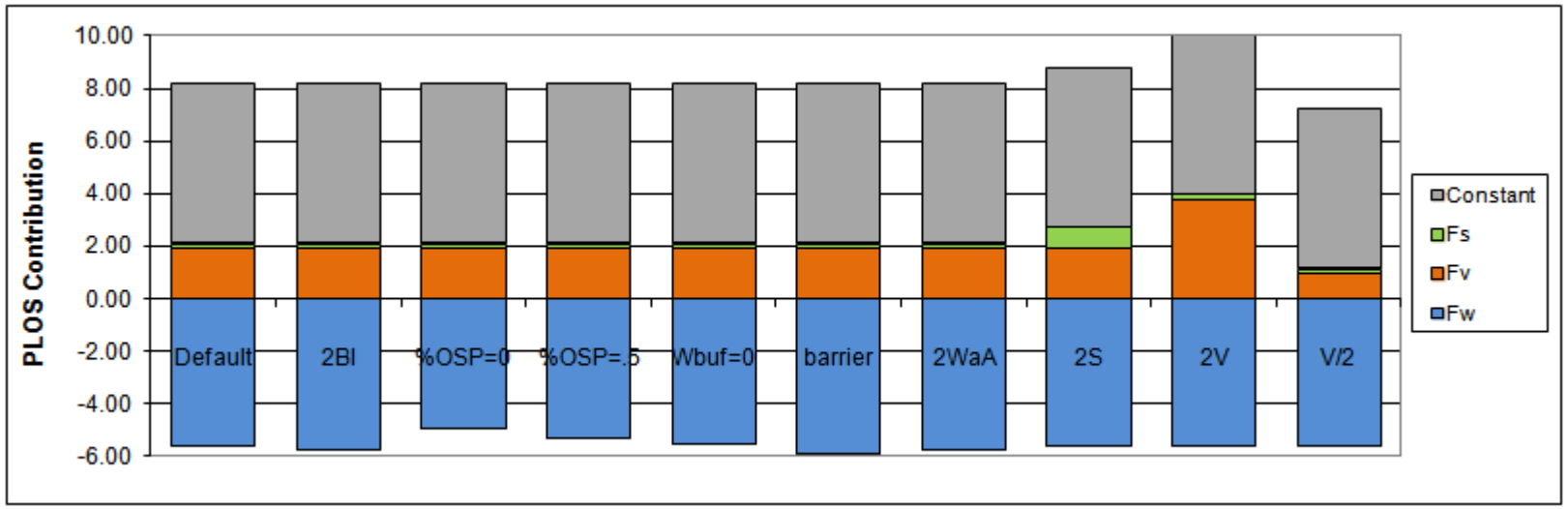
- Delay is not important: add a minute of delay, drop 0.05 in score (<10% of a grade)

Fw = Width Factor
Fv = Volumes Factor
Fs = Speed Factor



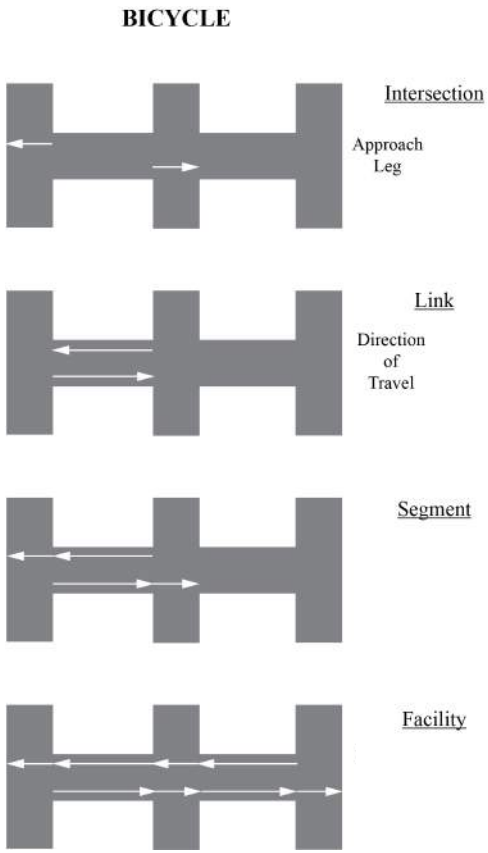
Link PLOS: Highlights

- Width and separation of walking area is very important
- Larger bonus for 100% on-street parking occupancy than for adding a sidewalk
- Not sensitive to presence of trees or lighting

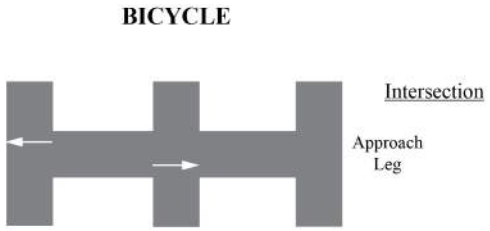


Bicycle LOS: Overview

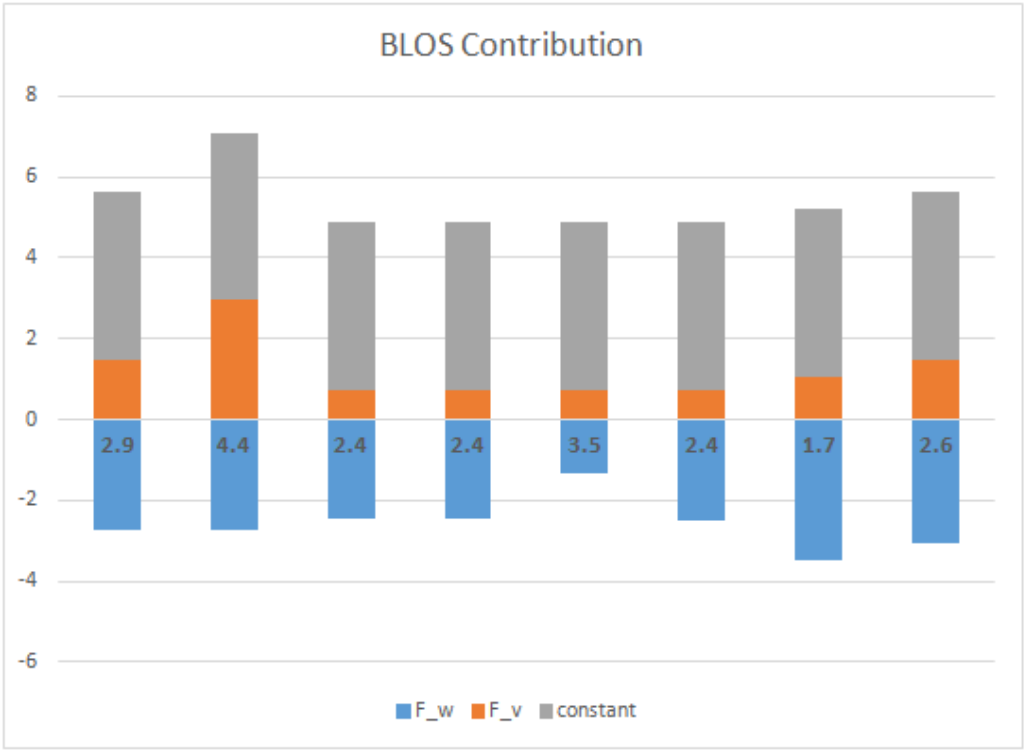
- Specific to a direction of travel
- Intersection BLOS: bicyclists' operating space, traffic density
- Link BLOS: traffic volumes, heavy vehicles, bicyclists' operating space
- Segment BLOS: error!



Intersection BLOS: Highlights



- Width of the bicycle 'operating space' is important
- Traffic density is important (traffic volumes / lane)
- Indifferent to intersection treatments: bicycle boxes, signals, markings through intersection
- No calculation for bicyclist delay



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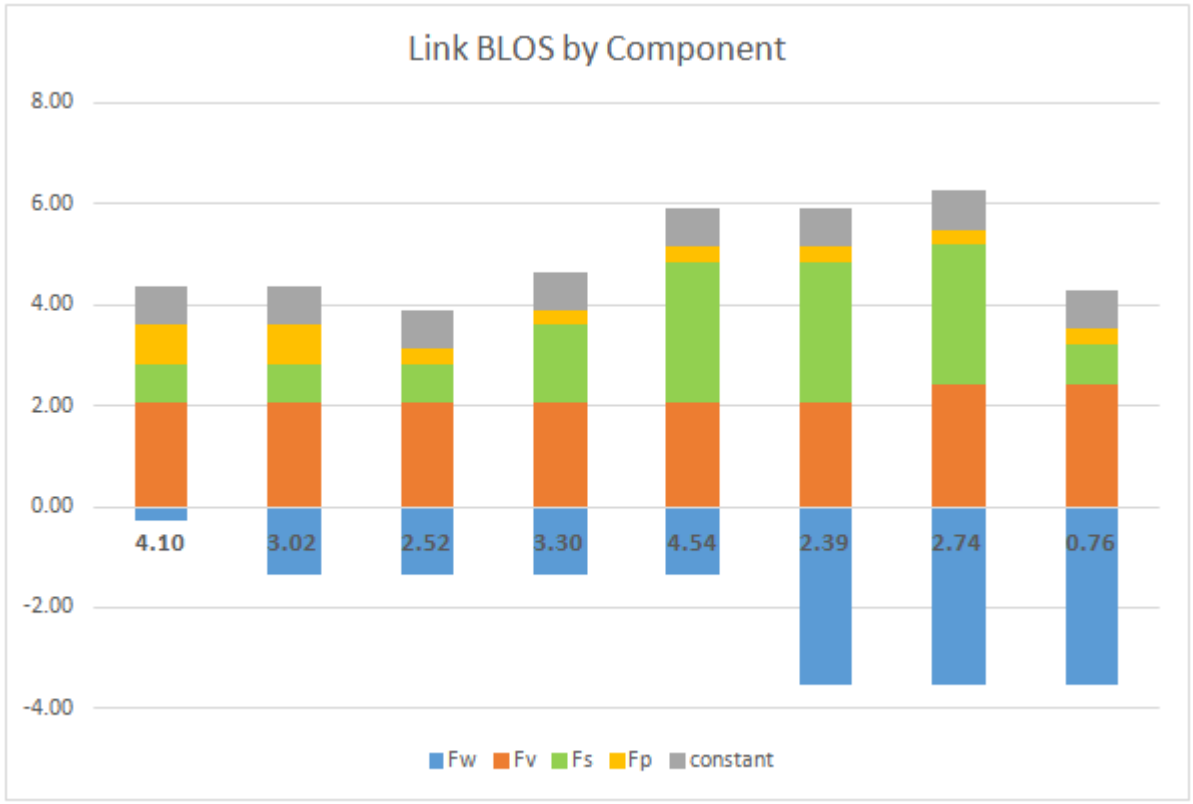
Link BLOS: Highlights

- Traffic volumes are very important, especially heavy vehicles
- Width of bicyclists' operating space (typically bike lane) very important
- Pavement quality is not important
- The score is not affected by striping: bike lane width and striped buffer width are considered equivalent
- Link BLOS is unable to analyze physical separation

Link BLOS: Highlights



Fw = Width Factor
Fv = Volumes Factor
Fs = Speed Factor

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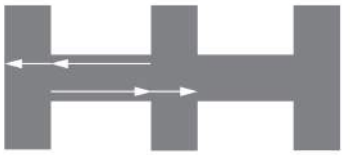
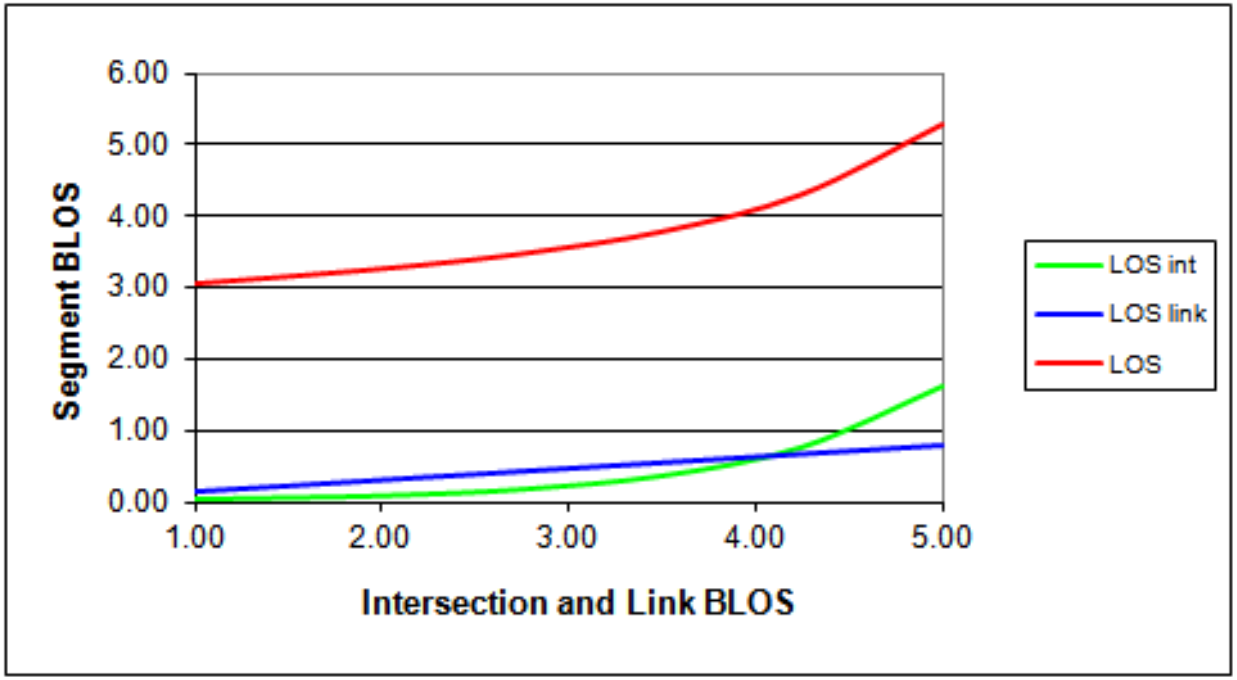
Segment BLOS: Highlights



- Segment BLOS has a mathematical error in it, and scores above C are not possible.

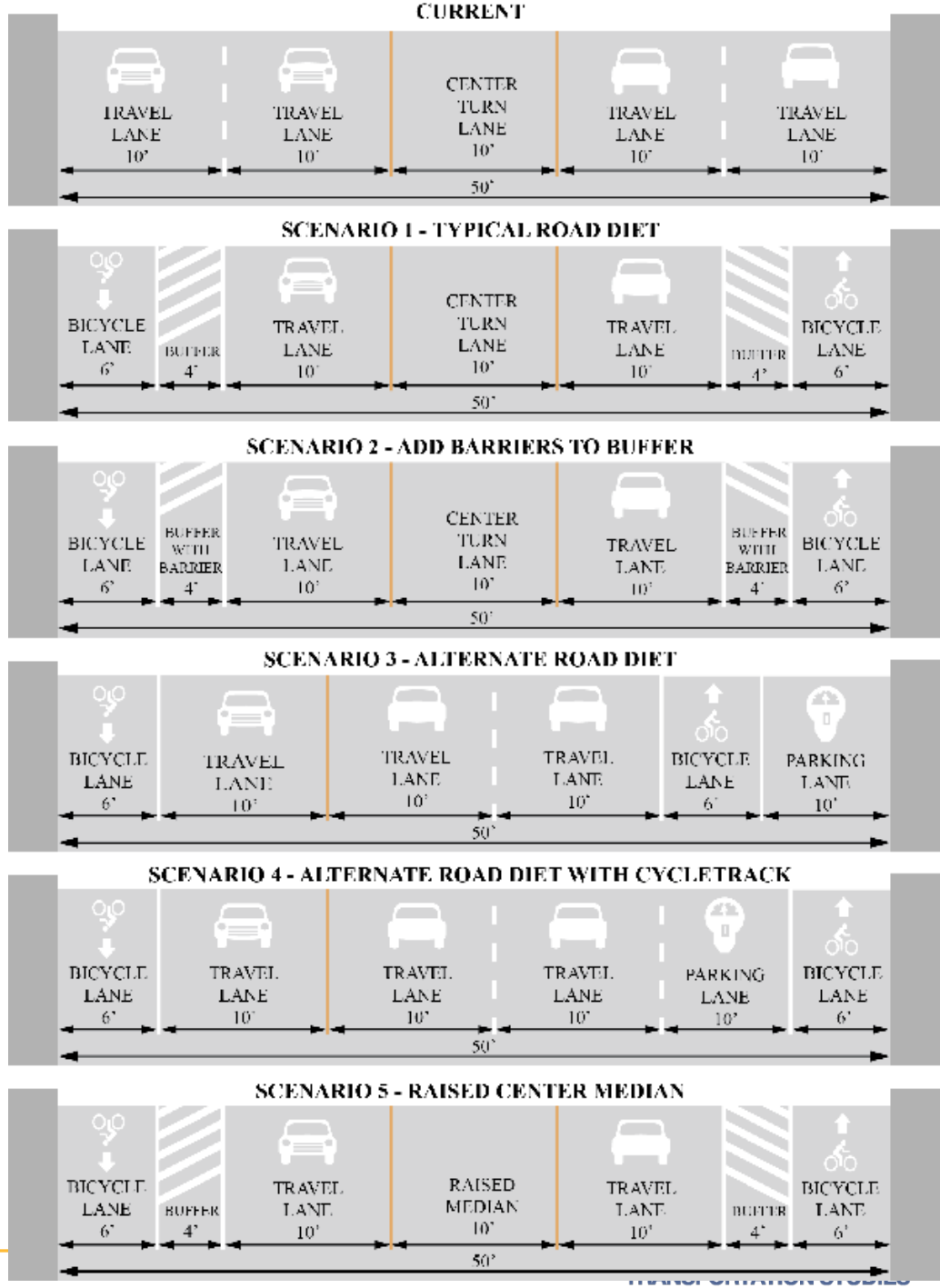


Question Break

Sensitivity Case Study: 20th Street

Intersection changes

- Right turn on red restrictions
- Leading pedestrian intervals
- Perpendicular curb ramps
- Bicycle boxes
- Protected left turns
- Bus bulb
- Nose on median



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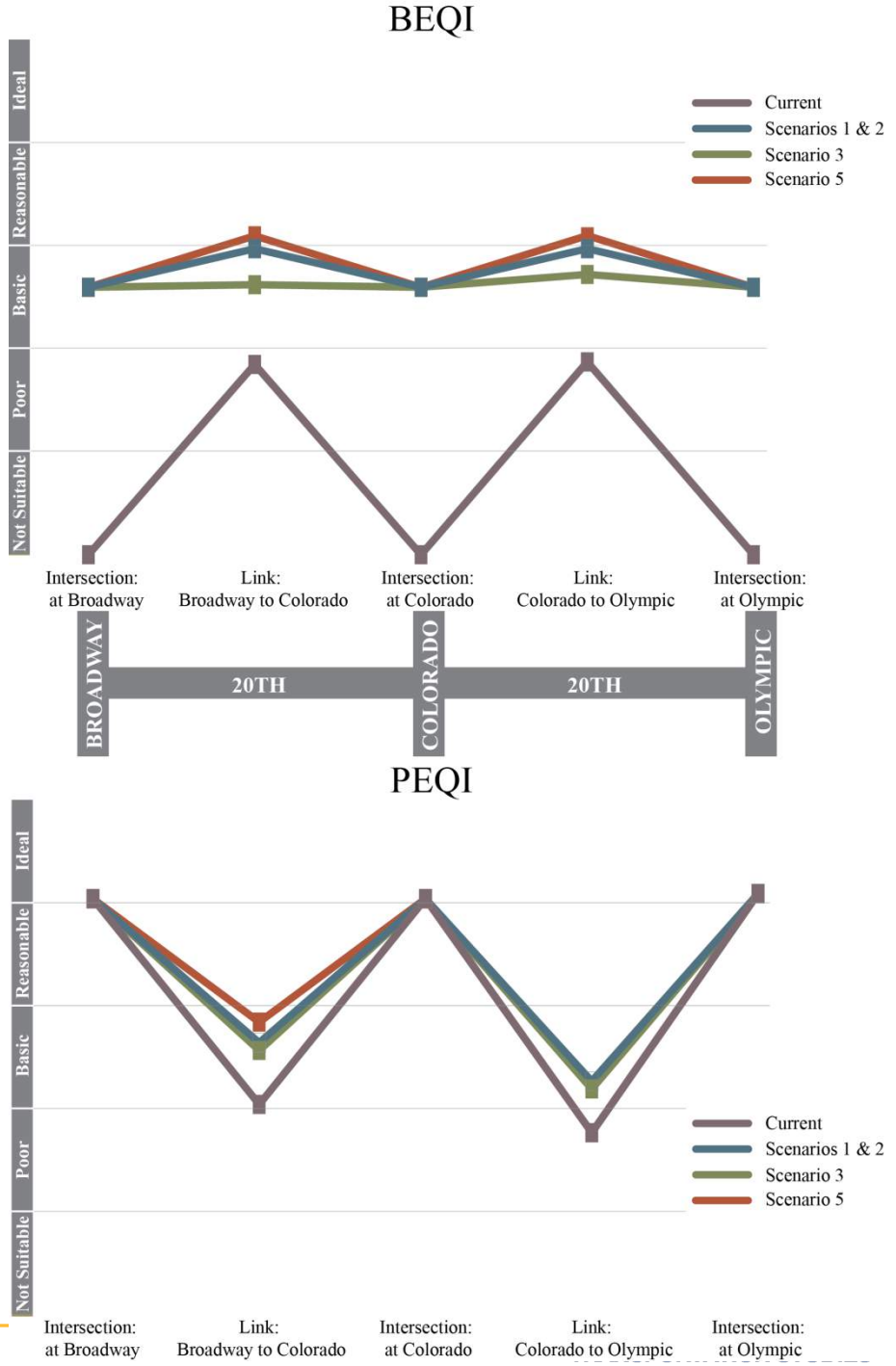
Scenario cheat sheet

Scenario	Change
1	Typical ‘road diet’ reconfiguration with 4’ painted buffers
2	Scenario 1 with physical barrier
3	Alternate ‘road diet’ with 1 lane in one direction, 2 lanes in other direction.
4	Scenario 3 with bicycle lane between parking and sidewalk
5	Scenario 1 with raised median

BEQI/PEQI Results

- Bicycle scores all increased from current scores
- Bicycle scenarios had little variation from each other; nothing got to *ideal category*

- Pedestrian improvement along link was minor
- Ped. Intersection scores did not change



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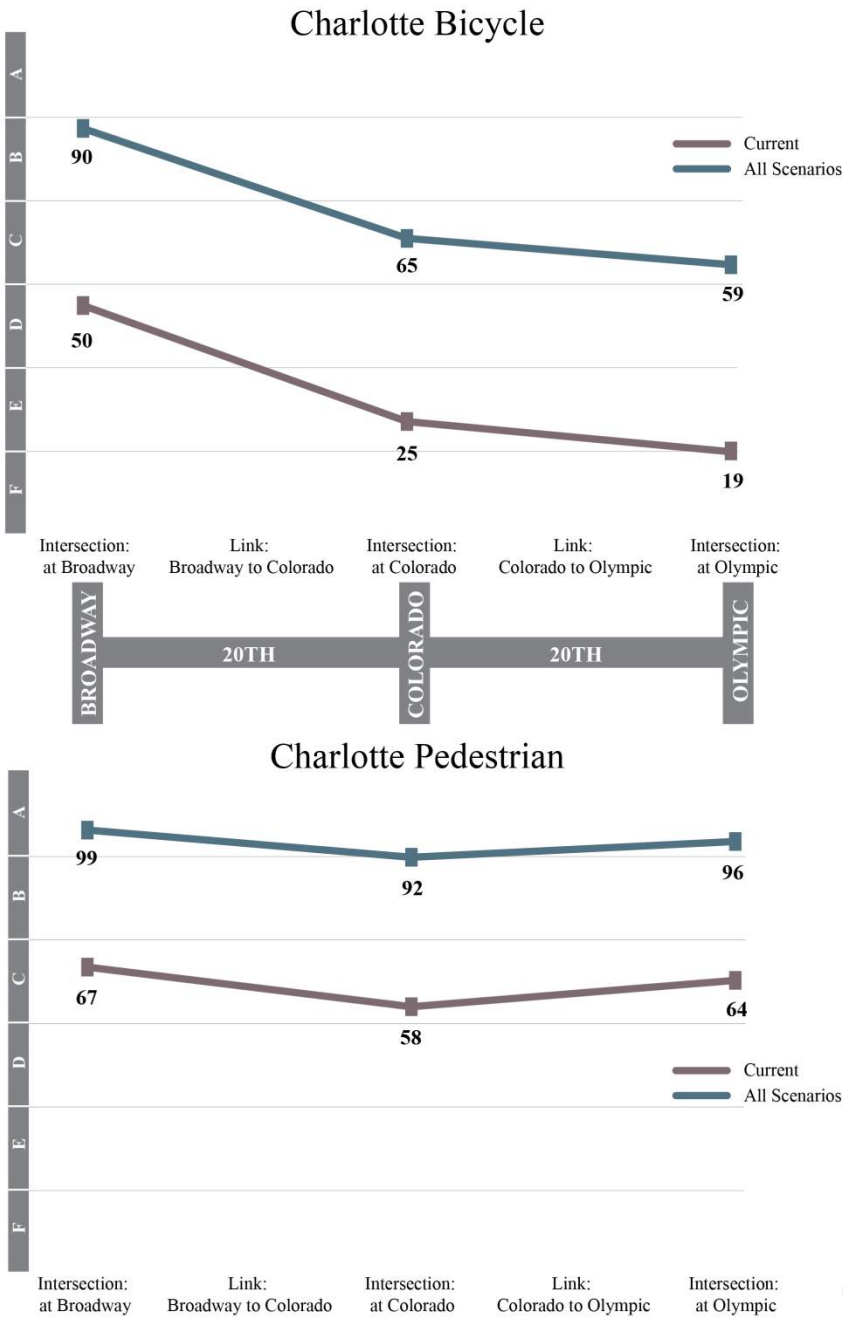
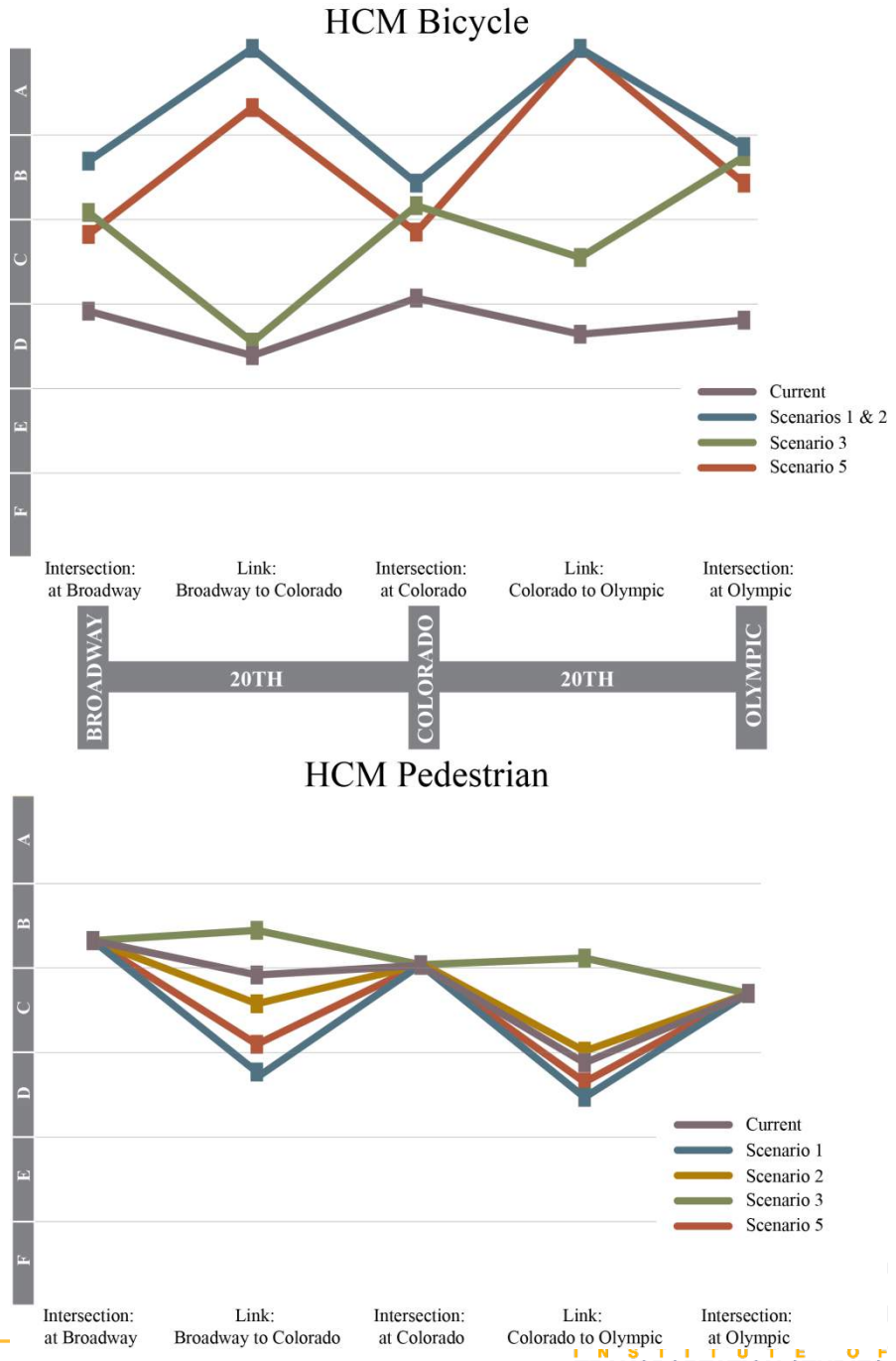
Charlotte Results

- Both modes improved by the same amount for all scenarios
- Intersection scores take all 4 intersections into consideration, improvements must be made to perpendicular approach
- Does not distinguish between turn lanes and general lanes



HCM Results

- Scenarios 1 and 2 were off the charts because both painted and physical barrier interpreted as *additional bike lane width*
- Scenario 3 was least promising because added on-street parking (assumed at 75% occupancy) reduced the score
- Pedestrian scores largely unchanged.
- On-street parking addition was greatest benefit to pedestrians



Limitations across the board

- Measures could not distinguish between painted and physical buffer
- No measure was able to score physical separations (cycletracks)
- Painted lane also not in any tool input
- All tools are rather inflexible; while a spreadsheet tool is easier to manipulate than software

Conclusions and discussion

- No tool conclusively helped to select “the best” improvement scenario - silver bullet does not exist
- Each measure is mired in the time it was created which may be problematic as toolbox continues to grow
- Rather than try to replace auto LOS with biking and walking LOS, cities may be better served by thinking about the bicycling and pedestrian experience and what aspects of it they want to measure.
- Walking and bicycling are modes that are influenced by a variety of inputs so information may be lost in the “grading” process

Thank you!

For more information and reports, please visit the project page: http://www.lewis.ucla.edu/project/exploration-implications-multimodal-street-performance-metrics-whats-passing-grade/

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