



STATEWIDE MULTIMODAL ACCESS MANAGEMENT AND TRANSPORTATION SITE IMPACT

WEBINAR SERIES 2025– 2026



Systems Implementation Office
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Agenda



Credits And Webinar Material



Topic



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Credits Information



Certificates will be distributed through email.

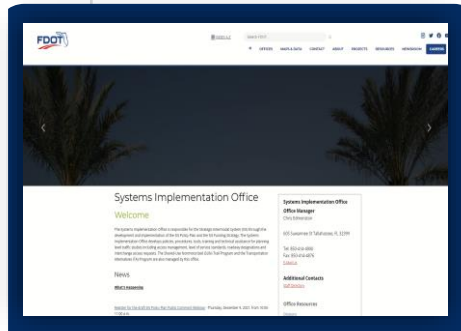


Your participation will be recorded by GoToWebinar.

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Webinar Material



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<https://www.fdot.gov/planning/systems/systems-management/trainings-webinars>

What organization do you represent?



FDOT



**Local
Government**



Private Firm



Other

Statewide Multimodal Access Management And Transportation Site Impact

WEBINAR SERIES 2025 - 2026



Webinar #1

Overview of Highway Capacity Manual (7th E.D.) and Highway Capacity Software

Tuesday, August 19, 2025
2:00PM – 3:30PM
Credits: 1

How familiar are you with the Highway Capacity Manual & Highway Capacity Software?

VERY FAMILIAR

SOMEWHAT FAMILIAR

NOT FAMILIAR

Overview of the Highway Capacity Software / Highway Capacity Manual (7th Ed.)

**Florida Department of Transportation
Statewide Multimodal AM and TSI Webinar Series**

August 2025

Fabio Sasahara, PhD, PMP

McTrans Center – University of Florida

Agenda

- HCM/HCS Overview
- HCM/HCS Scope of Analysis
- What is New in HCM 7
- New Research – Beyond HCM 7
- HCS – What is New
- Highway Safety Software

HCM Organization

- Overseen by TRB committee on Highway Capacity and Quality of Service (hcqstrb.org)
- Most methods are developed via national level projects such as NCHRP*s*.
- Four Volumes:
 - I. Concepts
 - II. Uninterrupted Flow
 - III. Interrupted Flow
 - IV. Applications Guide (Online only)

(*) NCHRP: National Cooperative Highway Research Program



HIGHWAY CAPACITY MANUAL
7TH EDITION | A GUIDE FOR MULTIMODAL MOBILITY ANALYSIS

HCM Organization

Volume 1 – Concepts

- 1 - HCM User's Guide
- 2 - Applications
- 3 - Modal Characteristics
- 4 -Traffic Flow and Capacity Concepts
- 5 - Quality and Level-of-Service Concepts
- 6 - HCM and Alternative Tools Analysis
- 7 - Interpreting HCM and Alternative Tools
- 8 - HCM Primer
- 9 - Glossary and Symbols

HCM Organization

Volume 2 – Uninterrupted Flow

- 10 - Freeway Facilities
- 11 - Freeway Facilities Reliability Analysis
- 12 - Basic Freeway and Multilane Highways
- 13 - Freeway Weaving Segments
- 14 - Freeway Merge and Diverge Segments
- 15 - Two-Lane Highways

Volume 3 – Interrupted Flow

- 16 - Urban Street Facilities
- 17 - Urban Streets Reliability and ATDM
- 18 - Urban Street Segments
- 19 - Signalized Intersections
- 20 - Two-Way Stop-Control
- 21 - All-Way Stop-Control
- 22 - Roundabouts
- 23 - Ramp Terminals and Alternative Intersections
- 24 - Off-Street Pedestrian and Bicycle Facilities

HCM Organization

Volume 4 – Applications

- Available at <http://hcmvolume4.org>
- Free to everyone
- Contains:
 - Supplemental Chapters
 - Application Guides
 - Technical Reference Library:
 - Research reports
 - Published papers
 - Useful references

The screenshot shows the website for HCM Vol 4. The header is dark blue with 'HCM Vol 4' in yellow on the left, and 'Register' and 'Login' buttons on the right. The main banner is dark blue with 'Highway Capacity Manual' in large yellow text, '7th Edition | A Guide for Multimodal Mobility Analysis' in smaller yellow text, and 'Volume 4: Applications Guide' in teal text. Below the banner is a white navigation bar with links: Supplemental Chapters, Technical Reference Library, Applications Guide, Errata & Updates, FAQs, and Discussion Forums. The main content area is white and features the heading 'What is Highway Capacity Manual Volume 4?'. Below this heading is a paragraph explaining that the HCM includes three printed volumes (1-3) and that Volume 4 is a free online resource. A bulleted list follows, detailing the contents of Volume 4: Supplemental chapters 25-38, a technical reference library, two applications guides, interpretations, updates, and errata, a discussion forum, and notifications of chapter updates.

HCM Vol 4 Register Login

Highway Capacity Manual

7th Edition | A Guide for Multimodal Mobility Analysis

Volume 4: Applications Guide

- Supplemental Chapters
- Technical Reference Library
- Applications Guide
- Errata & Updates
- FAQs
- Discussion Forums

What is Highway Capacity Manual Volume 4?

The HCM includes three printed volumes (Volumes 1-3) that can be purchased from the Transportation Research Board in print and electronic formats. Volume 4 is a free online resource that supports the rest of the manual. It includes:

- Supplemental chapters 25-38, providing additional details of the methodologies described in the Volume 1-3 chapters, example problems, and other resources.
- A technical reference library providing access to a significant portion of the research supporting HCM methods.
- Two applications guides demonstrating how the HCM can be applied to planning-level analysis and a variety of traffic operations applications.
- Interpretations, updates, and errata for the HCM (as they are developed).
- A discussion forum allowing HCM users to ask questions and collaborate on HCM-related matters.
- Notifications of chapter updates, active discussions, and more via an optional e-mail notification feature.

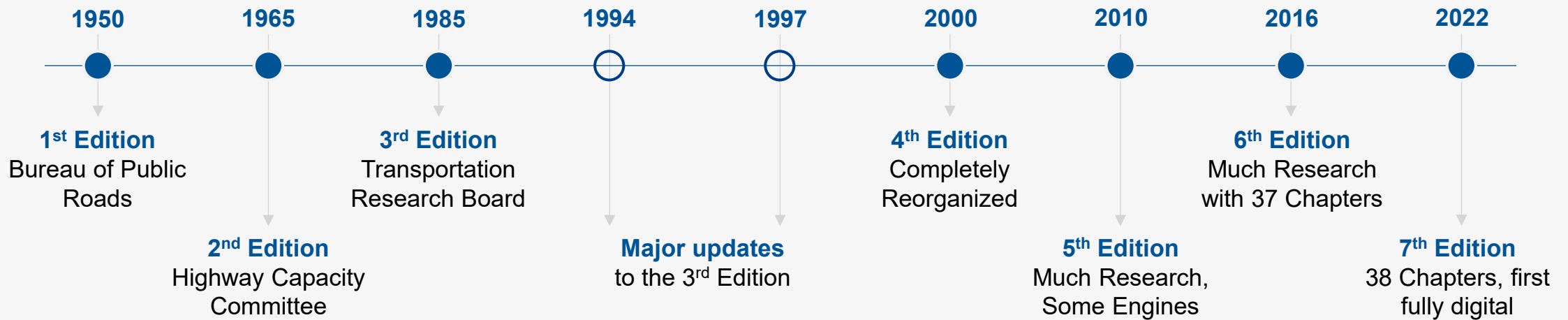
Highway Capacity Software

- Highway Capacity Software (HCS) is the faithful implementation of HCM methods.
- Developed in 1980s and kept updated based on the updates to the HCM.
 - McTrans Center is actively involved in Highway Capacity and Quality of Service Committee.
- Most users rely on HCS to fulfill requirements HCM applications.
- Around 15,000 users worldwide.

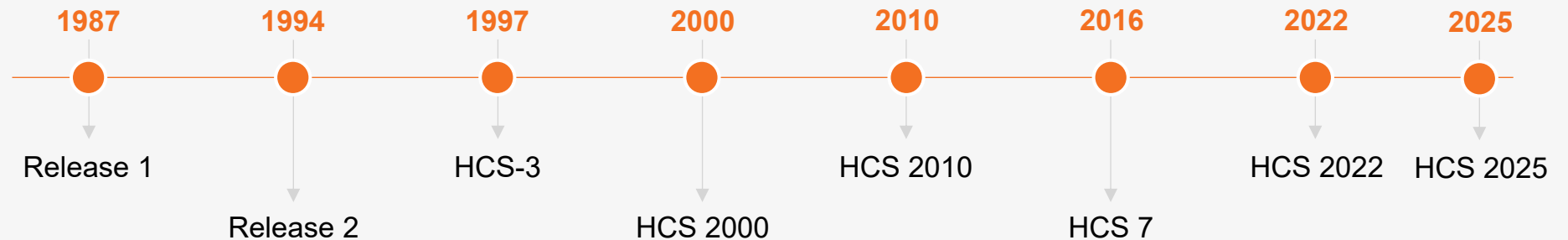


HCM/HCS Development

HCM Releases:



HCS Releases:



Freeways

- Can model full facility with queues
- Can model active and hidden bottlenecks
- Can model queue propagation and dissipation across multiple time periods



Texas Transportation Institute



Freeways

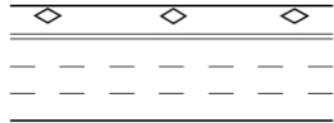
Managed Lanes (ML)

- Common uses: HOV, HOT, Express lanes
- 3 different separation types:

Continuous Access - Skip or Solid Stripe



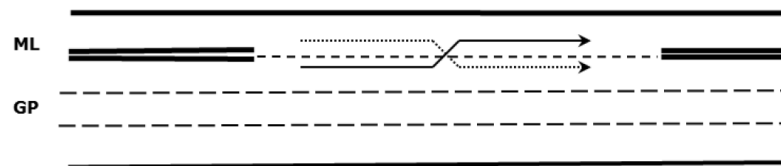
Buffer-Separated



Barrier-Separated



- Access point analyses:



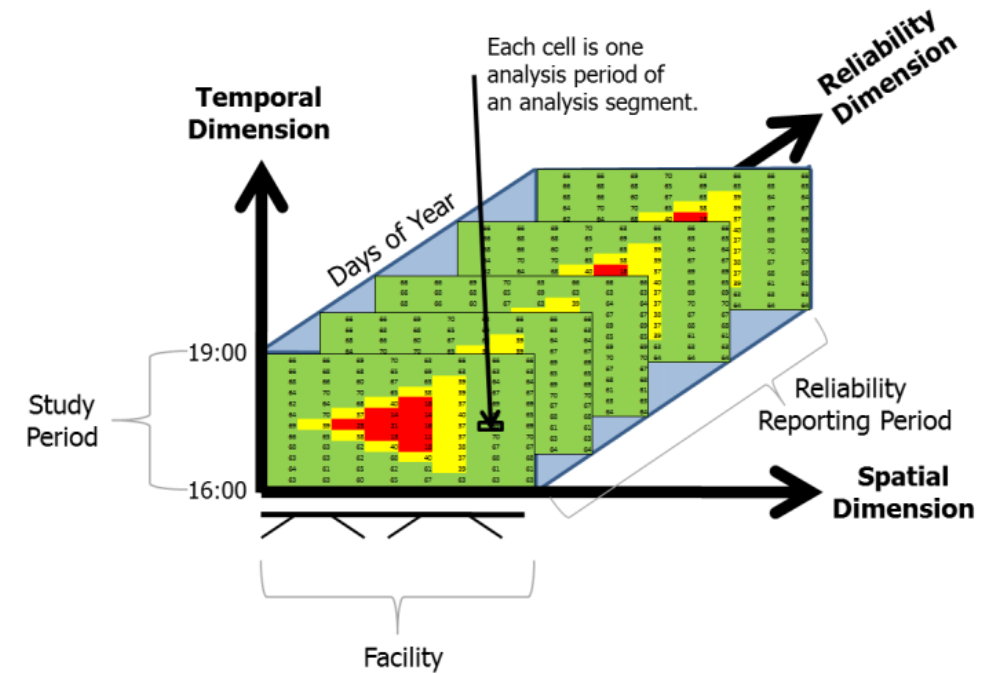
Freeways

- Work Zone Analyses
- Can model:
 - Shoulder / lane closures
 - Day vs night operation
 - Barrier type (hard vs soft)
 - WZ posted speed



Freeways

- Travel Time Reliability
 - Year long distribution of travel time
 - Recurring congestion
 - Demand variation
 - Non-recurring congestion
 - Incidents
 - Weather
 - Work Zones
 - Special Events



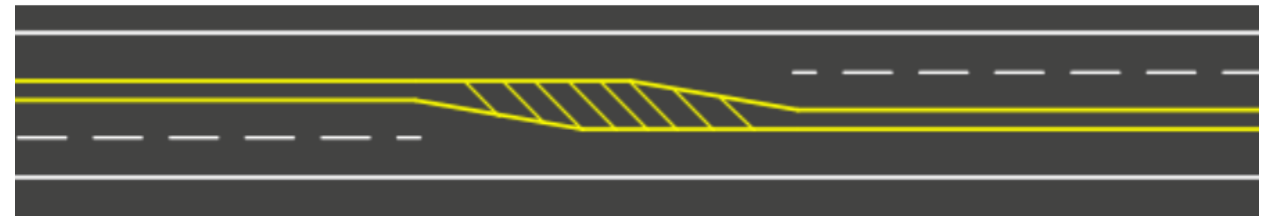
Multilane Highways

- Similar models to basic freeway segment
 - Access control less restrictive than freeways
 - Effects of different median types
- More than 2 miles between traffic signals



Two-Lane Highways

- New methodology in HCM 7
 - Facility segmentation:
 - Passing constrained
 - Passing zone
 - Passing lanes
- Can model:
 - Speed reduction on curve segments
 - Super-2 (2+1) segments



Stop-Controlled Intersections

- Can model:
 - TWSC - Two-Way-Stop-Controlled
 - AWSC - All-Way-Stop-Controlled
- Can model T (or three-leg) intersections



Roundabouts

- Single lane and multilane roundabouts
- Urban street corridors with multiple roundabouts



Photo: Larry Mayer for Sanderson Stewart



Example of a single-lane roundabout.

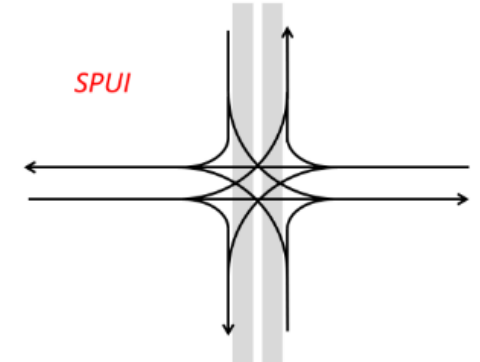
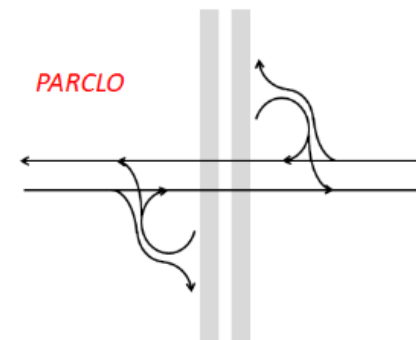
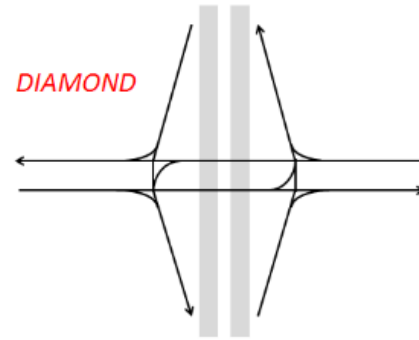
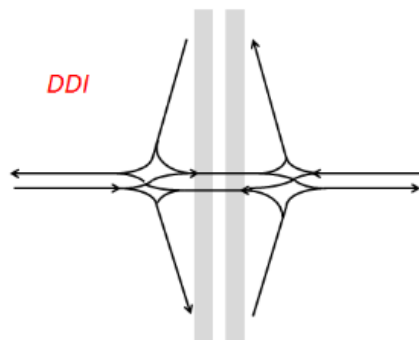
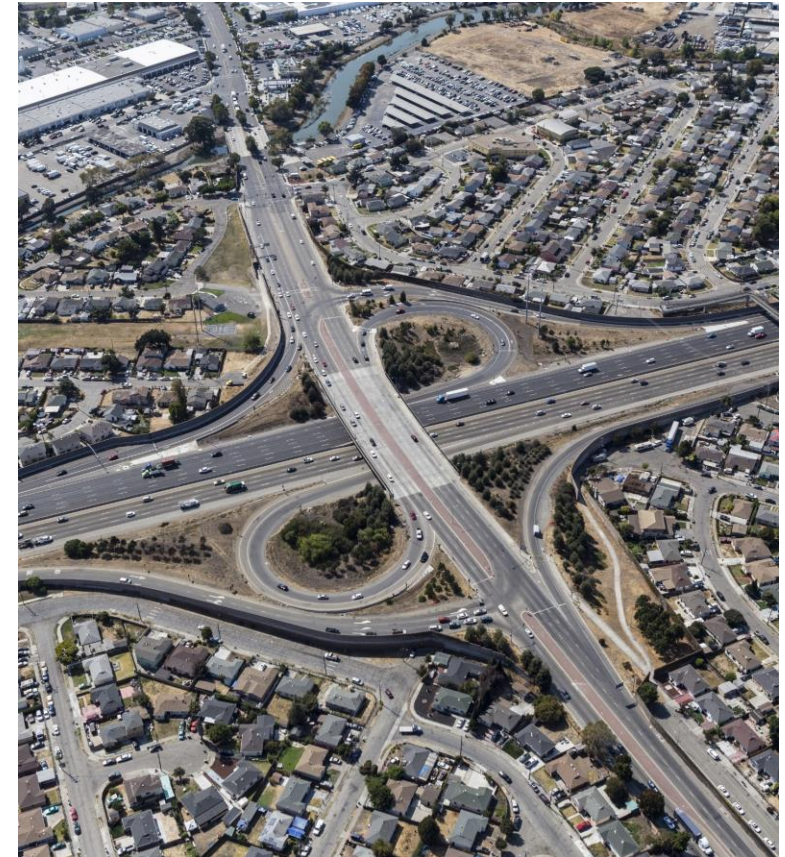
Signalized Intersections

- Can model:
 - Pre-timed, actuated and semi-actuated control
 - Single and multi-period (congested conditions)
 - Coordinated operation with multiple intersections
- Integrated with Urban Street Segment for more accurate analyses (arrivals on green, flow profiles)
- HCS can optimize signal timing (including safety and emissions)



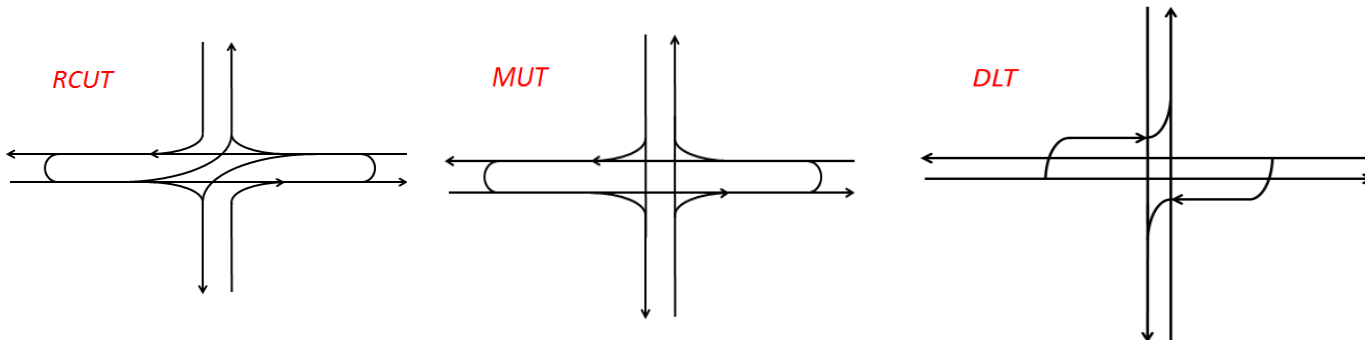
Interchange Ramp Terminals

- DDI – Diverging Diamond Interchange
- Diamond Interchange
- PARCLO
- SPUI – Single Point Urban Interchange



Alternative Intersections

- Can model
 - RCUT – Restricted Crossing U-Turn (*Superstreet / J-Turn*)
 - Yield & Signal
 - MUT – Median U-Turn (*Michigan Left*)
 - DLT – Displaced Left Turn (*Continuous Flow Intersection*)
 - Partial and Full



New Research – Updates to HCM 7th Edition

Research Project	Project Title	HCM Chapter(s) Updated
NCHRP 17-87	Enhancing Pedestrian Volume Estimation and Developing HCM Pedestrian Methodologies for Safe and Sustainable Communities	Updated Chapters 18, 19, 20, 30, 31 & 32
FHWA Pooled Fund TPF-5(371)	Capacity Adjustment Factors for Connected and Automated Vehicles (CAV) in the Highway Capacity Manual	Updated Chapter 26, 31 & 33
NCHRP 17-65	Improved Analysis of Two-Lane Highway Capacity and Operational Performance	New Chapter 15
FHWA (FHWA-HOP-16-088)	Active Transportation and Demand Management (ATDM) Analytical Methods for Urban Streets	Updated Chapters 17 & 37
NCHRP 15-57	Highway Capacity Manual Methodologies for Corridors Involving Freeways and Surface Streets	New Chapter 38

Various errata changes and interpretations

Over 350 pages of new/updated material

Capacity Impact for Connected and Automated Vehicles



Updates in HCM 7th Edition

Chapter 26

Freeway Facility Supplemental

Chapter 31

Signalized Intersections Supplemental

Chapter 33

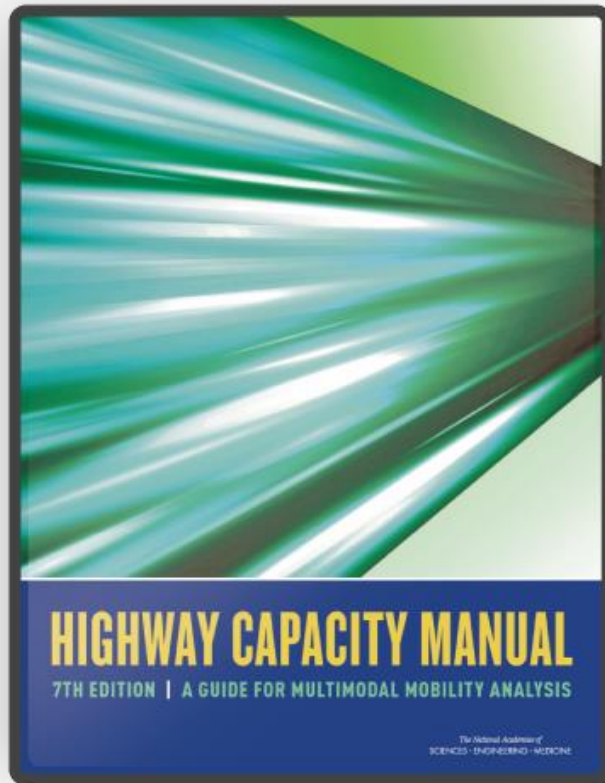
Roundabouts Supplemental

CHAPTER 26 FREEWAY AND HIGHWAY SEGMENTS: SUPPLEMENTAL

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Capacity Adjustment for CAVs



Designed for planning level analyses

State Transportation Improvement Programs (STIP)

Capacity Adjustment Factors (CAFs) for CAVs

Given a market penetration rate of CAVs, what percent increase in capacity can be expected?

Service Volume Tables for CAVs

Given a market penetration rate of CAVs, what hourly and/or daily service volumes are achievable for planning applications?

CAV Capacity Adjustment - Freeways

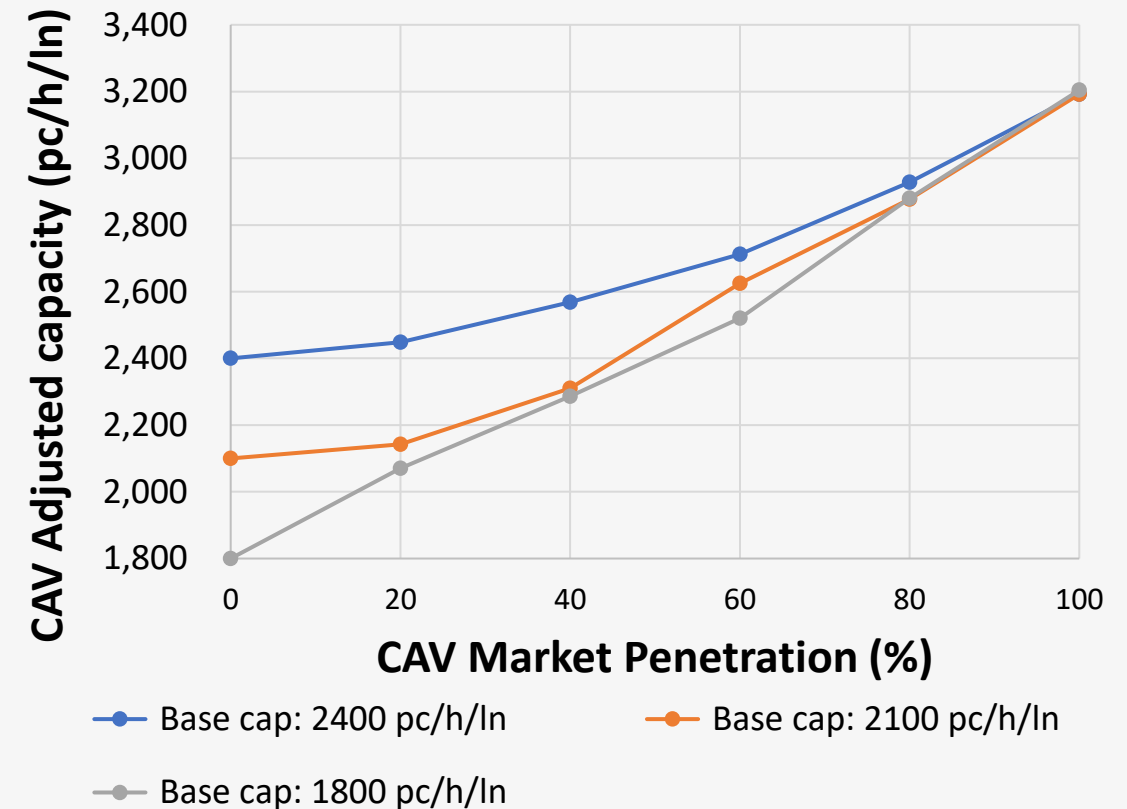
Capacity Adjustment Factor (CAF_{CAV}) with a multiplicative effect

Main user input: % Market Penetration (0 to 100%)

- What percentage of the traffic stream is comprised of CAVs?

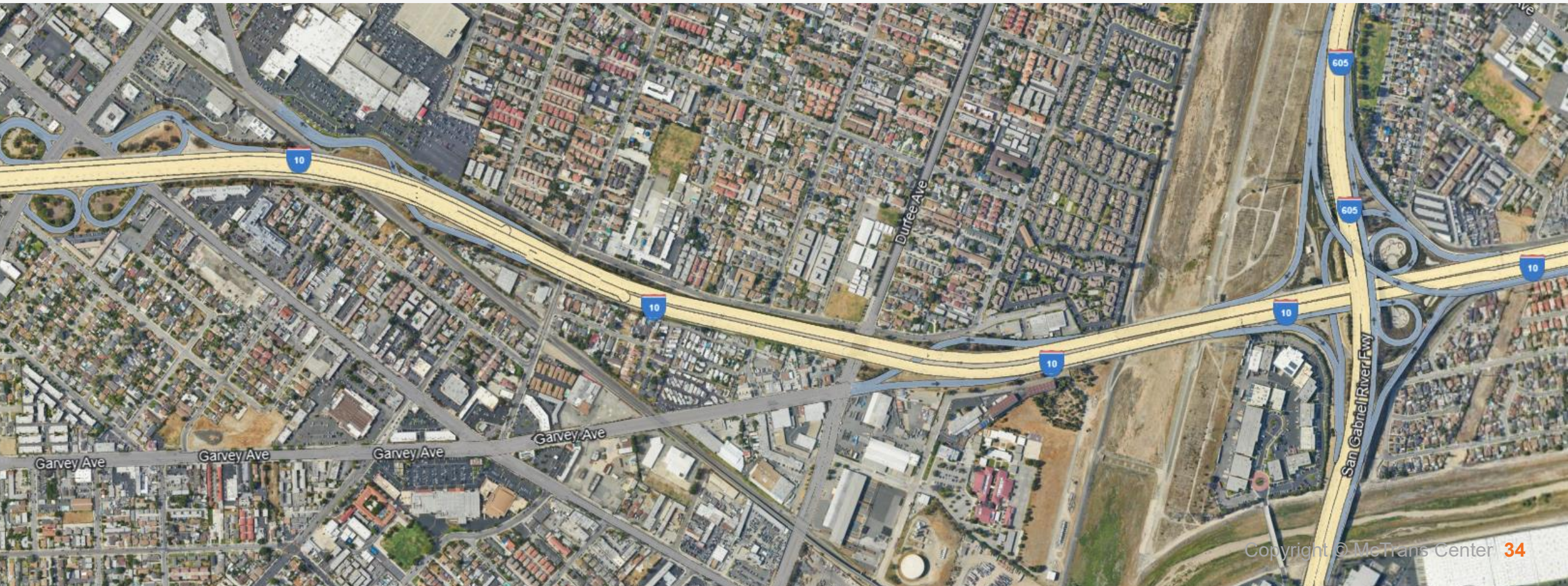
Proportion of CAVs in Traffic Stream	Adjusted Segment Capacity		
	2,400 pc/h/ln	2,100 pc/h/ln	1,800 pc/h/ln
0	1.00	1.00	1.00
20	1.02	1.02	1.15
40	1.07	1.10	1.27
60	1.13	1.25	1.40
80	1.22	1.37	1.60
100	1.33	1.52	1.78

Capacity adjustments – Basic Segments



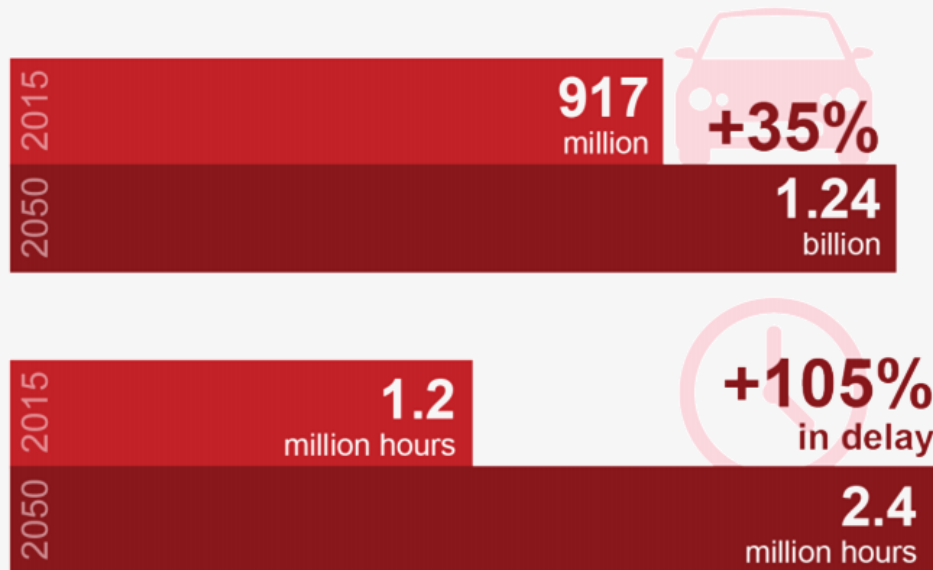
Case Example - I-10 WB @ Los Angeles, CA

What are the expected traffic conditions in 2050?



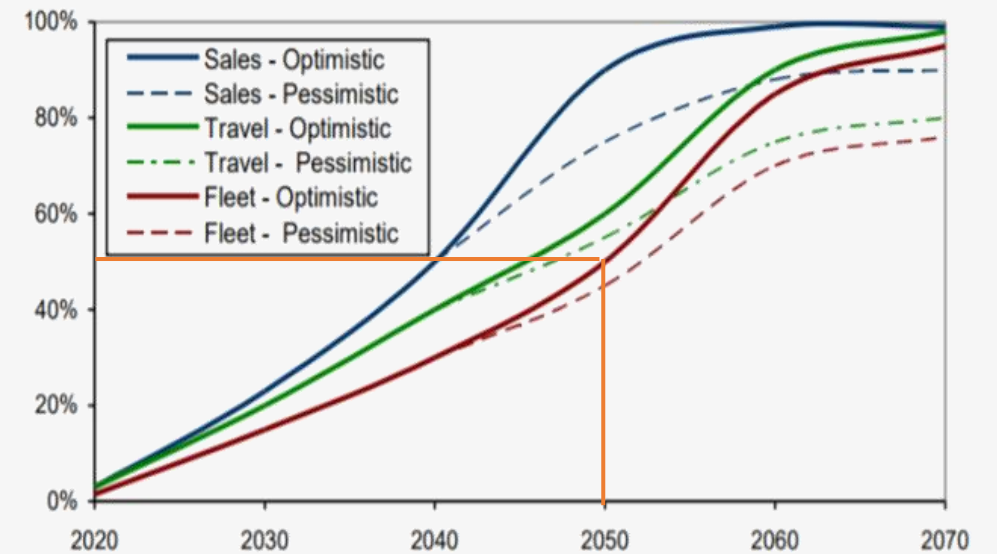
Case Example - Freeways

What are the expected traffic conditions on California roads by 2050?



Source: CSF2TDM

35% increase in traffic demand



Source: Litman, 2017

50% CAV market penetration rate

Case Example

2022 BASE CONDITIONS

I-10 WB @ Los Angeles, CA

GP Type	Basic	Diverge	Basic	Diverge	Basic	Diverge	Basic	Weaving	Basic	Merge	Overlap	Diverge	Basic	Merge	Basic
ML Type	ML Basic	ML Basic	ML Basic	ML Basic	ML Access	ML Basic	ML Basic	ML Basic	ML Basic	ML Basic	ML Basic	ML Basic	ML Basic	ML Basic	ML Basic
Length, ft	3000	1000	2290	1500	500	1500	250	1720	430	165	1335	165	2700	1500	1000
Segment ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
GP Lanes	4	4	4	5	5	5	5	6	5	5	4	4	4	4	4
ML Lanes	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2

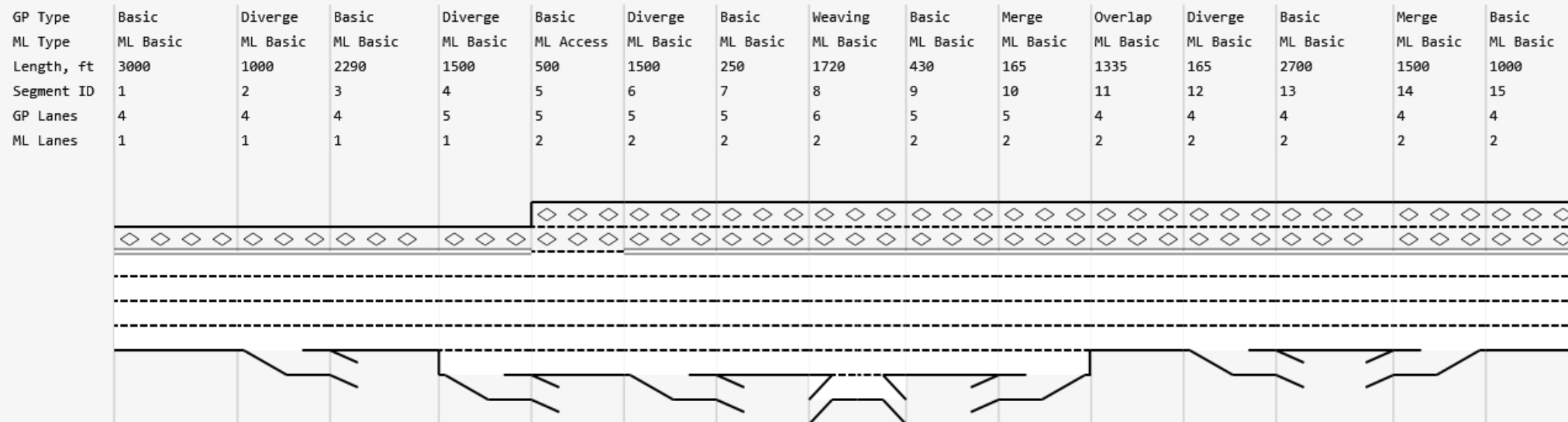
LOS – AM Peak (7 AM – 8:15 PM)

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7:00 - 7:15	D	D	C	C	C	B	B	B	C	C	D	C	C	C	C
7:15 - 7:30	D	C	D	C	C	C	C	C	D	D	D	D	D	C	D
7:30 - 7:45	C	C	C	C	C	C	B	B	C	C	D	D	C	C	D
7:45 - 8:00	C	C	C	C	C	B	B	B	B	C	C	C	B	C	C
8:00 - 8:15	C	C	C	C	C	B	B	B	B	C	C	C	B	C	C

Case Example

2050 – No CAVs

What is the expected LOS in 2050?



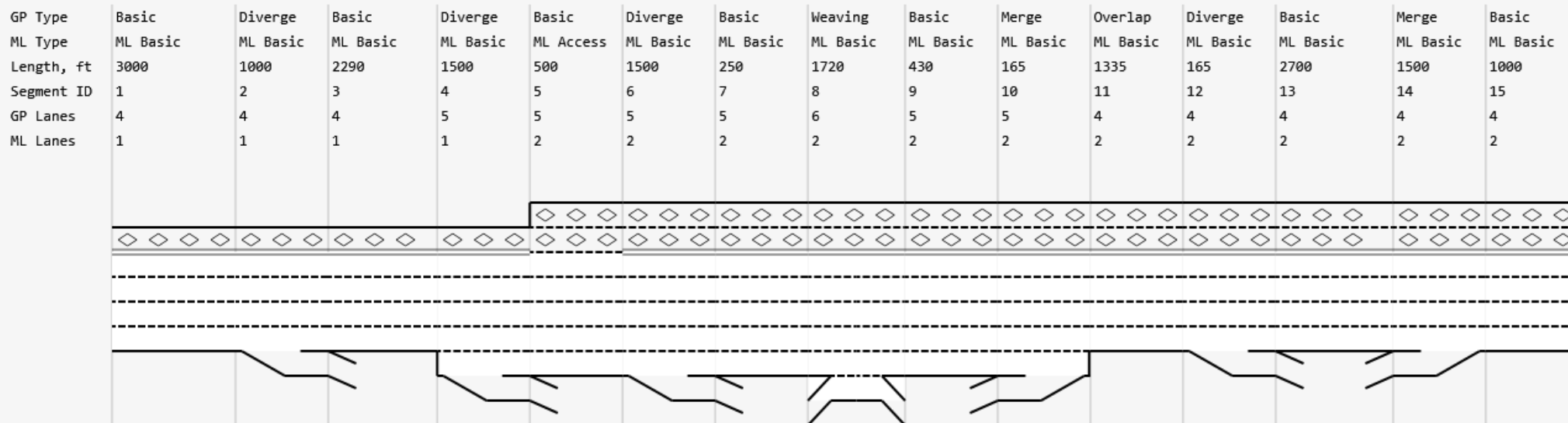
LOS – AM Peak (7AM – 8:15 PM) – no CAV considerations

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7:00 - 7:15	E	E	D	E	D	C	C	D	D	D	E	E	D	D	E
7:15 - 7:30	E	E	E	E	F	F	F	F	F	F	F	F	F	F	F
7:30 - 7:45	F	D	D	F	F	F	F	F	F	E	E	E	D	F	E
7:45 - 8:00	D	D	D	E	D	D	C	F	F	D	E	E	D	D	E
8:00 - 8:15	E	D	D	D	D	D	C	D	D	D	E	E	D	D	E

Case Example

2050 – 50% CAVs

What is the expected LOS in 2050?



LOS – AM Peak (7 AM – 8:15 PM) – 50% CAVs

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7:00 - 7:15	E	E	D	E	D	C	C	D	D	D	E	E	D	D	D
7:15 - 7:30	E	E	E	E	D	D	D	E	E	E	E	E	E	E	E
7:30 - 7:45	D	D	D	E	D	C	C	D	D	E	E	E	D	D	E
7:45 - 8:00	D	D	D	D	C	C	C	C	C	C	D	D	C	D	D
8:00 - 8:15	D	D	D	D	D	C	C	B	C	C	D	D	C	D	D

Case Example

Scenario Comparison

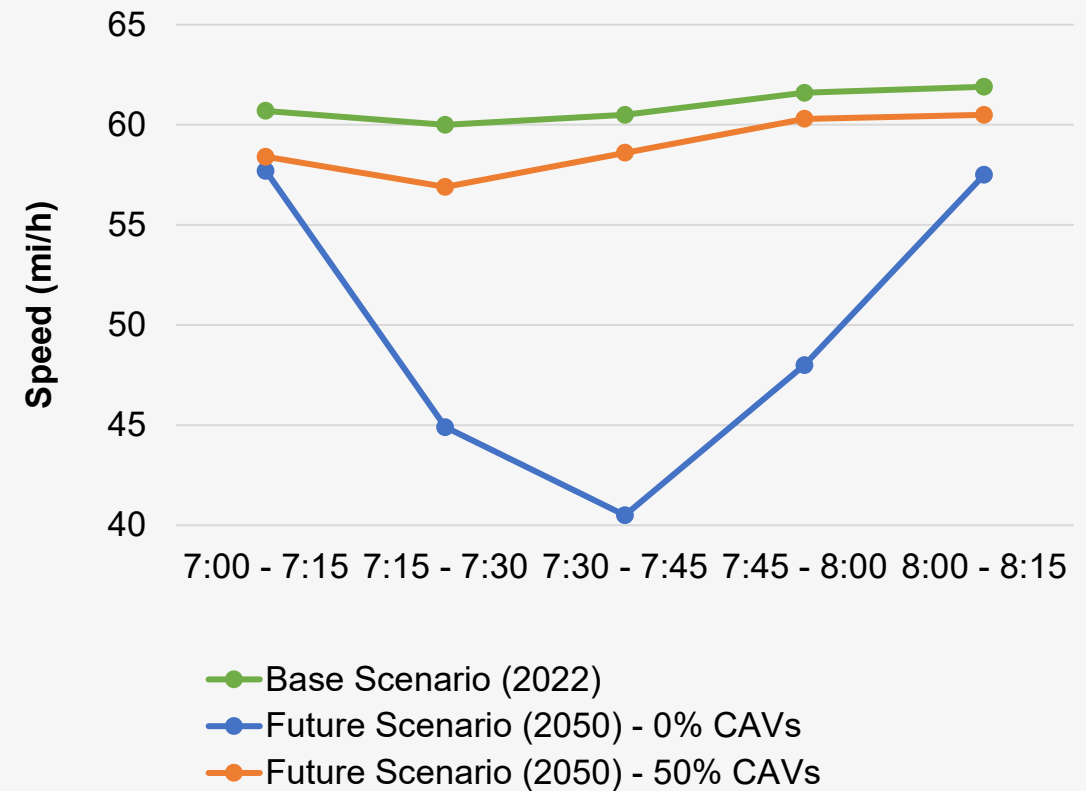
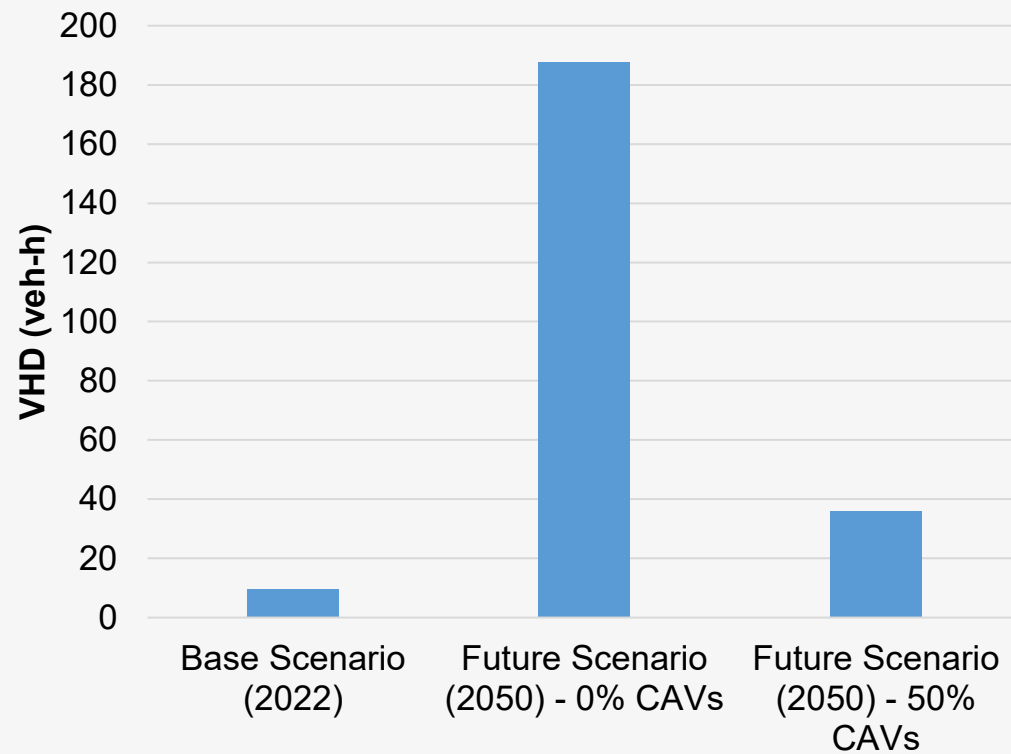
2022 Base Conditions	Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	7:00 - 7:15	D	D	C	C	C	B	B	B	C	C	D	C	C	C	C
	7:15 - 7:30	D	C	D	C	C	C	C	C	D	D	D	D	D	C	D
	7:30 - 7:45	C	C	C	C	C	C	B	B	C	C	D	D	C	C	D
	7:45 - 8:00	C	C	C	C	C	B	B	B	B	C	C	C	B	C	C
	8:00 - 8:15	C	C	C	C	C	B	B	B	B	C	C	C	B	C	C

2050 No CAVs	Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	7:00 - 7:15	E	E	D	E	D	C	C	D	D	D	E	E	D	D	E
	7:15 - 7:30	E	E	E	E	F	F	F	F	F	F	F	F	F	F	F
	7:30 - 7:45	F	D	D	F	F	F	F	F	F	E	E	E	D	F	E
	7:45 - 8:00	D	D	D	E	D	D	C	F	F	D	E	E	D	D	E
	8:00 - 8:15	E	D	D	D	D	D	C	D	D	D	E	E	D	D	E

2050 50% CAVs	Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	7:00 - 7:15	E	E	D	E	D	C	C	D	D	D	E	E	D	D	D
	7:15 - 7:30	E	E	E	E	D	D	D	E	E	E	E	E	E	E	E
	7:30 - 7:45	D	D	D	E	D	C	C	D	D	E	E	E	D	D	E
	7:45 - 8:00	D	D	D	D	C	C	C	C	C	C	D	D	C	D	D
	8:00 - 8:15	D	D	D	D	D	C	C	B	C	C	D	D	C	D	D

Case Example

Assuming a Market Penetration Rate of 50% at 2050:



New Two-Lane Highways Method



Updates in HCM 7th Edition

Chapter 15

Two-Lane Highways

- Completely revised methodology

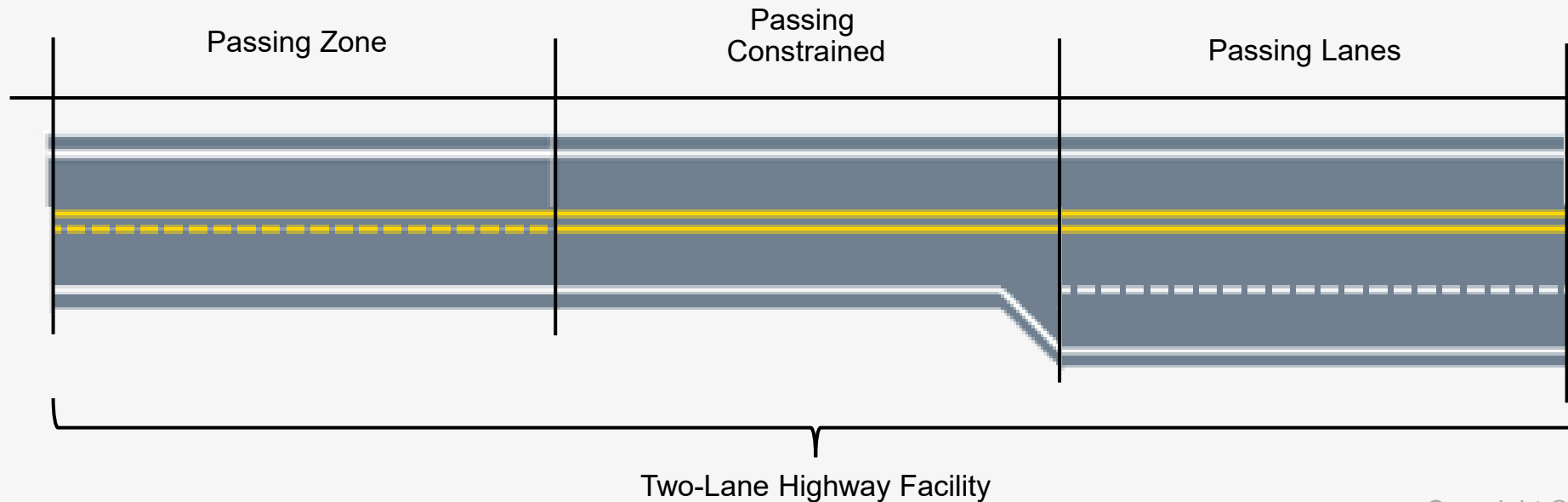
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Revised Chapter 15: Two-Lane Highways

	HCM 6 th Edition Methodology	HCM 7 th Edition Methodology
Segmentation	None - % of passing zones and length of passing lanes are provided	- Segment types: Passing zones, passing constrained and passing lanes - Subsegments based on horizontal alignment
Classification	Class I, Class II, Class III	N/A



Revised Chapter 15: Two-Lane Highways

HCM 6 th Edition Methodology		HCM 7 th Edition Methodology
Performance Measures	- Average Travel Speed - Percent Time Spent Following - Percent of Free-Flow Speed	- Average Speed - Percent Followers Follower Density (Service Measure)
Capacity	1,700 pc/h	1,700 veh/h for passing zones and passing constrained - Variable for passing lanes

LOS	Class I Highways		Class II Highways	Class III Highways
	ATS (mi/h)	PTSF (%)	PTSF (%)	PFFS (%)
A	>55	≤35	≤40	>91.7
B	>50–55	>35–50	>40–55	>83.3–91.7
C	>45–50	>50–65	>55–70	>75.0–83.3
D	>40–45	>65–80	>70–85	>66.7–75.0
E	≤40	>80	>85	≤66.7
F	Demand exceeds capacity			

Note: For Class I highways, LOS is determined by the worse of ATS-based LOS and PTSF-based LOS.

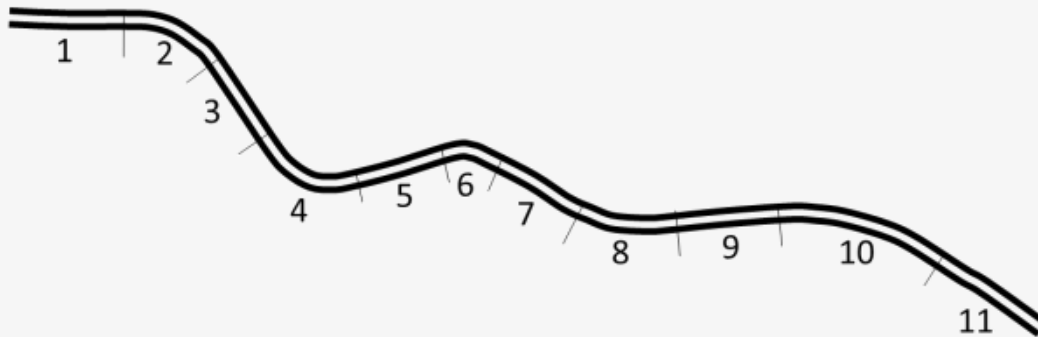
HCM 6th Edition – LOS criteria

LOS	Follower Density (followers/mi/ln)	
	Higher-Speed Highways Posted Speed Limit ≥ 50 mi/h	Lower-Speed Highways Posted Speed Limit < 50 mi/h
A	≤ 2.0	≤ 2.5
B	> 2.0 – 4.0	> 2.5 – 5.0
C	> 4.0 – 8.0	> 5.0 – 10.0
D	> 8.0 – 12.0	> 10.0 – 15.0
E	> 12.0	> 15.0
F	Demand exceeds capacity	

HCM 7th Edition – LOS criteria

Subsegments

- Smaller portions of a segment, defined by horizontal alignment
- Subsegment types: tangent and horizontal curve
- Applied to calculate segment speed



Subsegment	Type	Length (ft) ^a	Super- elevation (%)	Radius (ft)
1	Tangent	280	--	--
2	Horizontal curve	432	3	450
3	Tangent	260	--	--
4	Horizontal curve	366.5	2	300
5	Tangent	250	--	--
6	Horizontal curve	216	5	275
7	Tangent	275.6	--	--
8	Horizontal curve	458	0	750
9	Tangent	285	--	--
10	Horizontal curve	767.9	4	1,100
11	Tangent	369	--	--
Total		3,960		

Case Example – Two-Lane Highways

Evaluate LOS of a Two-Lane Highway Facility – Eastbound Direction

FL-40, a two-lane highway in Ocala/FL



PZ: Passing zone;

PC: Passing constrained;

PL: Passing lane;

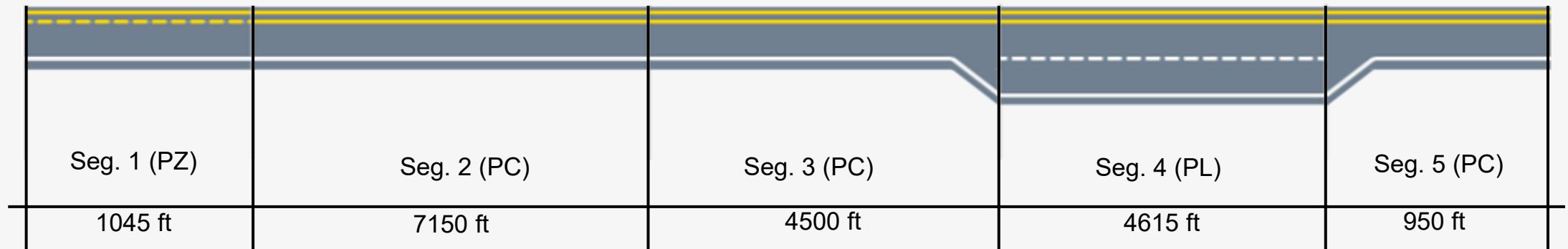
Case Example – Two-Lane Highways

Input Data

Highway schematic (Eastbound direction):

- Posted speed limit = 55 mi/h
- Level terrain (0% grade)
- 8% heavy vehicles
- PHF: 0.95

Segment #	Directional Volume (veh/h)	Opposing Volume (veh/h)
1	470	380
2	500	-
3	500	-
4	500	-
5	500	-

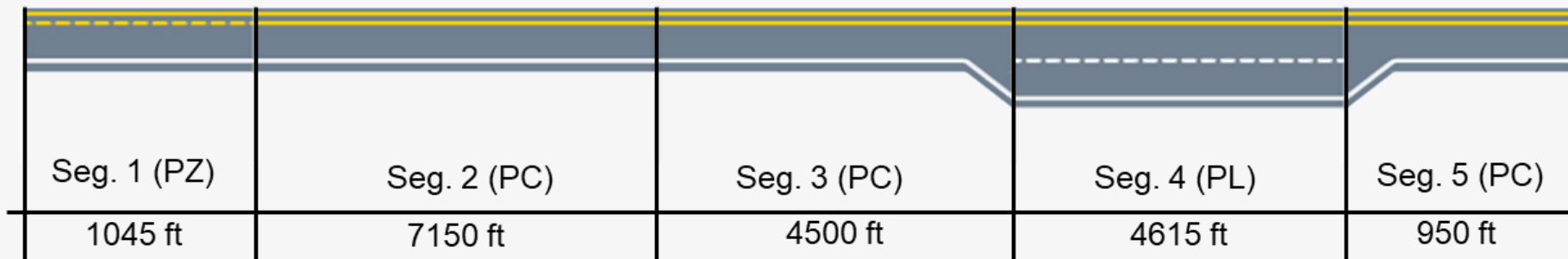


PZ: Passing zone;

PC: Passing constrained;

PL: Passing lane;

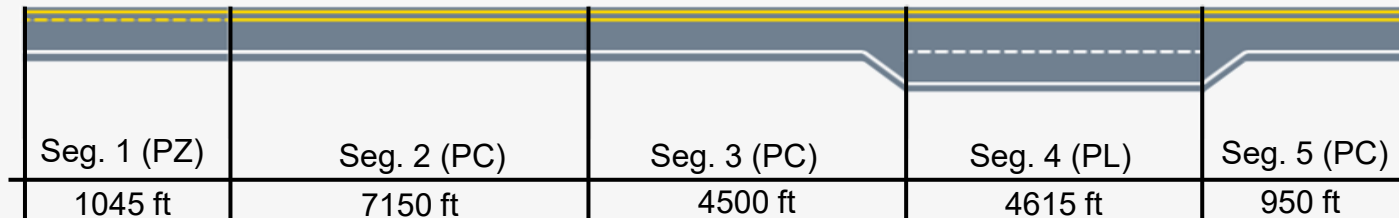
Case Example – Two-Lane Highways



Segment	Speed (mi/h)	Follower Density (foll./mi)	LOS
1	60.1	4.4	C
2	59.7	4.8	C
3	59.7	4.8	C
4	59.7	1.4	A
5	61.3	3.8	B
Facility	59.8	3.9	B

Case Example – Two-Lane Highways

How would this facility be modeled with HCM 6 methods?



- Single segment (3.5 mi)¹
- 69% no-passing zones²
- 0.9 mi passing lane, located 2.4 mi upstream the segment start³

(1)

Input Data

Data for the analysis direction only.

Terrain: Level

Percent Trucks Crawling: 0.0

TCS Difference: 0.0 mi/h

Shoulder Width: 6.0 ft

Grade: + % Length: mi

Lane Width: 12.0 ft

Segment Length: 3.5 mi

Peak Hour Factor, PHF: 0.95

Trucks and Buses: 8 %

Recreational Vehicles: 0 %

Percent No-Passing Zones: 69 % (2)

Access-Point Density: 8 /mi

Analysis Direction Volume: 500 vph

Opposing Direction Volume: 0 vph

Class I Highway (selected)

Class II Highway

Class III Highway

Passing Lane Analysis

Passing Lane

Total Length of Analysis Segment, L_t : 3.5 mi

Length of Two-Lane Highway Upstream of the Passing Lane, L_u : 2.4 mi

Length of Passing Lane Including Tapers, L_{pl} : 0.9 mi (3)

Average Travel Speed, ATS_d : 51.3 mi/h

Percent Time-Spent-Following, $PTSF_d$: 78.9

Level of Service, LOS_d : D

Level of Service D (based on ATS and PTSF)

Enhanced Pedestrian Volume Estimation and Evaluation Method



Updates in HCM 7th Edition

Chapter 18

Urban Streets Segments

Chapter 19

Signalized Intersections

Chapter 20

Two-Way Stop-Controlled Intersections

CHAPTER 19 SIGNALIZED INTERSECTIONS

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What's New: Uncontrolled Crossings (TWSC & Midblock)

TWSC – New Level of Service Criteria

LOS	Control Delay (s/p)	Comments
A	0–5	Usually no conflicting traffic
B	5–10	Occasionally some delay due to conflicting traffic
C	10–20	Delay noticeable to pedestrians, but not inconveniencing
D	20–30	Delay noticeable and irritating, increased likelihood of risk taking
E	30–45	Delay approaches tolerance level, risk-taking behavior likely
F	>45	Delay exceeds tolerance level, high likelihood of pedestrian risk taking

Note: Control delay may be interpreted as seconds per pedestrian group if groups of pedestrians were counted as opposed to individual pedestrians.

HCM 6th Edition – LOS criteria

LOS	Condition	Comments
A	$P_D < 0.05$	Nearly all pedestrians would be satisfied
B	$0.05 \leq P_D < 0.15$	At least 85% of pedestrians would be satisfied
C	$0.15 \leq P_D < 0.25$	Fewer than one-quarter of pedestrians would be dissatisfied
D	$0.25 \leq P_D < 0.33$	Fewer than one-third of pedestrians would be dissatisfied
E	$0.33 \leq P_D < 0.50$	Fewer than one-half of pedestrians would be dissatisfied
F	$P_D \geq 0.50$	The majority of pedestrians would be dissatisfied

Note: P_D = proportion of pedestrians giving a "dissatisfied" rating or worse.

HCM 7th Edition – LOS criteria

What's New: Uncontrolled Crossings (TWSC & Midblock)



HCS Implementation – crossing treatments

Pedestrian Volumes and Adjustments for the Major Street Crossing			
Crosswalk Length, Stage One (ft)	20	20	
Crosswalk Length, Stage Two (ft)	20	20	
Median Refuge	☒ Yes	☒ Yes	☐ Yes
Start-Up and End Clearance Time (s)	3.0	3.0	
Crosswalk Markings	☒ Yes	☒ Yes	☐ Yes
Crossing Treatment	Rectangular rapid-flashing beacon (RRFB) ▾	No extra treatment ▾	No extra treatment ▾
Motorist Yield Rate	0.82		
Rectangular Rapid-Flashing Beacon	☐ Yes		☐ Yes
Pedestrian Platooning	☐ Yes		☐ Yes
Crosswalk Width (ft)			
Show Pedestrian Delay and LOS	☐ Yes		
No extra treatment Pedestal-mounted flashing beacon Overhead sign Overhead flashing beacon (push-button) Overhead flashing beacon (passive) In-roadway warning lights Median refuge island Pedestrian crossing flags In-street pedestrian crossing signs Rectangular rapid-flashing beacon (RRFB) School crossing guard School crossing guard and RRFB Left Thru Right			
Upstream Signal	☐ Yes		
	Left	Thru	Right

What's New: Uncontrolled Crossings (TWSC & Midblock)

Effects of crossing treatments on motorist yield rates

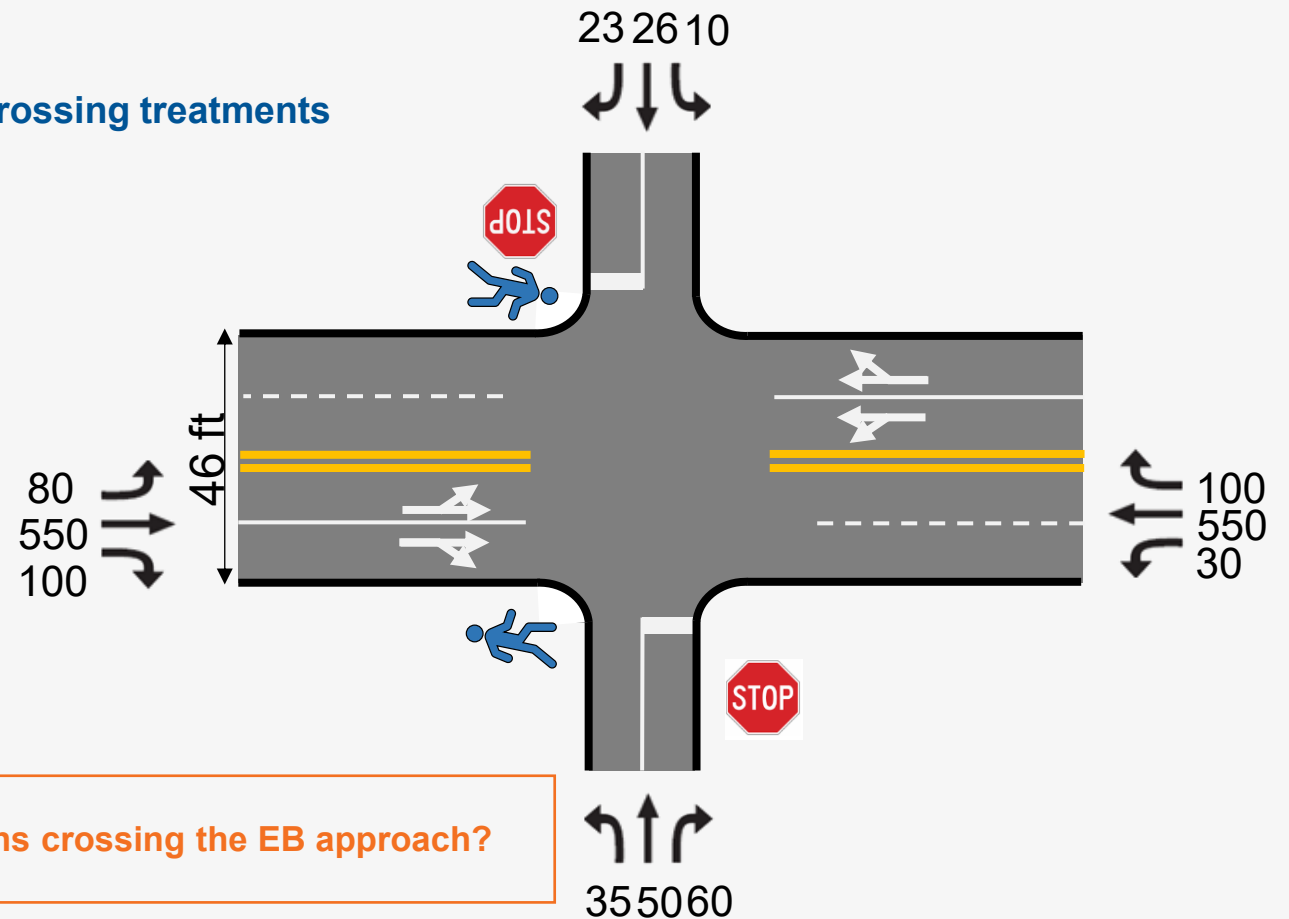
Crossing Treatment	Average Yield Rate (%)
No treatment (unmarked)	24
Crosswalk markings only (any type)	33
Crosswalk markings, plus:	
Pedestal-mounted flashing beacon	26
Overhead sign	35
Overhead flashing beacon (push-button activation)	51
Overhead flashing beacon (passive activation)	73
In-roadway warning lights	58
Median refuge island	60
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Case Example - TWSC

Pedestrian LOS for a TWSC intersection with different crossing treatments

Base scenario:

- No crosswalk
- Pedestrian demand: 50 ped/h on every approach
- Total crossing distance: 46 ft
- Average walking speed: 3.5 ft/s
- Motorist yield rate: 10%



How different crossing treatments affect pedestrians crossing the EB approach?

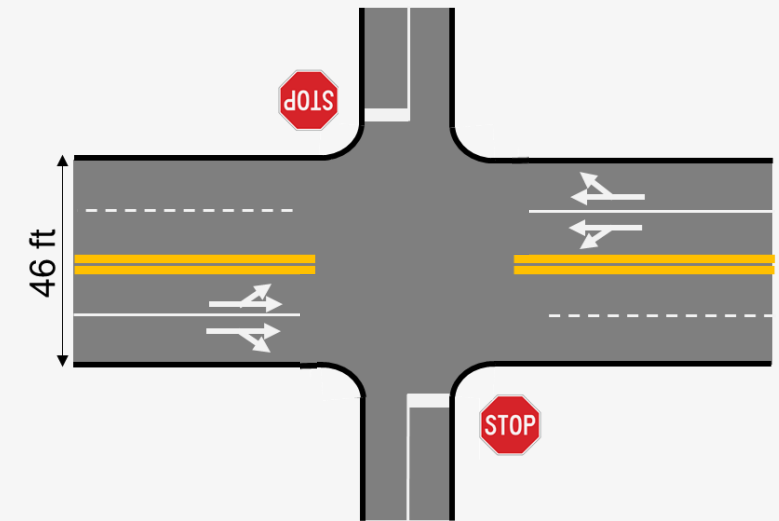
Case Example - TWSC

Pedestrian LOS for a TWSC intersection with different crossing treatments

Pedestrian Volumes and Adjustments				
	Eastbound	Westbound	Northbound	Southbound
Flow (ped/hr)	50	50	50	50
Lane Width (ft)	12	12	12	12
Walking Speed (ft/sec)	3.5	3.5	3.5	3.5

Pedestrian Volumes and Adjustments for the Major Street Crossing				
Crosswalk Length (ft)	46	46		
Crosswalk Length, Stage Two (ft)				
Median Refuge	☐ Yes	☐ Yes	☐ Yes	☐ Yes
Start-Up and End Clearance Time (s)	3.0	3.0		
Crosswalk Markings	☐ Yes	☐ Yes	☐ Yes	☐ Yes
Crossing Treatment	No extra treatment	No extra treatment	No extra treatment	No extra treatment
Motorist Yield Rate	0.10	0.10		
Rectangular Rapid-Flashing Beacon	☐ Yes	☐ Yes	☐ Yes	☐ Yes
Pedestrian Platooning	☐ Yes	☐ Yes	☐ Yes	☐ Yes
Crosswalk Width (ft)				
Show Pedestrian Delay and LOS	☒ Yes			

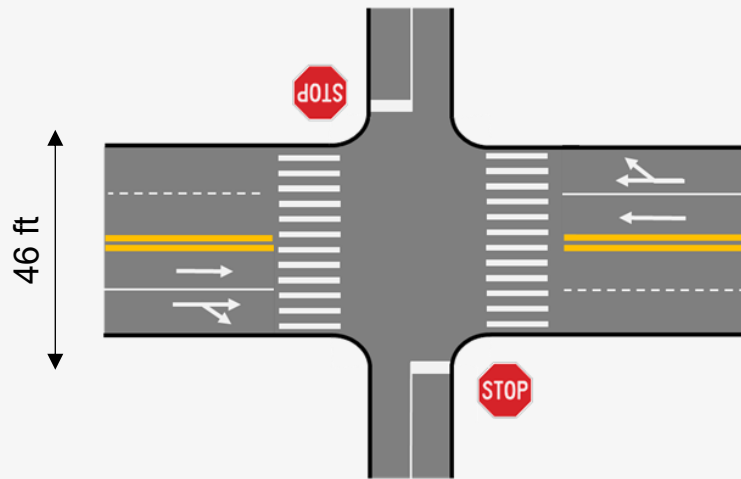
	EB	WB
Average delay (s)	497.5	442.1
Probability of non-delayed crossing	0.6%	0.8%
Average proportion of dissatisfied pedestrians	82%	81.6%
LOS	F	F



Base scenario – no treatment

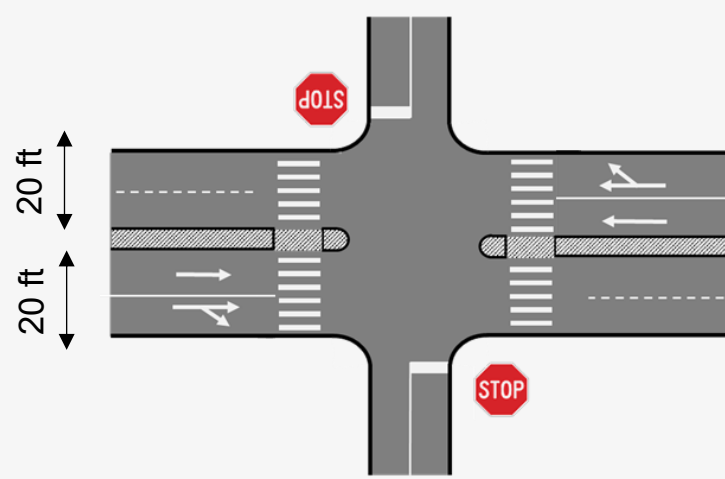
Case Example - TWSC

Pedestrian LOS for a TWSC intersection with different crossing treatments



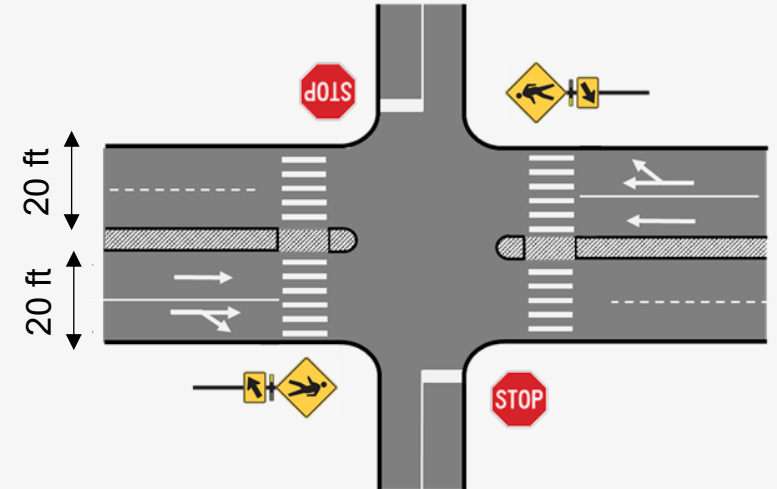
Option A

Pedestrian crosswalks



Option B

Crosswalk + median refuge

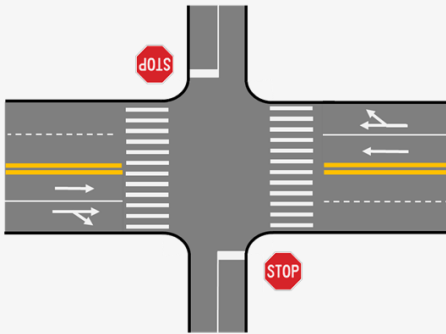


Option C

Crosswalk + median refuge + RRFB

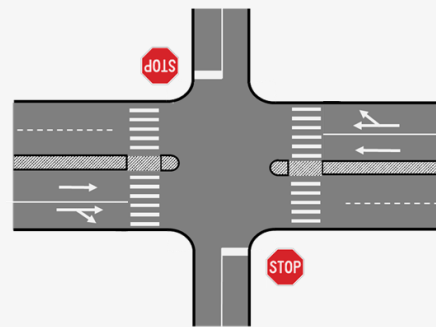
Case Example - TWSC

Pedestrian LOS for a TWSC intersection with different crossing treatments



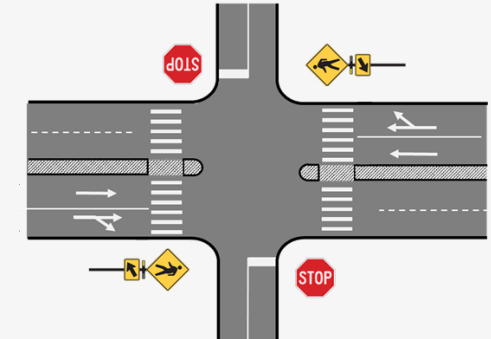
Crosswalk Length (ft)	46
Crosswalk Length, Stage Two (ft)	
Median Refuge	☐ Yes
Start-Up and End Clearance Time (s)	3.0
Crosswalk Markings	☒ Yes
Crossing Treatment	No extra treatment
Motorist Yield Rate	0.33
Rectangular Rapid-Flashing Beacon	☐ Yes
Pedestrian Platooning	☐ Yes
Crosswalk Width (ft)	

Average delay (s)	53.6
Probability of non-delayed crossing	4.7%
Avg. proportion of dissatisfied pedestrians	61.4%
LOS	F



Crosswalk Length, Stage One (ft)	20
Crosswalk Length, Stage Two (ft)	20
Median Refuge	☒ Yes
Start-Up and End Clearance Time (s)	3.0
Crosswalk Markings	☒ Yes
Crossing Treatment	No extra treatment
Motorist Yield Rate	0.33
Rectangular Rapid-Flashing Beacon	☐ Yes
Pedestrian Platooning	☐ Yes
Crosswalk Width (ft)	

Average delay (s)	14.9
Probability of non-delayed crossing	37.8%
Avg. proportion of dissatisfied pedestrians	18.7%
LOS	C



Crosswalk Length, Stage One (ft)	20
Crosswalk Length, Stage Two (ft)	20
Median Refuge	☒ Yes
Start-Up and End Clearance Time (s)	3.0
Crosswalk Markings	☒ Yes
Crossing Treatment	Rectangular rapid-flashing beacon (RRFB)
Motorist Yield Rate	0.82
Rectangular Rapid-Flashing Beacon	☒ Yes
Pedestrian Platooning	☐ Yes
Crosswalk Width (ft)	

Average delay (s)	4.2
Probability of non-delayed crossing	68.6%
Avg. proportion of dissatisfied pedestrians	2.1%
LOS	A

New Network Method



Updates in HCM 7th Edition

Chapter 38

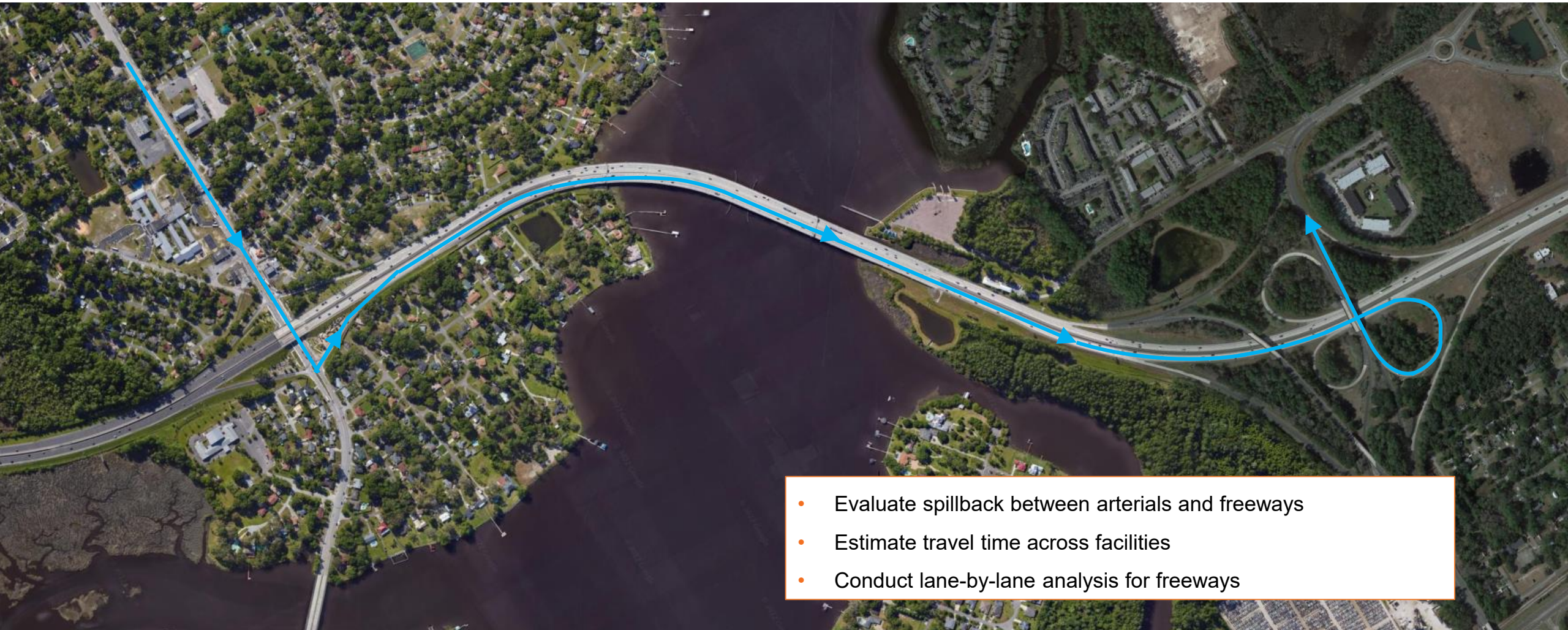
Network Analysis

CHAPTER 38 NETWORK ANALYSIS

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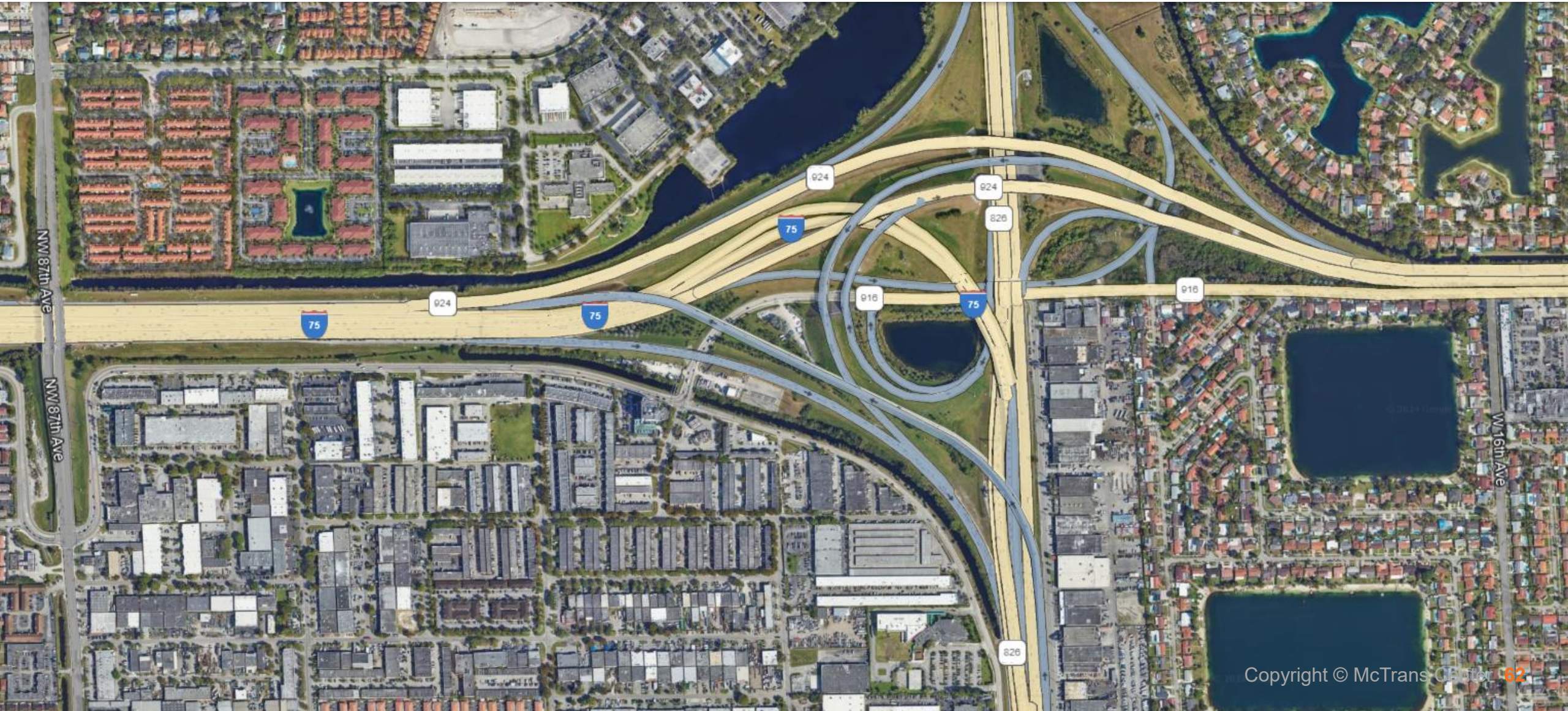
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NCHRP 15-57: New HCM Chapter 38 on Network Analysis



- Evaluate spillback between arterials and freeways
- Estimate travel time across facilities
- Conduct lane-by-lane analysis for freeways

Case Example – I-75 SB & SR-826 - Miami ,FL



Case Example – I-75 SB & SR-826 - Miami ,FL

- System interchange – SR-826 and I-75
- Heavy congestion on SR-826 SB during peak hours
- Queues back up from SR826 to I-75



Source: Florida DOT

Case Example – I-75 SB & SR-826 - Miami ,FL

Step 1 – Model two freeway facilities separately:

I-75 SB

GP Type	Basic	Diverge	Basic	Weaving	Diverge	Basic	Merge	Basic
ML Type	ML Basic	ML Basic	ML Basic	ML Basic	ML Basic	ML Basic	ML Basic	ML Basic
Length, ft	3000	1500	3200	4450	1055	2880	1500	3000
Segment ID	1	2	3	4	5	6	7	8
GP Lanes	4	4	4	5	4	3	3	3
ML Lanes	1	1	1	1	1	1	1	1



Off-ramp to SR-826

SR-826 SB

Type	Basic	Merge	Basic	Basic
Length, ft	15000	1500	5280	5280
Segment ID	1	2	3	4
Lanes	4	4	4	4



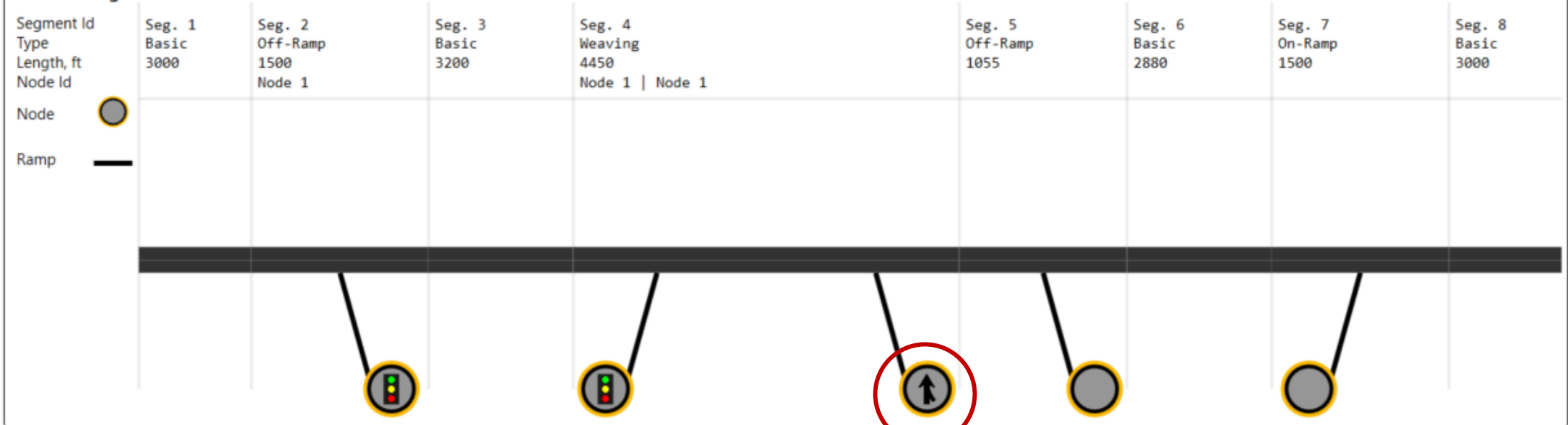
On-ramp from I-75

Case Example – I-75 SB & SR-826 - Miami ,FL

Step 2 – Connect facilities through HCS Network module:

Segment	External File	Segment Type	Ramp Terminal Type	Ramp Terminal Facility Name	Connected Int./Seg. ID	Connected Int./Seg. Name	Approach	Ramp Roadway Length, ft	Details
2	Network3-HialeahGardensBlvd.xus	Off-Ramp	Signal	Hialeh Gardens Blvd	1	138th St @ Hialeah Gardens Blvd.	SB	1850	Details
4	Network3-HialeahGardensBlvd.xus	Weaving On-Ram	Signal	Hialeh Gardens Blvd	1	138th St @ Hialeah Gardens Blvd.	WB	2630	Details
4	Network3-SR826SBMiamiFL.xuf	Weaving Off-Ram	Freeway	SR-826 SB	2: OnRamp	SR-826 SB - Seg 2 - Merge	-	3780	Details
5	Select	On-Ramp	-					5280	Details
7	Select	On-Ramp	-					5280	Details

Network Segments



Case Example – I-75 SB & SR-826 - Miami ,FL

Spillback analysis report:

- Ramp queue is compared to ramp storage length
- Queue storage ratio = 1.33 → queue spillback occurs
- Queue spillback expected to exceed 908 ft upstream of off-ramp gore

Spillback Analysis and Queues					
Analysis Period 1 (07:00-07:15)					
Ramp Number	1	2	3	4	5
Segment Number	2	4	4	5	7
Ramp Terminal	OFR	WONR	WOFR	OFR	ONR
Ramp Terminal Type	SIG	SIG	FRWY	-	-
Number of Ramp Lanes	2	1	2	1	1
Ramp Roadway Capacity (pc/h)	4200	2100	4200	2100	2100
Ramp Demand, vR (pc/h)	1008	651	2626	420	368
Adjusted Ramp Demand, vRadj (pc/h)	1008	651	2626	420	368
Ramp Metering?	No	No	No	No	No
Ramp Metering Rate (pc/h)	-	-	-	-	-
Spillback Occurs?	Yes	No	Yes	No	No
Ramp L1 (R) Queue (veh)	0.0	15.7	141.8	-	-
Ramp L2 (L) Queue (veh)	143.0	-	141.8	-	-
Ramp L1 (R) Queue (ft)	0	408	3688	-	-
Ramp L2 (L) Queue (ft)	3718	-	3688	-	-
Average Vehicle Spacing (ft)	26.0	26.0	26.0	-	-
Ramp L1 (R) Total Storage Length (ft)	1850	2630	2780	-	-
Ramp L2 (L) Total Storage Length (ft)	2700	-	2780	-	-
Ramp L1 (R) Queue Storage Ratio	0.00	0.16	1.33	-	-
Ramp L2 (L) Queue Storage Ratio	1.38	-	1.33	-	-
Ramp L1 (R) Queue Length Past Ramp Storage (ft)	0	0	908	-	-
Ramp L2 (L) Queue Length Past Ramp Storage (ft)	1018	-	908	-	-

Research Beyond HCM 7

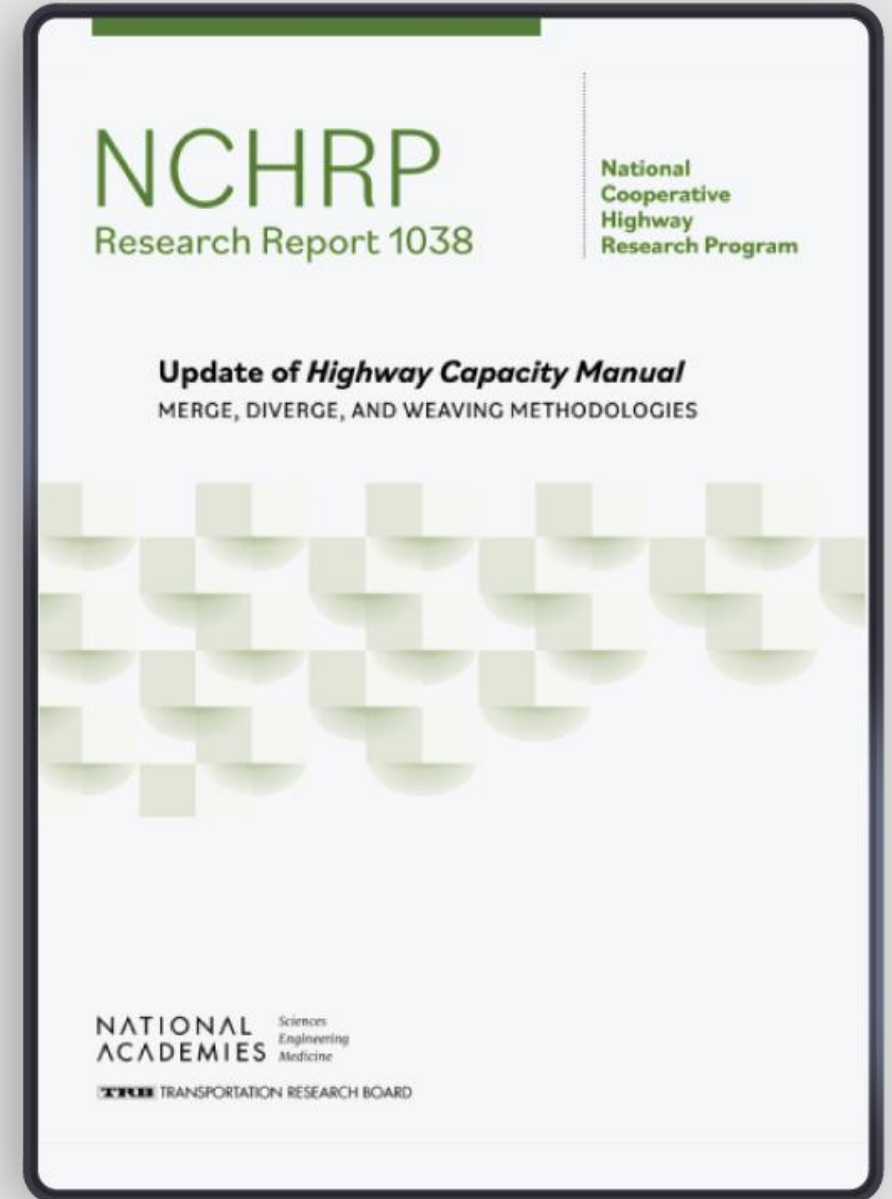


New Research – Beyond HCM 7th Edition

Research Project	Project Title
NCHRP 07-26	Update of Highway Capacity Manual: Merge, Diverge, and Weaving Methodologies
NCHRP 15-66	Operational Performance and Safety Effects of Arterial Weaving Sections
NCHRP 03-136	Evaluating the Performance of Right-Turn-On-Red Operation at Signalized Intersections (with single and dual right-turn lanes)

HCM 7.1 – New Freeway Methods

- New methods for Freeway Merge, Diverge and Weaving segments (single segment only).
- Revised **HCM Chapters 13** (*Weaving Segments*) and **14** (*Merge/Diverge Segments*) internally approved by the Highway Capacity and Quality of Service Committee at TRB
- Methods already implemented in HCS



HCM 7.1 – New Freeway Methods

New HCM Merge/Diverge Methods

- Better speed and capacity predictions than current HCM model
- Simpler model (no look-up tables and multiple conditions)
- Consistent with fundamental speed–flow relationships
- Merge & diverge capacities lower than current HCM
- Density at capacity reduced to 35 pc/mi/ln

New HCM Weaving Methods

- Better speed and capacity predictions for complex weaves than current HCM model
- No maximum weaving segment length
- Simpler model
- Consistent with fundamental speed–flow relationships
- Density at capacity reduced to 35 pc/mi/ln

HCM 7.1 – New Freeway Methods

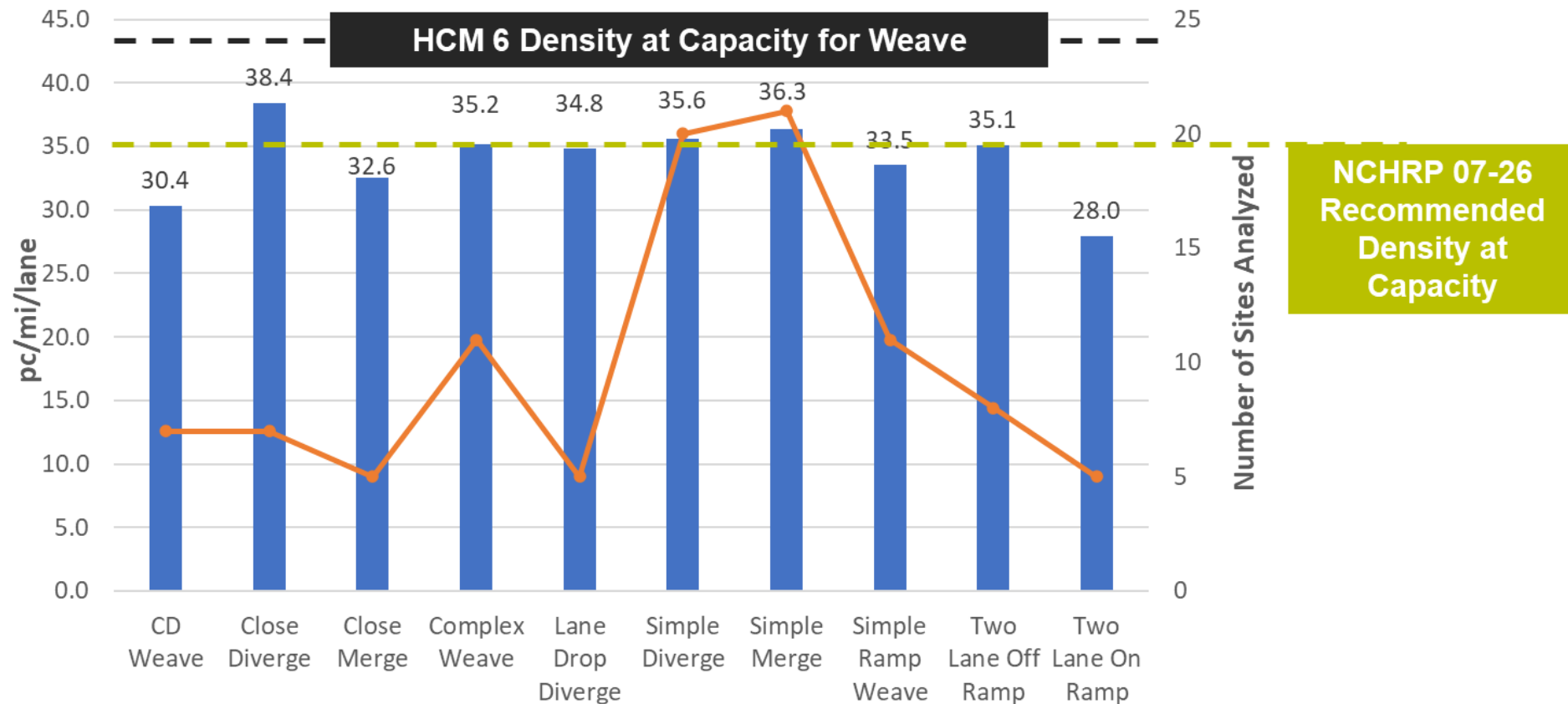
Review of Capacity Estimates – Merge Segments

Source	3-lane Capacity	4-lane Capacity
HCM 6 th Ed.	2,250–2,400 pc/h/ln	2,250–2,400 pc/h/ln
Elefteriadou et al. (2014)	2,100 pc/h/ln 1,950 veh/h/ln	2,000 pc/h/ln 1,860 veh/h/ln
Kondyli et al. (2016)	1,920–2,080 veh/h/ln	1,800–1,960 veh/h/ln
Morris et al. (2011)	2,020 veh/h/ln	1,870 veh/h/ln

Source: NCHRP Research Report 1038

HCM 7.1 – New Freeway Methods

Review of Density at Capacity - Weaving

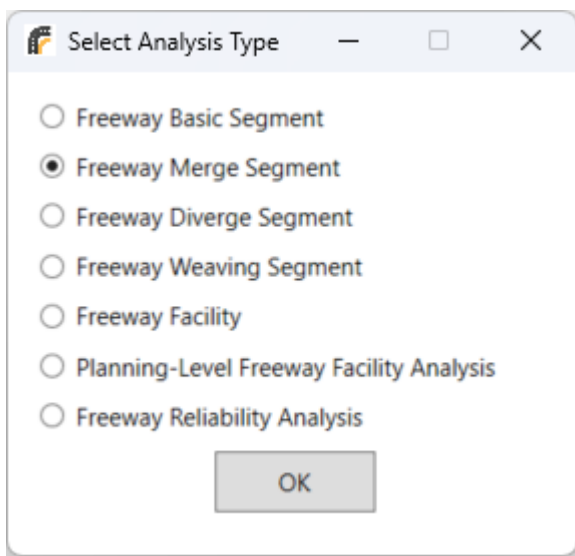


Source: NCHRP Research Report 1038

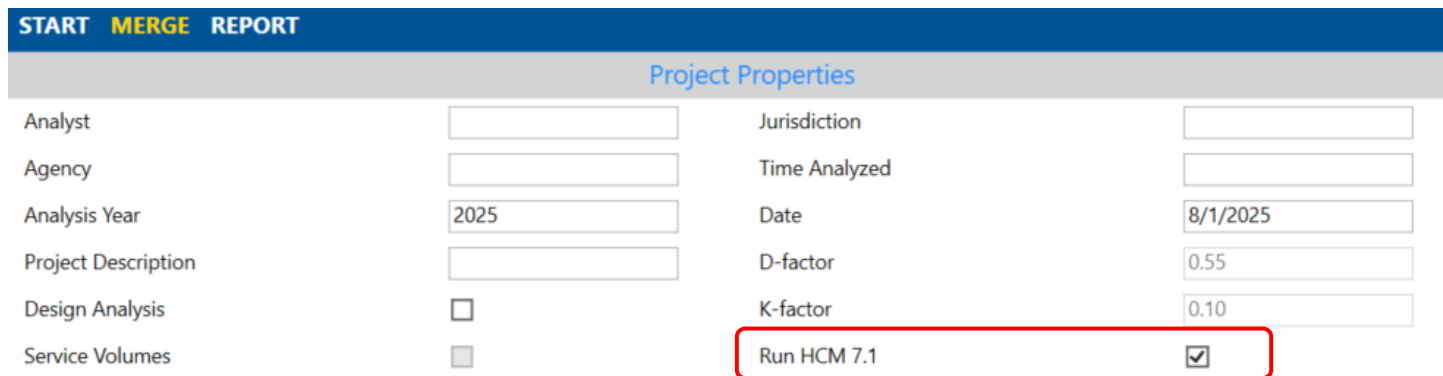
HCM 7.1 – New Freeway Methods

HCS Implementation

Already implemented in HCS2025 (single segment analysis only):



A dialog box titled "Select Analysis Type" with a close button (X) in the top right corner. It contains seven radio button options: "Freeway Basic Segment", "Freeway Merge Segment" (which is selected), "Freeway Diverge Segment", "Freeway Weaving Segment", "Freeway Facility", "Planning-Level Freeway Facility Analysis", and "Freeway Reliability Analysis". An "OK" button is located at the bottom center.



A form titled "Project Properties" with a blue header bar containing the tabs "START", "MERGE", and "REPORT". The "MERGE" tab is active. The form contains several input fields and checkboxes. A red box highlights the "Run HCM 7.1" checkbox, which is checked.

Project Properties	
Analyst	
Agency	
Analysis Year	2025
Project Description	
Design Analysis	☐
Service Volumes	☐
Jurisdiction	
Time Analyzed	
Date	8/1/2025
D-factor	0.55
K-factor	0.10
Run HCM 7.1	☒

HCM 7.1 – New Freeway Methods

Merge/Diverge

LOS	Density (pc/mi/ln)
A	≤ 10
B	$> 10-20$
C	$> 20-28$
D	$> 28-35$
E	> 35
F	Demand exceeds capacity

LOS Criteria - HCM 7

LOS	Density (pc/mi/ln)
A	0–11
B	$> 11-18$
C	$> 18-25$
D	$> 25-30$
E	$> 30-35$
F	> 35 , or demand exceeds capacity

Proposed LOS Criteria - HCM 7.1

Weaving

LOS	Freeway Weaving Segments
A	0–10
B	$> 10-20$
C	$> 20-28$
D	$> 28-35$
E	$> 35-43$
F	> 43 , or demand exceeds capacity

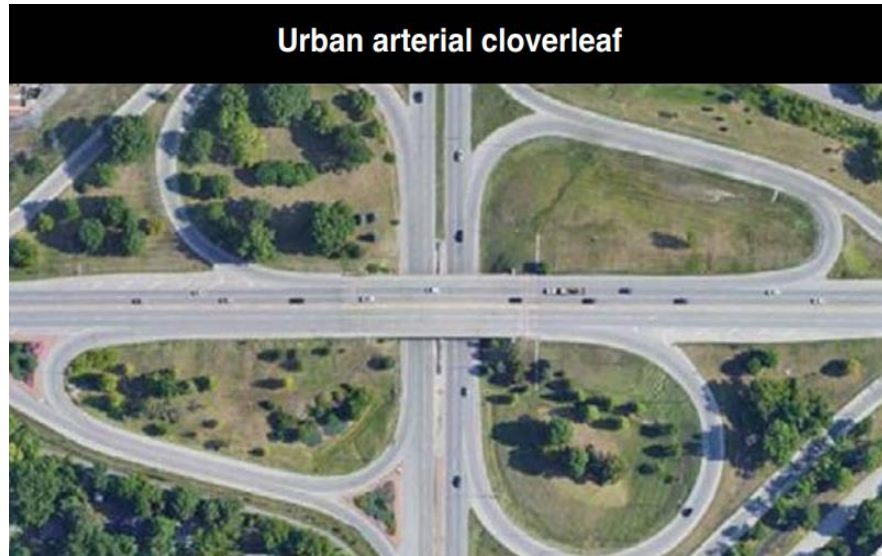
LOS Criteria - HCM 7

LOS	Density (pc/mi/ln)
A	0–11
B	$> 11-18$
C	$> 18-25$
D	$> 25-30$
E	$> 30-35$
F	> 35 , or demand exceeds capacity

Proposed LOS Criteria - HCM 7.1

Arterial Weaving

- Objective: evaluating the operational performance of weaving sections on arterials
- Methodology based on the existing HCM's Urban Street Segment analysis



Source: NCHRP Research Report 1094

Right-Turn on Red

- Objectives:
 - Provide guidance on RTOR volume estimation
 - Provide better estimation of the delay due to RTOR
- Current HCM limitations:
 - RTOR demand is simply subtracted from right-turn demand at signals
 - No guidance to estimate RTOR volumes
 - No methods to estimate delays for RTOR



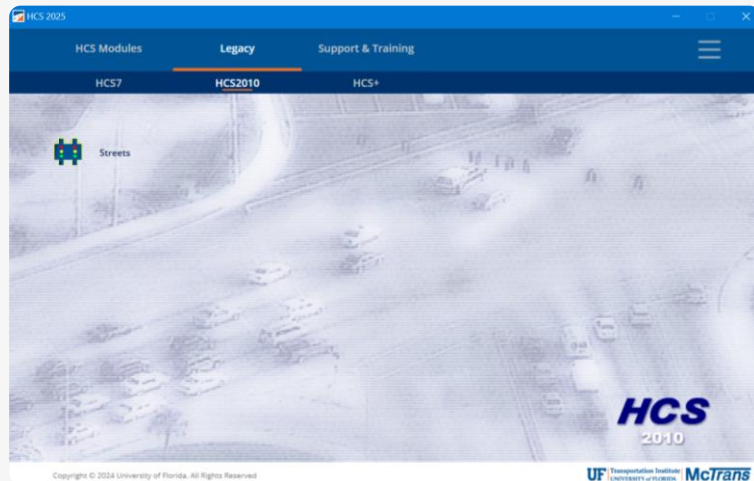
Source: FHWA

HCS – What is New

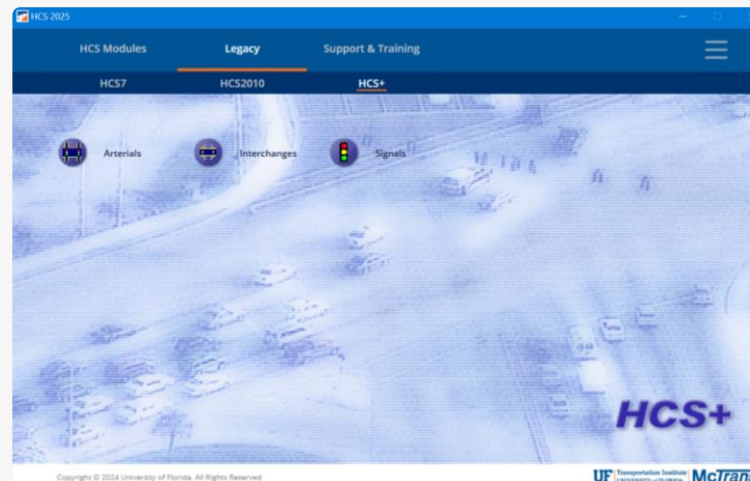


HCS Legacy

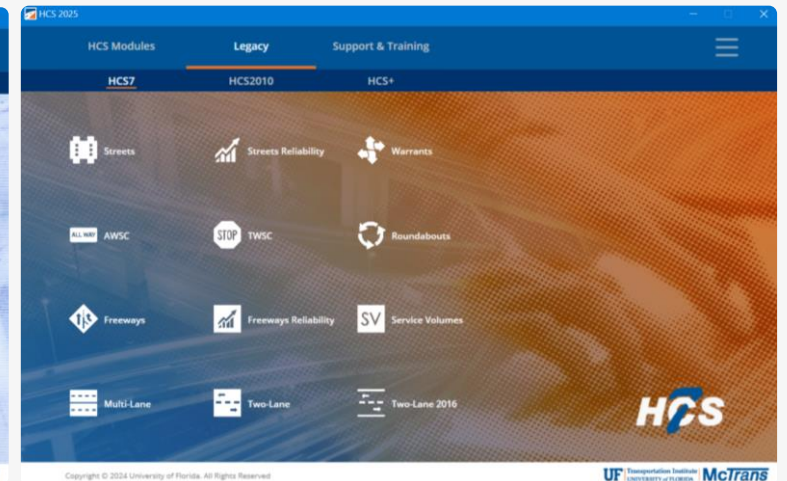
HCS 2025 provides free access to Legacy HCS versions, including:



HCS 2010 (HCM 2010):
Streets



HCS+ (HCM 2000):
Arterials, Interchanges, and Signals



HCS7 (HCM 6th Edition):
Streets, AWSC, TWSC, Roundabouts, Freeways,
Service Volumes, Multilane and Two-Lane Highways

Ideal for:

- Revisiting older projects
- Special cases requiring older methods



Segmentation Database

Freeway systems pre-coded in HCS, including geometry and typical volumes

Required user inputs: start/end mile markers, start/end time

Query Segmentation Database

Segmentation Database Query Inputs

State: Florida

Freeway Name: I4

Direction: EB

Mile Marker Start: 2.73

Mile Marker End: 17.08

Query Summary

Number of Segments: 25

Facility Length, mi: 14.9

Global Inputs

Study Period Start: 06:00

Study Period End: 08:00

Directional Dist. Factor: 0.5

Hourly Profile: Facility Specific (week)

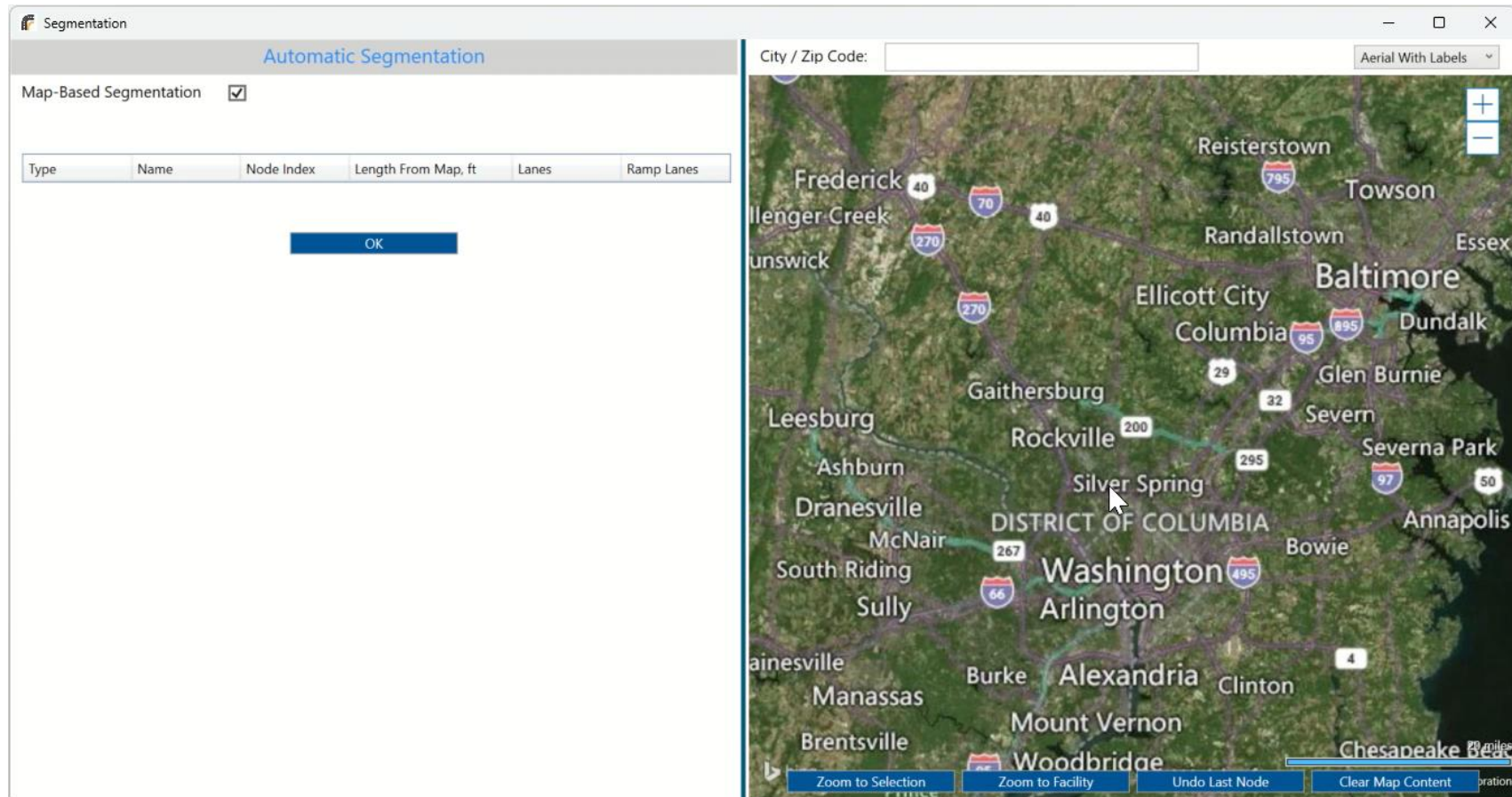
OK Cancel

Map showing the I4 freeway system in the Tampa Bay area, with segments highlighted in different colors (Basic, Merge, Diverge, Overlap, Weaving).



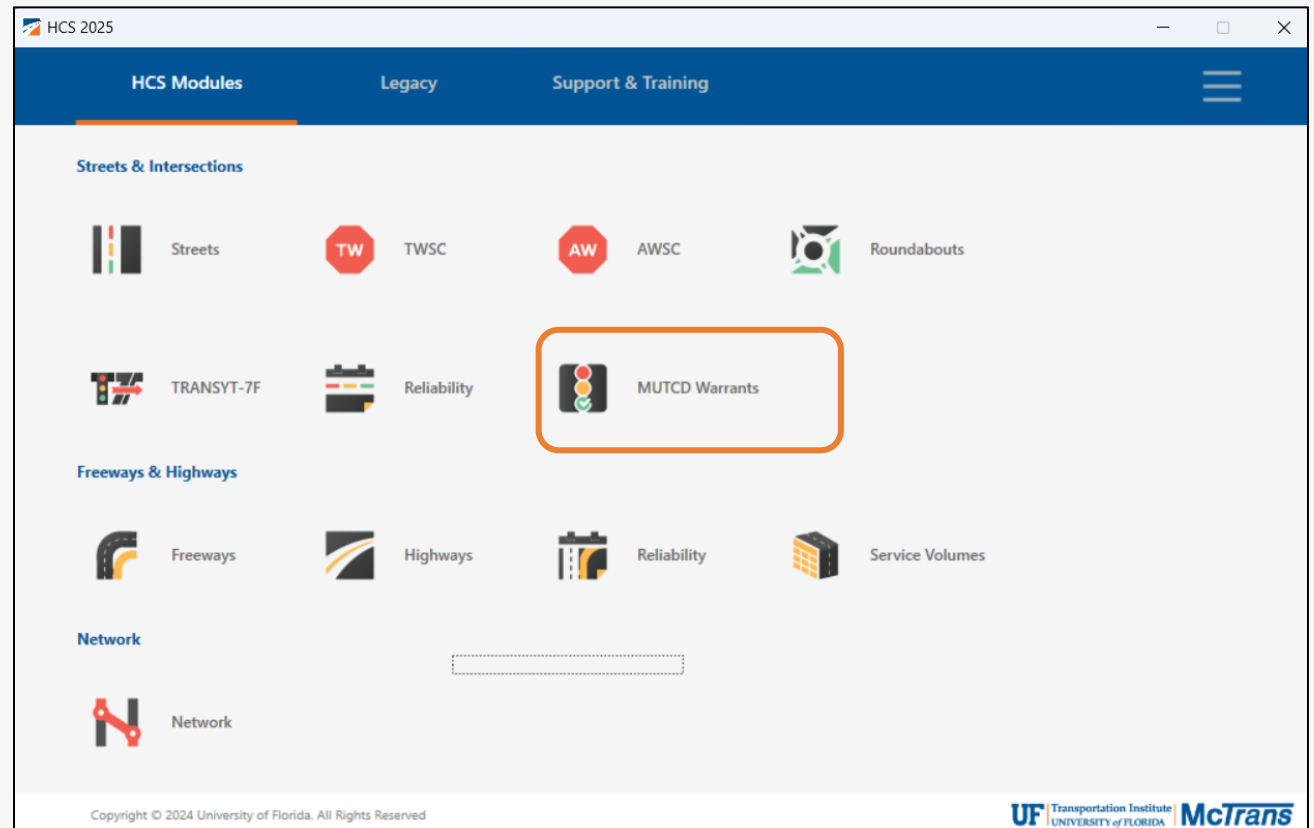
Map-Based Segmentation

New feature to HCS **Freeways** and **Highways**, enabling users to effortlessly design their facilities using an intuitive map interface.



HCS Signal Warrants Tool

- Implements the Signal Warrants Analysis process from MUTCD Chapter 4C
- Included as a module of HCS (Highway Capacity Software)
- Latest release includes MUTCD 11th Edition (2023) updates
- Support for a data-driven decision making on installing a traffic signal



Highway Safety Software



HSS (Highway Safety Software)

- Crash prediction tool, based on the Highway Safety Manual Part C
- Previously a HCS module, now a standalone tool
- Updated yearly
- Incorporates HSM2 new predictive methods



HSS

START GENERAL DETAILS REPORT			
Intersection			
Facility Type	Urban	Model Type	Four-leg, Signal (4SG)
Is Major Street One-Way?	☐	Number of Through Lanes on Major Street	4
Is Minor Street One-Way?	☐	Number of Through Lanes on Minor Street	2
Method Type	General		
Input			
AADT (maj), veh/day	1000	AADT (min), veh/day	1000
Forward Direction	EB	Approaches with Left-Turn Lanes	0
Left-Turn Phasing for EB	None	Left-Turn Phasing for WB	None
Left-Turn Phasing for SB	None	Left-Turn Phasing for NB	None
Approaches with Right-Turn Lanes	0	Approaches for which RTOR is Prohibited	0
Pedestrian Volume, ped/day	0	Maximum Lanes Crossed by Pedestrian	0
Lighting	☐	Red Light Cameras	☐
Number of Bus Stops	0	Presence of School	☐
Number of Alcohol Sales Establishments	0		
Parameters			
Output			
Safety Performance Function (SPF)	0.160	Predicted Crash Frequency (Npredicted)	0.162
CMF1 (Left-Turn Lanes)	1.000	CMF2 (Left-Turn Phases)	1.000
CMF3 (Right-Turn Lanes)	1.000	CMF4 (Right-Turn on Red)	1.000
CMF5 (Lighting)	1.000	CMF6 (Red Light Running Cameras)	1.000
CMF1p (Bus Stops)	1.000	CMF2p (Schools)	1.000
CMF3p (Alcohol Sales)	1.000		

Empirical Bayes Analysis

Observed crash data is weighted into calculations for a more accurate crash prediction:

START GENERAL DETAILS REPORT			
Project Description			
Analyst		Jurisdiction	
Agency		Analysis Year	2023
Date	12/14/2023	Project Description	
Empirical Bayes Analysis	☒	Number of Years of Observed Crashes	1
Facility Type	Rural Two-Lane Segment	Area Type	Rural

New Pedestrian / Bike CPMs

- Incorporated new methods from NCHRP 17-84 to predict pedestrian and bicycle crashes
- New models more sensitive to site-specific conditions (exposure and infrastructure):
 - Bike lane configurations
 - Shared-use paths
 - Crossing treatments
 - Signal phasing
 - Area population
 - Land use



Urban/Suburban Arterials Segments

HSM 1 – Existing models

- Two-lane undivided (2U)
- Three-lane with TWLTL (3T)
- Four-lane undivided (4U)
- Four-lane divided (4D)
- Five-lane with TWLTL (5T)

HSM 2 – New models

- Six-lane divided (6D) ✓
- Six-lane undivided (6U) ✓
- Seven-lane with TWLTL (7T) ✓
- Eight-lane divided (8D) ✓
- Two-lane One Way (2O) ✓
- Three-lane One Way (3O) ✓
- Four-lane One Way (4O) ✓

Intersections

HSM 1 – Existing models

- 3-leg stop control (3ST)
- 4-leg stop control (4ST)
- 3-leg signal control (3SG)
- 4-leg signal control (4SG)

Roundabouts: NCHRP 17-70

New intersections: NCHRP 17-68

Intersections for new urban segments: NCHRP 17-58

HSM 2 – New models

- Roundabouts (R) ✓
- 3-leg turning (3STT)
- Intersections on high-speed arterials (≥ 50 mph)
 - Stop control (3ST-HS, 4ST-HS)
 - Signal (3SG-HS, 4SG-HS)
- All-way stop control ✓
 - 3-leg (3aST) ✓
 - 4-leg (4aST) ✓
- 5-leg signal (5SG)

✓ *Implemented in HSS*

Urban Intersections

New crash prediction models for existing urban intersections (signal and stop-control):

- Two-way street intersecting a two-way street (2x2) ✓
- One-way street intersecting a two-way street (1x2) ✓
- One-way street intersecting a one-way street (1x1) ✓
- 6+lane major roads ✓

START GENERAL **DETAILS** REPORT

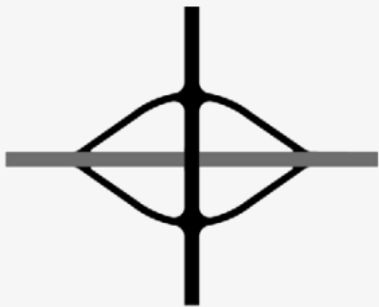
Intersection

Facility Type	Urban	Model Type	Four-leg, Signal (4SG) ▼
Is Major Street One-Way?	☒	Number of Through Lanes on Major Street	4
Is Minor Street One-Way?	☒	Number of Through Lanes on Minor Street	2
Method Type	One-Way		

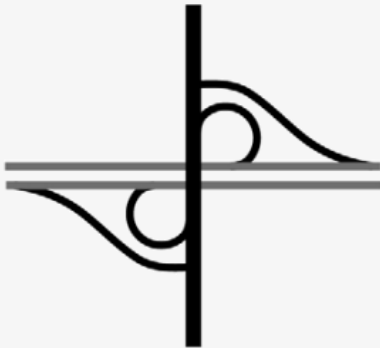
Ramp Terminals CPMs

HSM 1 – Existing models

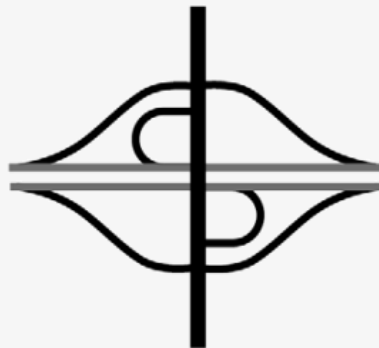
- 3-leg terminals with diagonal ramp (D3en/D3ex) ✓
- 4-leg terminals with diagonal ramps (D4) ✓
- 4-leg terminals at four-quadrant Parclo A/B (A4/B4) ✓
- 3-leg terminals at two-quadrant Parclo A/B (A2/B2) ✓



Conventional Diamond Interchange



Partial Cloverleaf – A2



Partial Cloverleaf – B4

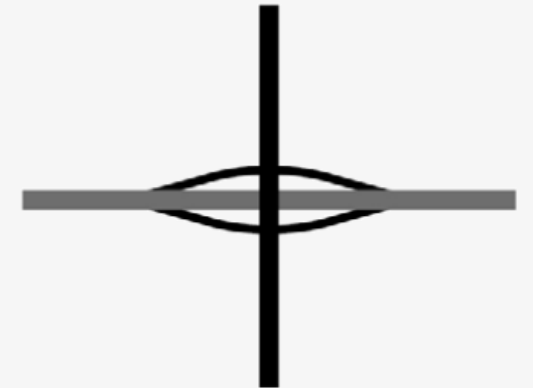
HSM 2 – New models

All models in HSM1, plus:

- Single-point interchanges (SP) ✓
- Tight diamond interchanges (TD) ✓



Single-Point Diamond Interchange (SPDI)



Tight Urban Diamond Interchange

User-Defined CMFs

Add external CMFs not included in HSM, adding flexibility to safety models:

- CMF Clearing House (FHWA)
- State-approved CMFs

▼ Countermeasure: Install shoulder rumble strips								
Compare	CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
☐	0.87	13	★★★★☆	Run off road	All	Rural	PATEL ET AL., 2007	[READ MORE]

User-Defined CMFs			
Add User-Defined CMF		Delete User-Defined CMF	
CMF Name	CMF Description	CMF Type	CMF Value
1 Shoulder rumble strips	Install rumble strips on both shoulders; applicable ot SV run off-road crashes. (CMF ID #1195)	Total ▼	0.870

Highway Capacity Software Live Training

- Training session schedule: two consecutive days, 7h each;
- Instructional material sent to students in PDF format prior to class;
- Time-limited versions of HCS2023 can be provided to attendees upon request;
- Maximum attendance: 25 per training session;
- 14 PDHs provided to all attendees.

Highway Capacity Software Live Training

- **Overview – HCS and HCM Overview (1 hour):** this section provides a high-level overview of the HCM and its applications and provides an introduction to the Highway Capacity Software and its modules. Additionally, with the publication of the HCM 7th Edition by the Transportation Research Board in 2022, this section will highlight the applications and capabilities of new methods and updates to existing methods.
- **Urban Streets (6 hours):** hand-on training of HCS to analyze: Unsignalized Intersections (AWSC, TWSC, and Roundabouts); Signalized Intersections, Urban Streets, Interchanges, and Alternative Intersections;
- **Freeways and Highways (7 hours):** hands-on training of HCS to analyze: Freeways Segments (basic, merge, diverge, and weaving), Freeway Facilities; Multilane Highways; Two-Lane Highways.

Statewide Multimodal Access Management And Transportation Site Impact

WEBINAR SERIES 2025 - 2026



Webinar #2

Statewide Non-Motorized Traffic Monitoring Program

Wednesday, November 5, 2025

2:00PM – 3:30PM

Credits: 1

Webinar link: <https://attendee.gotowebinar.com/register/1428610200795315035>

QUESTIONS



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**THANK
YOU!**