July 2019

NCDOT Greenfields Office – Computer Lab
750 N Greenfield Pkwy, Garner, NC 27529

FREEVALNC

ONE-DAY HANDS-ON CLASS

ITRE
Institute for Transportation Research and Education

KITTELSON & ASSOCIATES

WELCOME

LET'S LEARN ALL ABOUT FREEVAL-NC!

Instructors

Behzad Aghdashi, PhD, PMP
ITRE, NC State University
saghdas@ncsu.edu

Bastian Schroeder, PhD, PE
Kittelson and Associates
bschroeder@kittelson.com

Lake Trask, PhD
Kittelson and Associates
ltrask@kittelson.com

Thomas Chase, PE
ITRE, NC State University
rtchase@ncsu.edu

Nagui Rouphail, Ph.D.
ITRE, NC State University
rouphail@ncsu.edu

Introductions

- Name
- Company
- Experience/Common Uses of HCM
- Key Questions for Today

Class Outline

Time	Topic		Session Type
9:00a - 9:15a	**Welcome, Introductions, Agenda, Learning Outcomes**		**Discussion**
9:15a – 9:45a	Session #1	Introduction to the Single-Day Freeway Analysis, Including Work Zone Effects	Lecture
9:45a – 10:30a	Session #2	How to Perform a Single Day Analysis in FREEVAL-NC	Demo/Hands-on
10:30a – 10:45a	Break		
10:45a – noon	Session #3	How to Create, Review, Revise & Interpret FREEVAL-NC Single Day Analyses Results	Hands-on
noon – 1:30p	Lunch Break (Lunch not provided)		
1:30p - 2:00p	Session #4	Introduction to Freeway Reliability Analysis	Lecture
2:00p - 2:45p	Session #5	How to Perform a Reliability analysis in FREEVAL-NC	Demo/Hands-on
2:45p - 3:00p	Break		
3:00p - 3:45p	Session #6	How to Create, Review, Revise, & Interpret FREEVAL-NC Reliability Analyses Results	Hands-on
3:45p – 4:00p	Questions and Closing Discussions		Discussion

Learning Outcomes

- How to set up a FREEVAL-NC Analysis
- How to review and edit a FREEVAL-NC file
- How to interpret results from:
  - A single-day analysis
  - A reliability (longer-term) analysis
- How to assess the impact of
  - Work zones
  - Severe weather conditions
  - Incidents
  - Special events
  - Other sources of non-recurring congestion

What is FREEVAL?

- FREEVAL was developed in the late 1990s and has been continuously improved since that time.
- It is the official computational engine of HCM to perform freeway analyses.
- It encompasses all freeway segment methods (basic, merge, diverge, and weave) as well as managed lanes, work zone, reliability and other analyses.
- It is able to model oversaturated conditions, queue formation, and dissipation over time and space.

What can FREEVAL do?

FREEVAL Can perform the following analyses:

- Segment Level
- Travel Time Reliability
- Work Zone
- Managed Lanes
- Active Traffic Management
  - Ramp Metering
  - Hard Shoulder Running
  - Incident Management
  - Traffic Diversion

Image Sources: Kittelson & Associates, ITRE

What is FREEVAL-NC?

FREEVAL 2015-E
- Integrates all HCM Freeway Chapters (Core Method)
- Managed lanes, Reliability, ATDM

FREEVAL-WZ
- NCDOT sponsored planning-level interface (demand profiles)
- Explicit modeling of work zone scenarios and user cost
- Customized report generation functionality

FREEVAL-DSS
- Dynamic Strategy Selection (DSS) for ATDM strategy implementation
- Modeler and operator modes to assess reaction to congestion in near real-time

FREEVAL+
- Integrates all Prior Features and additional customization
- Adds Google Map Integration for Segmentation
- Enhanced ATDM Interface (Ramp Metering, Hard Shoulder Running, etc.)

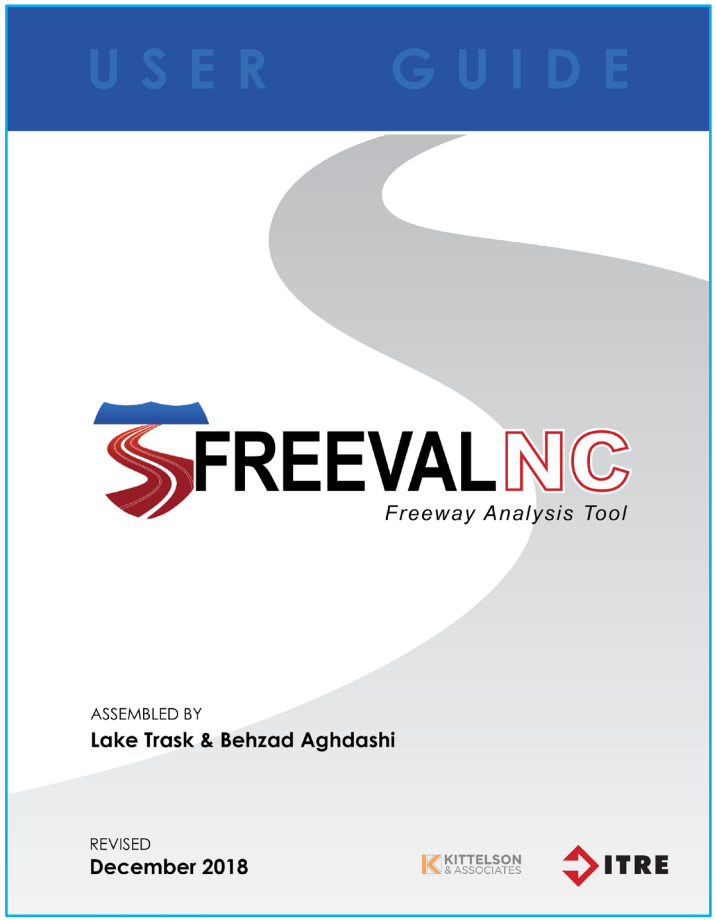
FREEVAL-NC
- Integrates Geometric and Demand Information for All NC Freeways
- Contains NC specific parameters for reliability analysis
- Has standard NCDOT reporting functionalities

Review of Important Resources

- Class Handout
  - Includes detailed examples.
- FREEVAL-NC User Guide
  - Detailed descriptions of FREEVAL-NC's features and functions help you operate the tool.
- http://freeval.org
  - Download the latest version of FREEVAL-NC.
  - Download the user guide.
  - Access the segmentation database.
- YouTube Videos (http://go.ncsu.edu/freeval)
  - Short videos give you a big-picture idea on what different FREEVAL analyses are about.

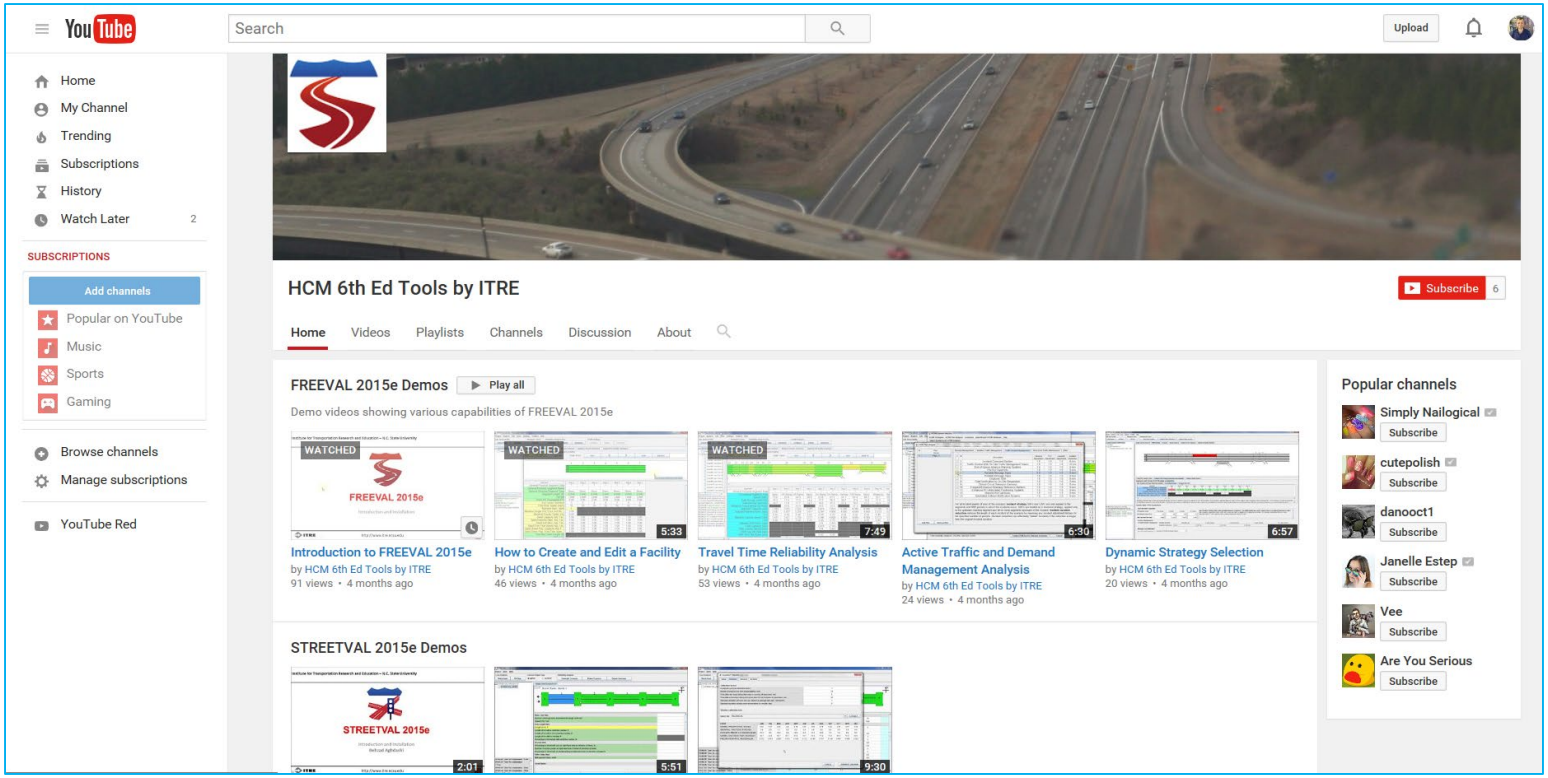
User Guide

- Accessible at http://freeval.org



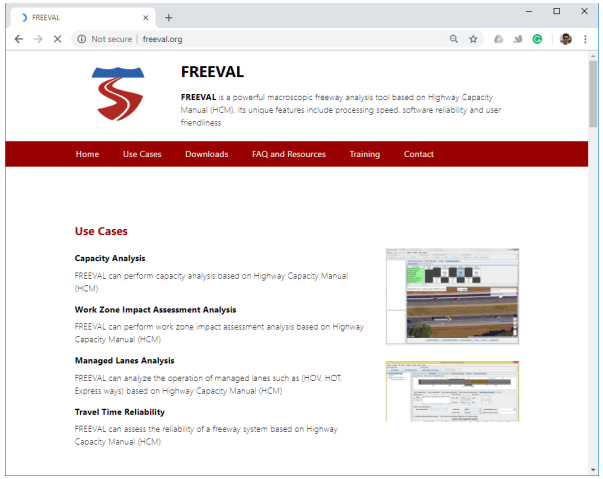
YouTube Videos

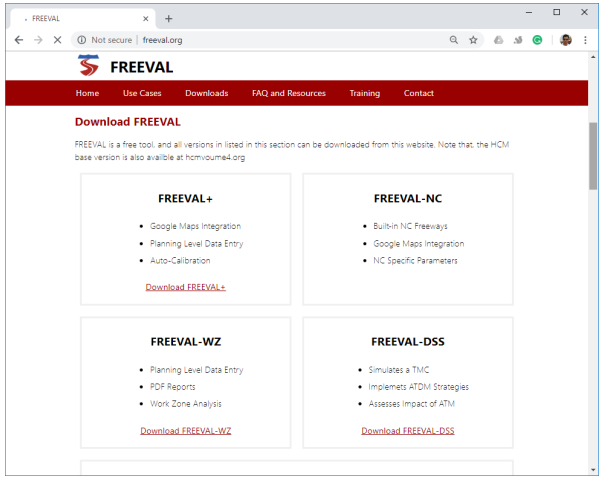
Link: http://go.ncsu.edu/FREEVAL



http://freeval.org

- Freeval.org is a central place to host latest versions of FREEVAL along with any supporting materials, such as:
  - User Guide
  - Useful links to external websites
  - Q&A
- The base FREEVAL version is also accessible through HCM Volume IV (hcmvolume4.org).





System Requirements

- FREEVAL-NC can run on any operating system including Windows, Linux, Mac OS etc.
- Some features require internet access.

- However, it will need Java Runtime Environment (JRE) 8+ being installed before its execution.
- JRE download: https://www.java.com/en/download
- You need to have administrative rights to install JRE

Common Mistakes

- By default “windows” shows the content of the zip folder without unzipping it.
- You cannot execute FREEVAL when it resides inside a zip file.
- Always remember to unzip FREEVAL’s zip folder when you download it from freeval.org.
- Do not store FREEVAL in an in-house server and try to execute it from different locations simultaneously.

SESSION #1

Introduction to Single-Day Freeway Analysis, Including Work Zone Effects

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Analysis Types Supported

- FREEVAL-NC can perform any freeway analysis cited in the 6th edition of HCM.
- FREEVAL-NC also includes methods from other research projects:
  - Planning Level Data Entry
  - Auto-Segmentation
  - Facilitated Calibration

Image Sources: Kittelson & Associates, ITRE

HCM 6th Edition:
Uninterrupted Flow Chapters

Chapter 10: Freeway Facilities

Chapter 11: Freeway Reliability Analysis

Chapter 12: Basic Freeway and Multilane Highway Segments

Chapter 13: Freeway Weaving Segments

Chapter 14: Freeway Merge and Diverge Segments

Chapter 25: Freeway Facilities Supplemental

Chapter 26: Freeway and Highway Segments Supplemental

Chapter 27: Freeway Weaving Supplemental

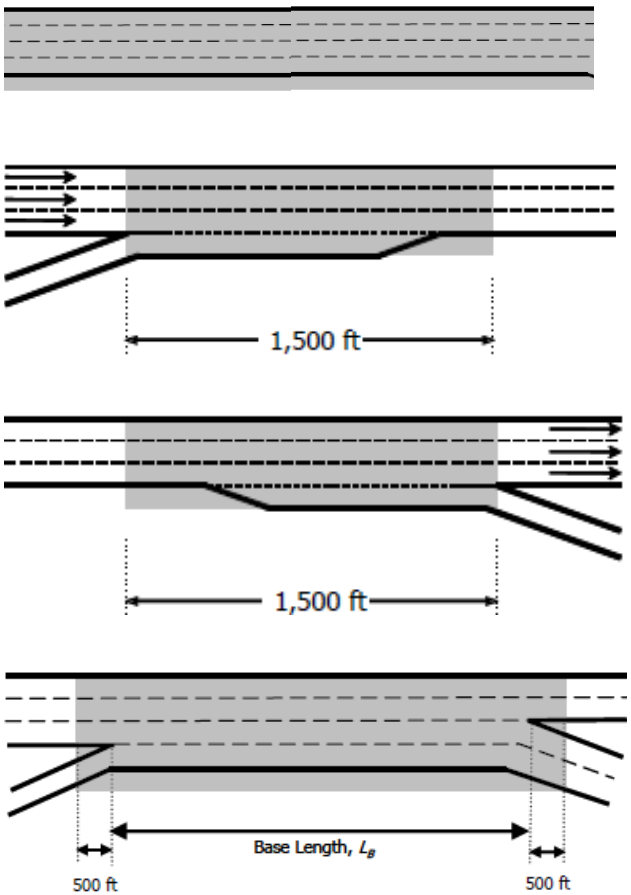
Chapter 28: Freeway Merges and Diverges Supplemental

Why Analyze Freeways as Facilities?

Photo: Bastian Schroeder

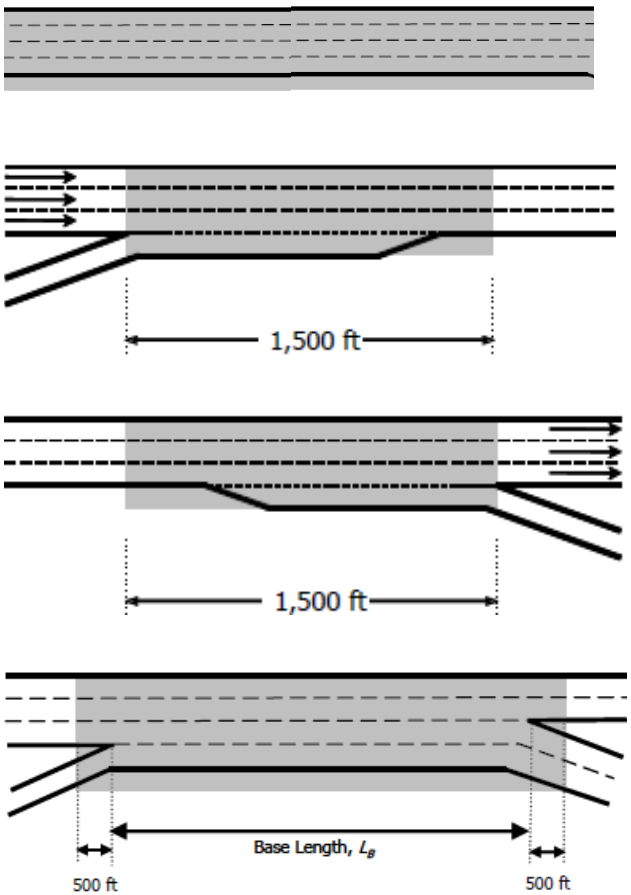
Spatial Unit of FREEVAL-NC Analysis

- The smallest spatial building block of a freeway in FREEVAL is an “HCM Segment.”
- HCM Segment Types:
  - Basic Freeway Segments
  - Weaving Segments
  - On-Ramp and Off-Ramp Segments
  - Overlapping Segments
  - Managed Lane Segments
- HCM Segments are different from TMC Segments!

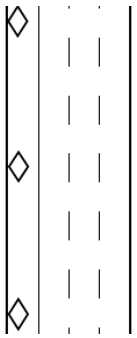


How to do Segmentation

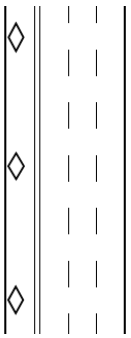
- **FREEVAL-NC has access to "HCM Segmentation" of North Carolina freeways.**
- Always for any existing freeway, embedded maps can be called, and the Auto-Segmentation Wizard will guide you through creating HCM segments.
- If the scope of the analysis is not contained in FREEVAL-NC's Segmentation Database, use HCM Chapter 10 procedures and definitions to split the freeway stretch into HCM segments.



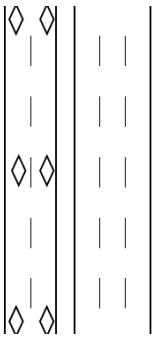
Managed Lanes Segments



Continuous Access



Buffer 1



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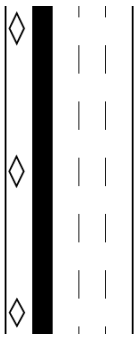
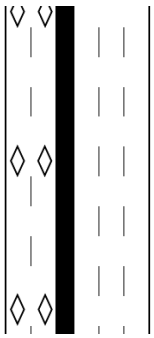


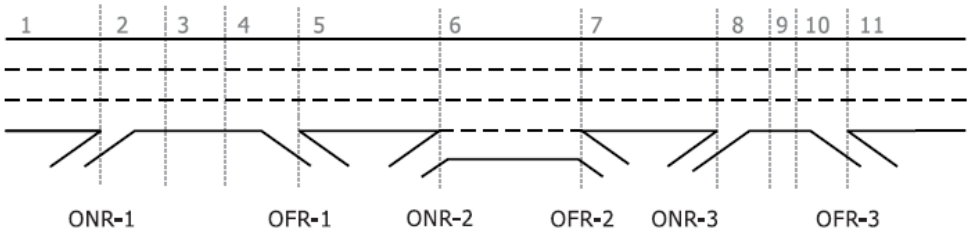
Barrier 1



Barrier 2

Freeway Facilities Method - Other Details

- Method combines the analysis of multiple segments along an extended length of a freeway (up to 15 miles).
- Considers oversaturated conditions including queue spillback and effects on upstream and downstream flows.
- Can model queue propagation between segments and over multiple time periods.
- Considers operations over multiple (15-minute) contiguous analysis periods up to 24 hours.



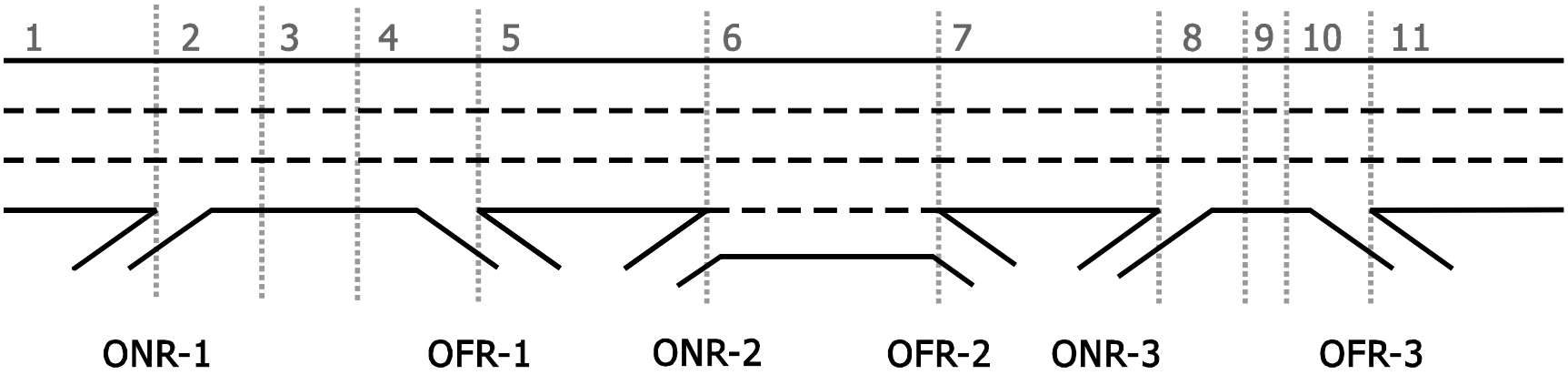
FREEVAL Capabilities

- Enables the modeling of oversaturated & under-saturated conditions in an extended time-space domain (24 hrs).
- Models the effect of all active and highlights hidden mainline bottlenecks.
- Allows time-variant demands and capacities each 15 minutes.
- Therefore, can model effect of incidents, weather and work zones.
- Validated against field data and compared to microsimulation very favorably.

Be Cautious!

- HCM methods do not account for off-ramp congestion due to surface street control and spillback onto mainline.
- The method is not reliable in reporting the effect of multiple overlapping queues with very high Demand to Capacity ratio.
- Requires input manipulation for the analysis of extended facilities (free-flow travel time greater than 15 minutes).

An Illustrative Example



Segment No.	1	2	3	4	5	6	7	8	9	10	11
Segment type	B	ONR	B	OFR	B	B or W	B	ONR	R	OFR	B
Segment length (ft)	5,280	1,500	2,280	1,500	5,280	2,640	5,280	1,140	360	1,140	5,280
No. of lanes	3	3	3	3	3	4	3	3	3	3	3

Example Details

- Single Unit Trucks and Buses = 1.25% (all movements)
- Mainline Tractor Trailers = 1.00% (all movements)
- Driver population → regular commuters
- *FFS* = 60 mi/h (all mainline segments)
- Ramp *FFS* = 40 mi/h (all ramps)
- Acceleration lane length = 500 ft (all ramps)
- Deceleration lane length = 500 ft (all ramps)
- D_{jam} = 190 pc/mi/ln
- L_s = 1,640 ft (for Weaving Segment 6)
- *TRD* = 1.0 ramp/mi
- Terrain = level
- Analysis duration = 75 min (divided into five 15-min time steps)
- Demand adjustment = +11% increase in demand volumes across all segments and time steps compared with Example Problem 1
- A queue discharge capacity drop of 7% is assumed

FREEVAL Outputs

Time Step	Demand-to-Capacity Ratios by Segment										
	1	2	3	4	5	6	7	8	9	10	11
1	0.74	0.82	0.82	0.82	0.77	0.7	0.8	0.87	0.87	0.87	0.83
2	0.82	0.9	0.9	0.9	0.84	0.78	0.9	0.99	0.99	0.99	0.95
3	0.86	0.96	0.96	0.96	0.92	0.85	0.99	1.1	1.1	1.1	1.02
4	0.77	0.83	0.83	0.83	0.79	0.68	0.79	0.86	0.86	0.86	0.82
5	0.62	0.65	0.65	0.65	0.61	0.52	0.62	0.67	0.67	0.67	0.64

Time Step	Volumes Served (veh/h) by Segment										
	1	2	3	4	5	6	7	8	9	10	11
1	5,001	5,500	5,500	5,500	5,200	5,800	5,400	5,900	5,900	5,900	5,600
2	5,500	6,099	6,099	6,099	5,700	6,499	6,099	6,699	6,699	6,699	6,399
3	5,800	6,499	6,499	6,499	5,831	6,281	5,584	6,284	6,284	6,284	5,859
4	5,200	5,600	5,600	5,600	5,668	6,311	5,776	6,276	6,276	6,276	5,934
5	4,201	4,401	4,401	4,401	4,102	4,608	4,840	5,140	5,140	5,140	4,912

Time Step	Speed (mi/h) by Segment										
	1	2	3	4	5	6	7	8	9	10	11
1	59.8	53.2	58.6	55.9	59.5	46.8	59	52.5	52.5	55.7	58.3
2	58.6	52.1	55.8	55.5	57.9	45.4	55.8	50.6	50.6	51.5	53.9
3	57.4	51.1	53.1	53.1	45.3	24.2	28.1	51.6	51.6	54.7	57.1
4	47.2	47.5	51.5	48.3	56.5	24.7	29.6	51.7	51.7	54.7	56.8
5	60	54.5	59.7	56.2	60	51.4	50.9	53.7	53.7	56.1	59.9

FREEVAL Outputs

Density-Based LOS

Analysis Period	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 9	Seg. 10	Seg. 11
#1 17:00 - 17:15	D	D	D	D	D	D	D	D	E	D	D
#2 17:15 - 17:30	D	D	E	D	D	E	E	E	E	D	E
#3 17:30 - 17:45	D	D	E	D	E	F	F	D	E	D	E
#4 17:45 - 18:00	D	E	E	E	D	F	F	D	E	D	E
#5 18:00 - 18:15	C	C	C	C	C	C	D	C	D	C	C

Demand-Based LOS

Analysis Period	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 9	Seg. 10	Seg. 11
#1 17:00 - 17:15											
#2 17:15 - 17:30											
#3 17:30 - 17:45								F	F	F	F
#4 17:45 - 18:00											
#5 18:00 - 18:15											

Real World Case Studies

Impacts from Major Freeway Work Zone

- Estimating Queuing Impacts
- Identifying Diversion Targets

Work Zone Lane-Closure Sensitivity

- Setting allowable work hours
- Estimating Queuing Impacts

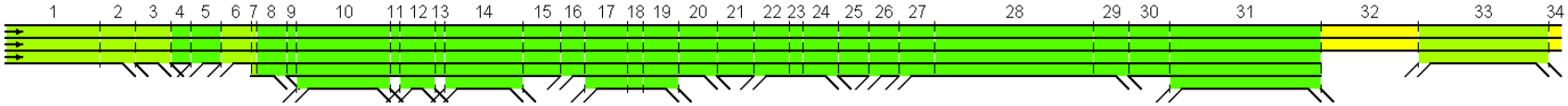
Calibration Example

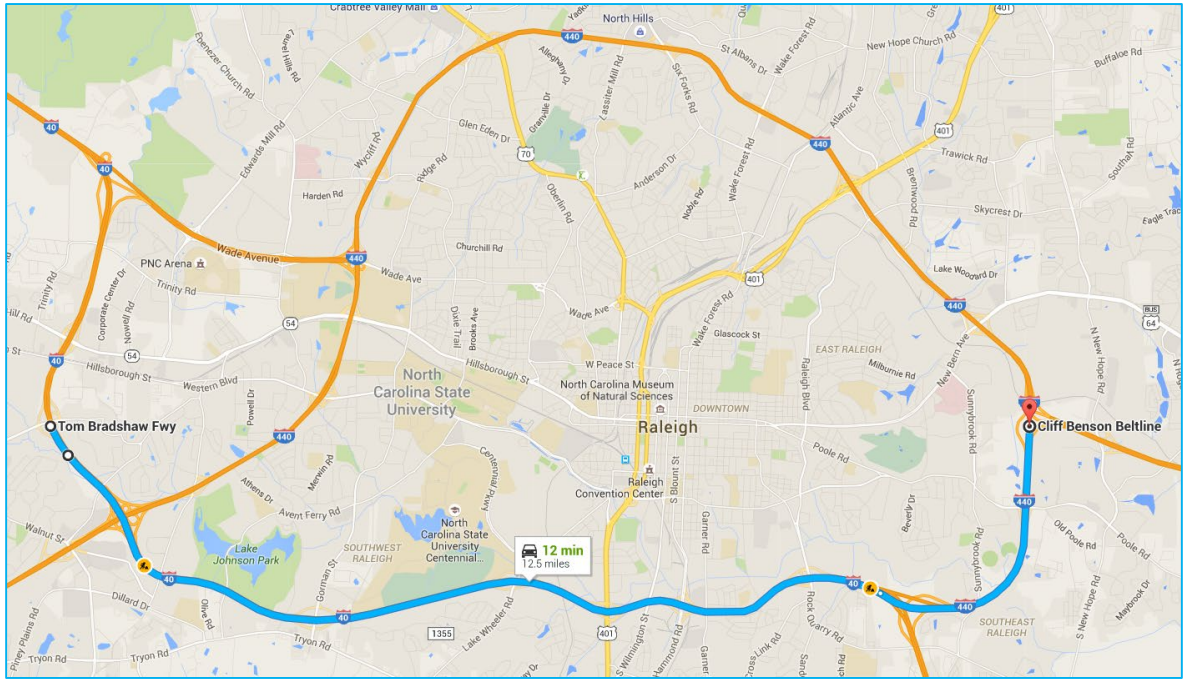
- Using probe data to calibrate facility travel times and speed contours

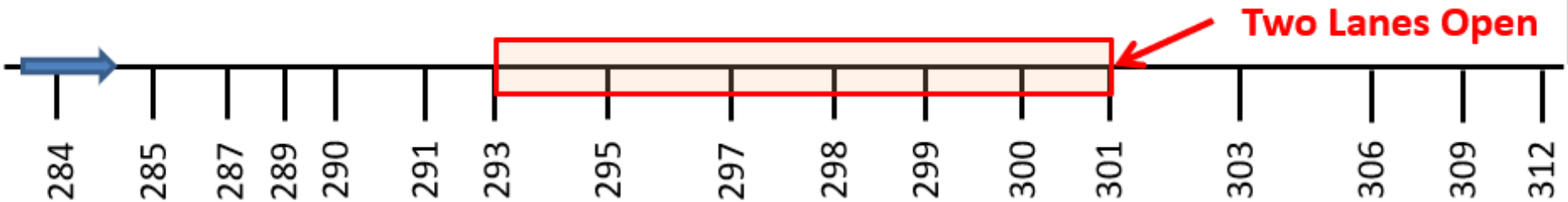
Interchange Evaluation

- Comparing Scenario Performance
- Identifying Interim Countermeasures

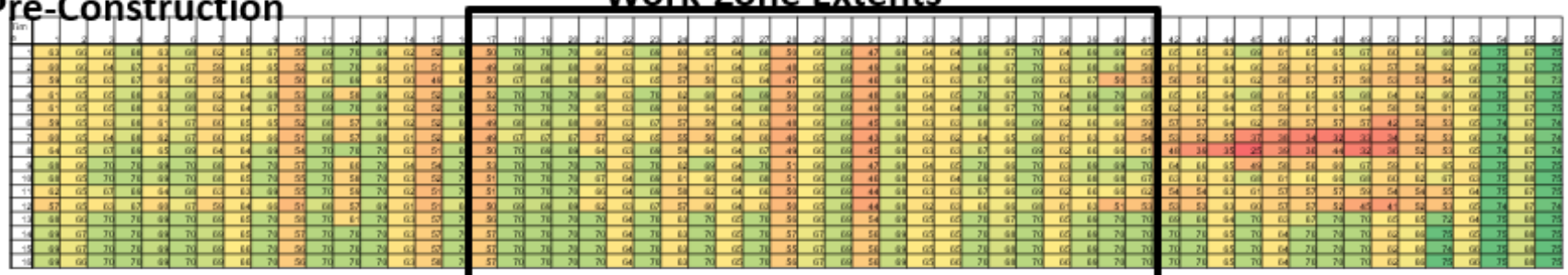
Case Study 1:
Impacts from Major Freeway Work Zone



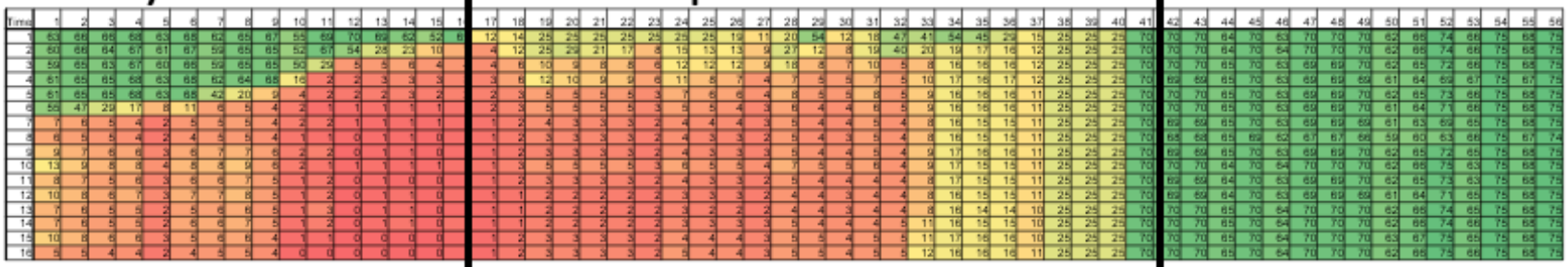




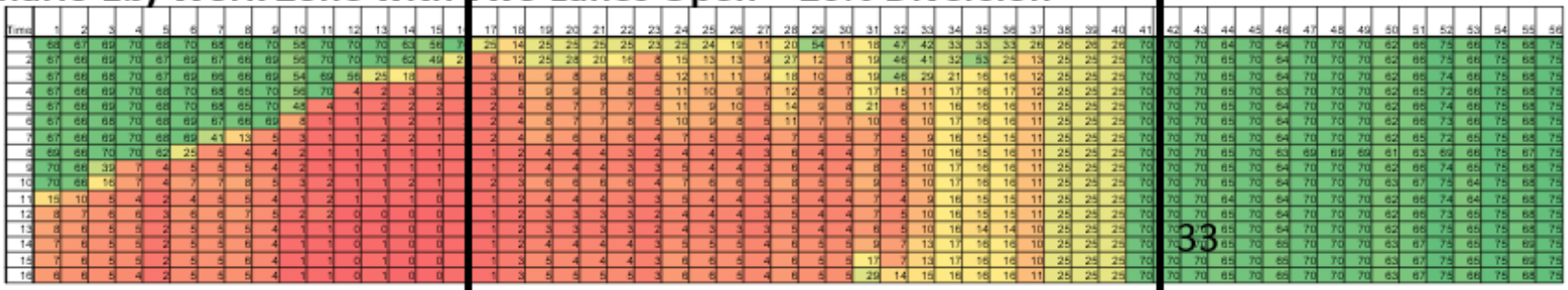
0) Pre-Construction



Scenario 1a) Work Zone with Two Lanes Open – No Diversion

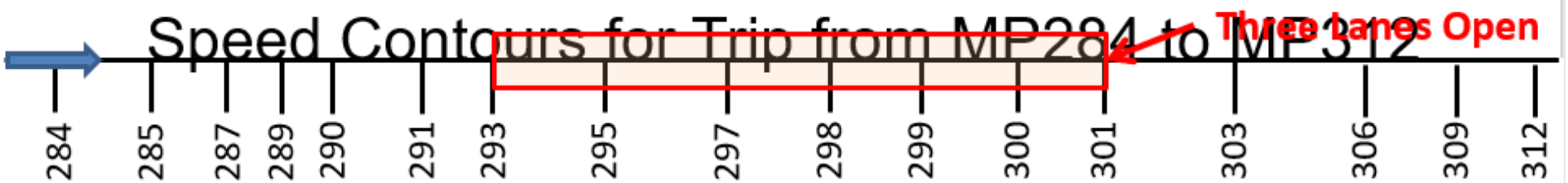


Scenario 1b) Work Zone with Two Lanes Open – 20% Diversion



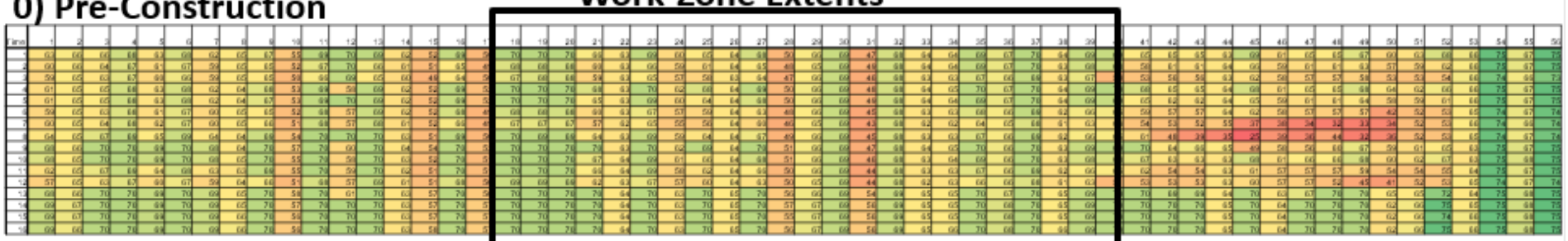
PM Peak I-40 Eastbound – Three - Lane Pattern

Speed Contours for Trip from MP284 to MP312

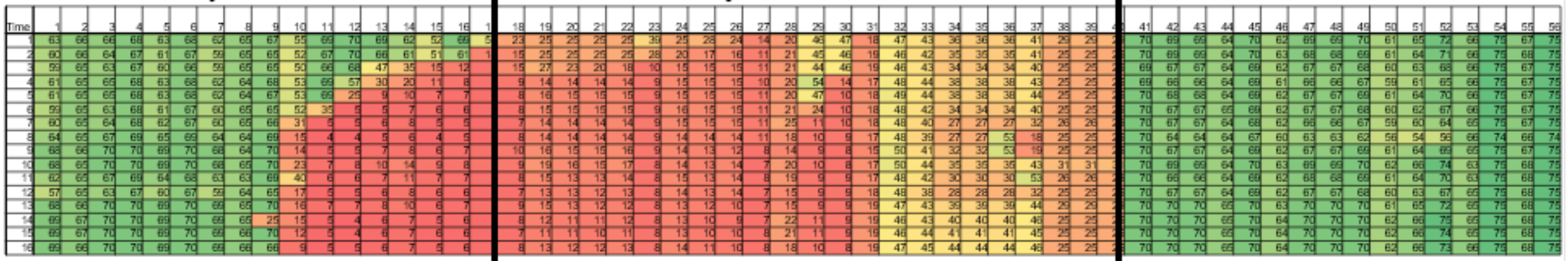


Work-Zone Extents

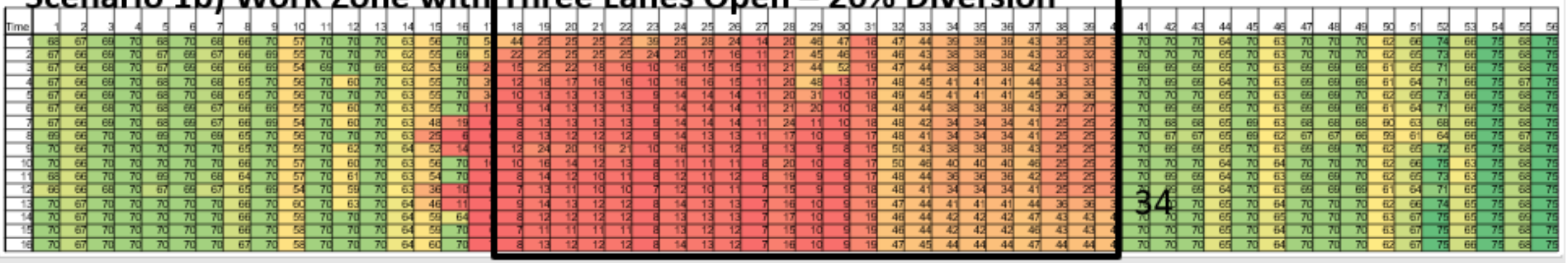
0) Pre-Construction



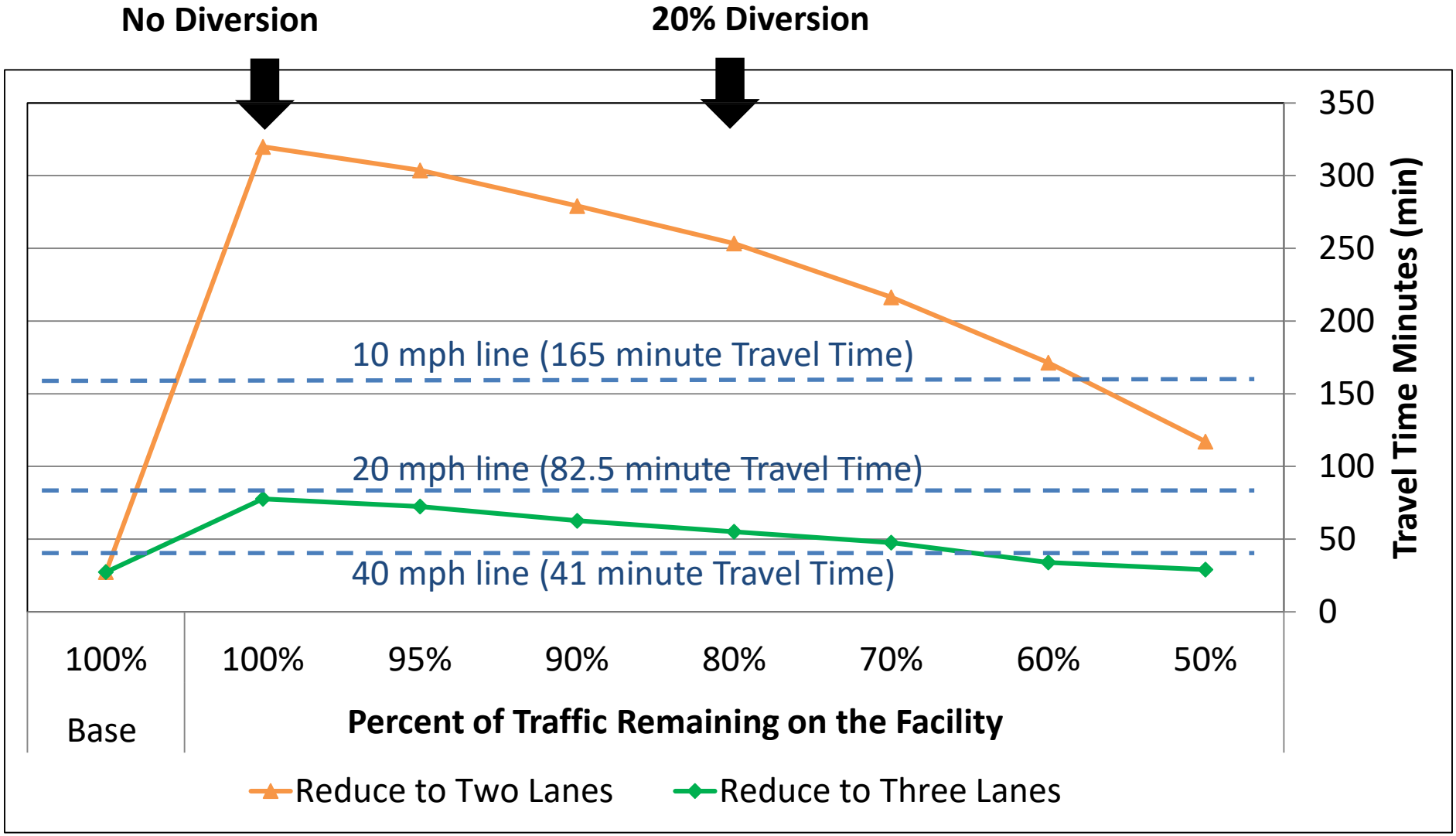
Scenario 1a) Work Zone with Three Lanes Open – No Diversion



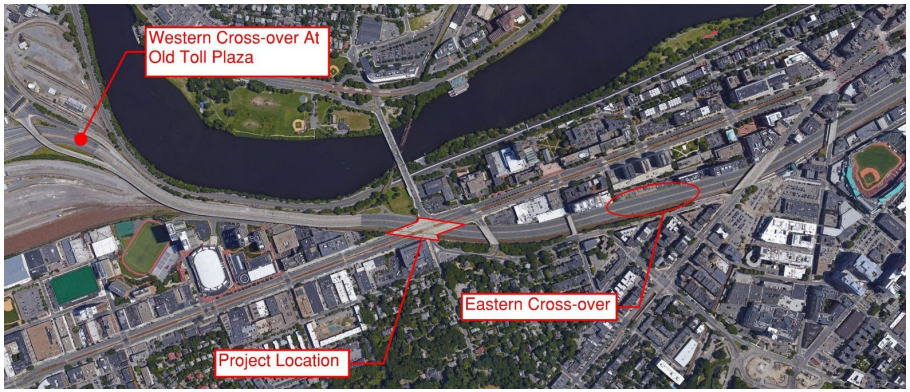
Scenario 1b) Work Zone with Three Lanes Open – 20% Diversion

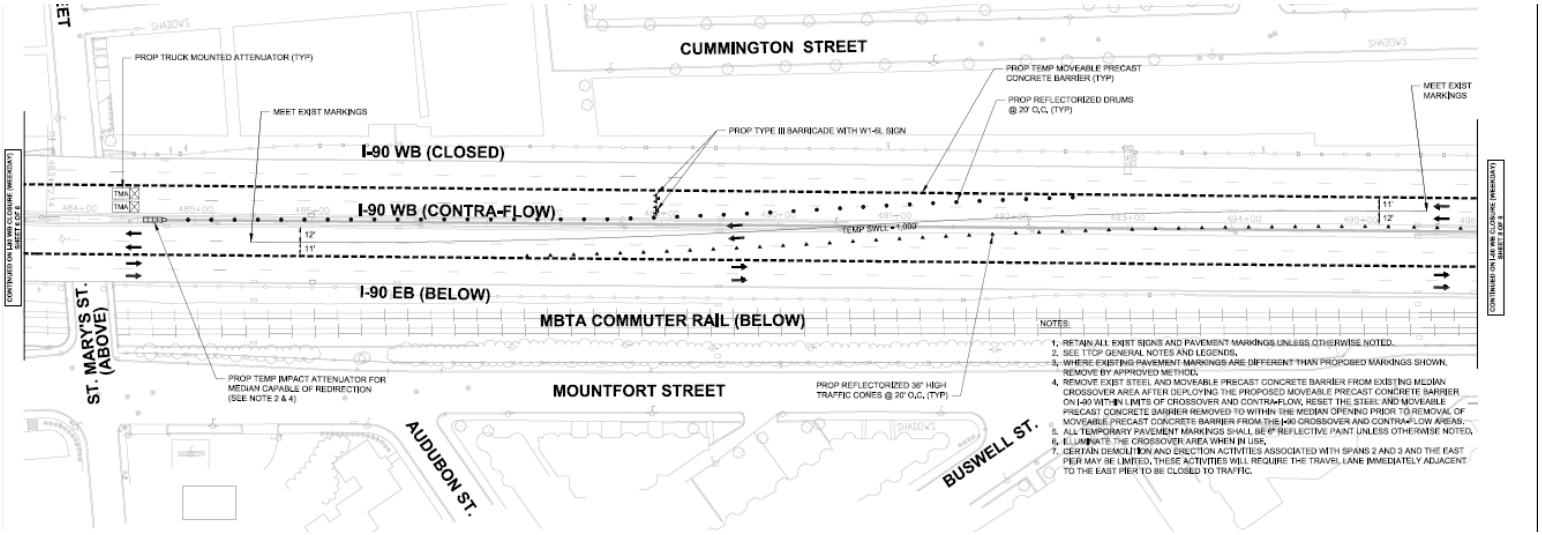


PM Peak Travel Time Estimate - I-40 Eastbound

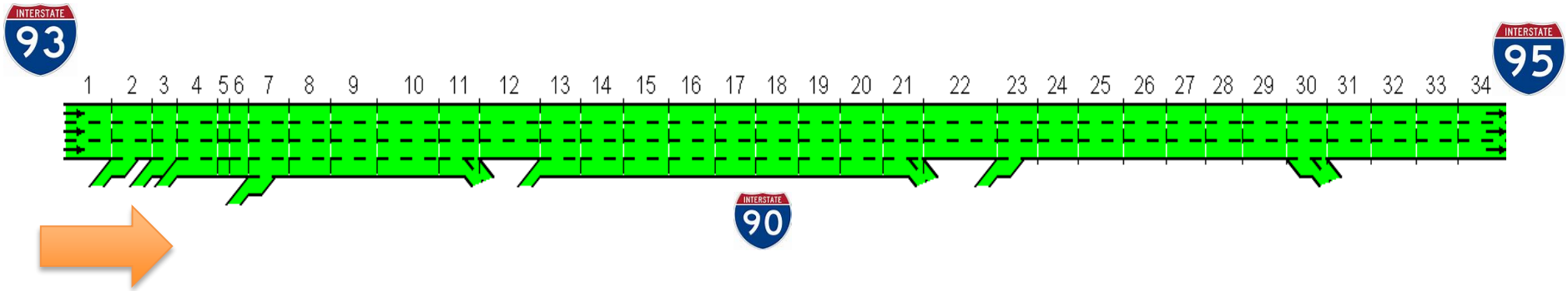


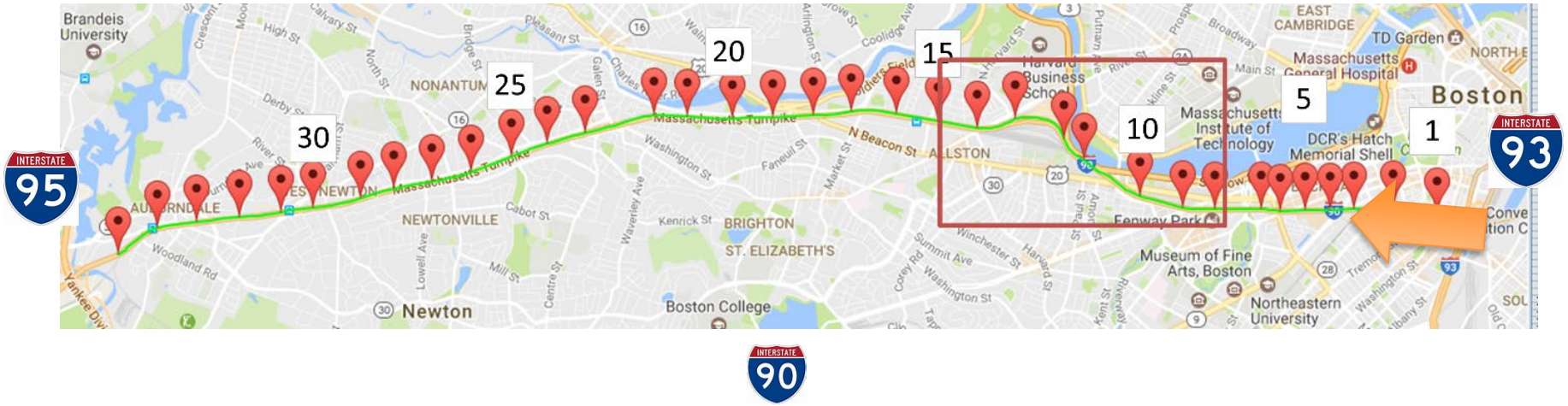
Case Study 2 - Calibration





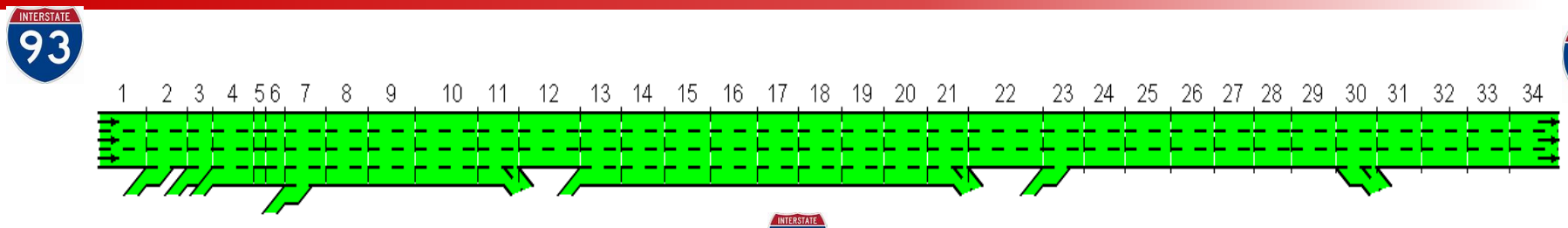
I-90 Westbound Facility

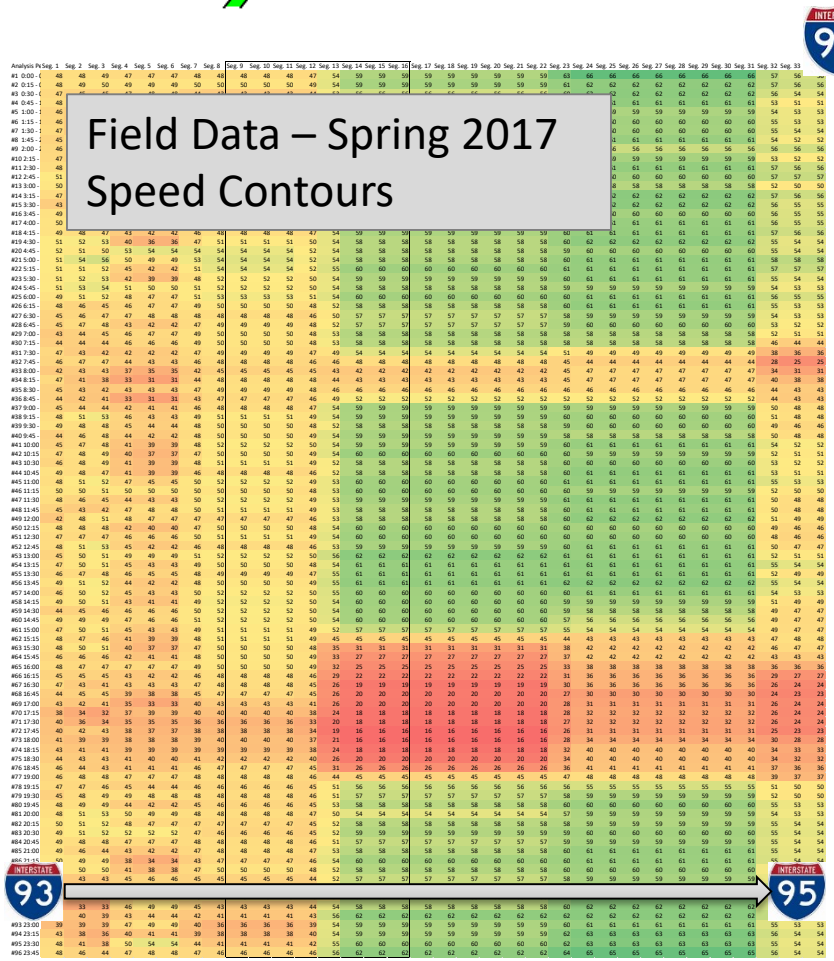




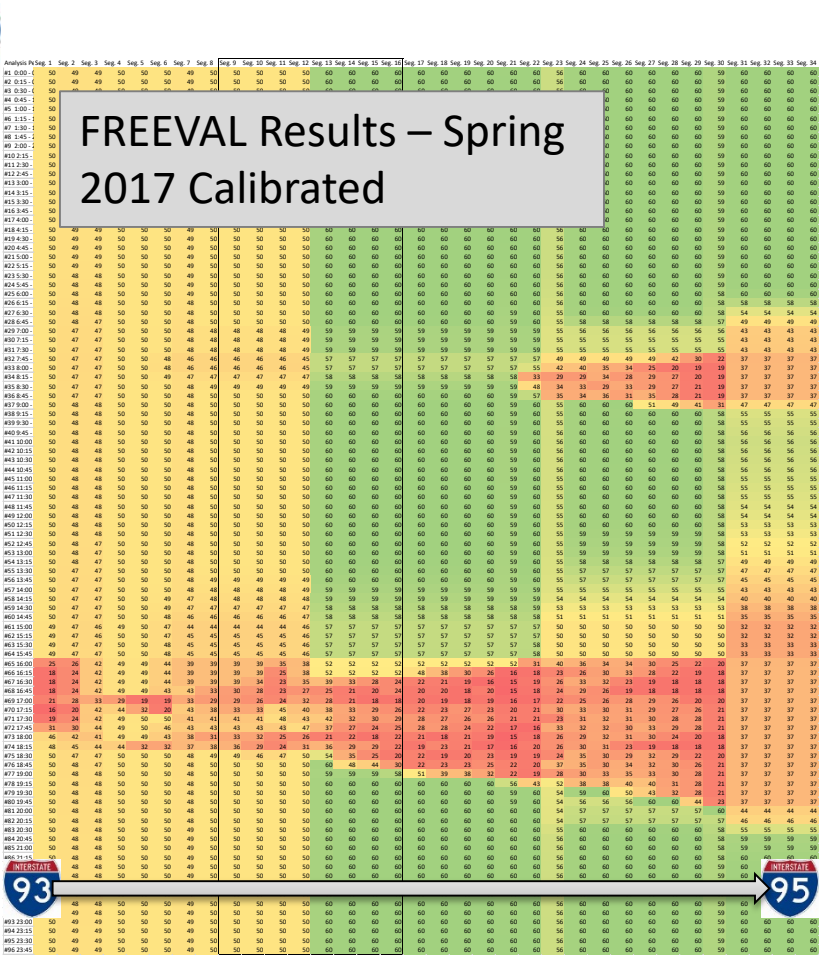
FREEVAL Calibration Approach

- Calibrate Free-Flow Speeds (Off-Peak)
- Calibrate Bottleneck Capacities (Peak Congestion)
- Calibrate Peak Demand Profiles (Demand vs. Volume Served)



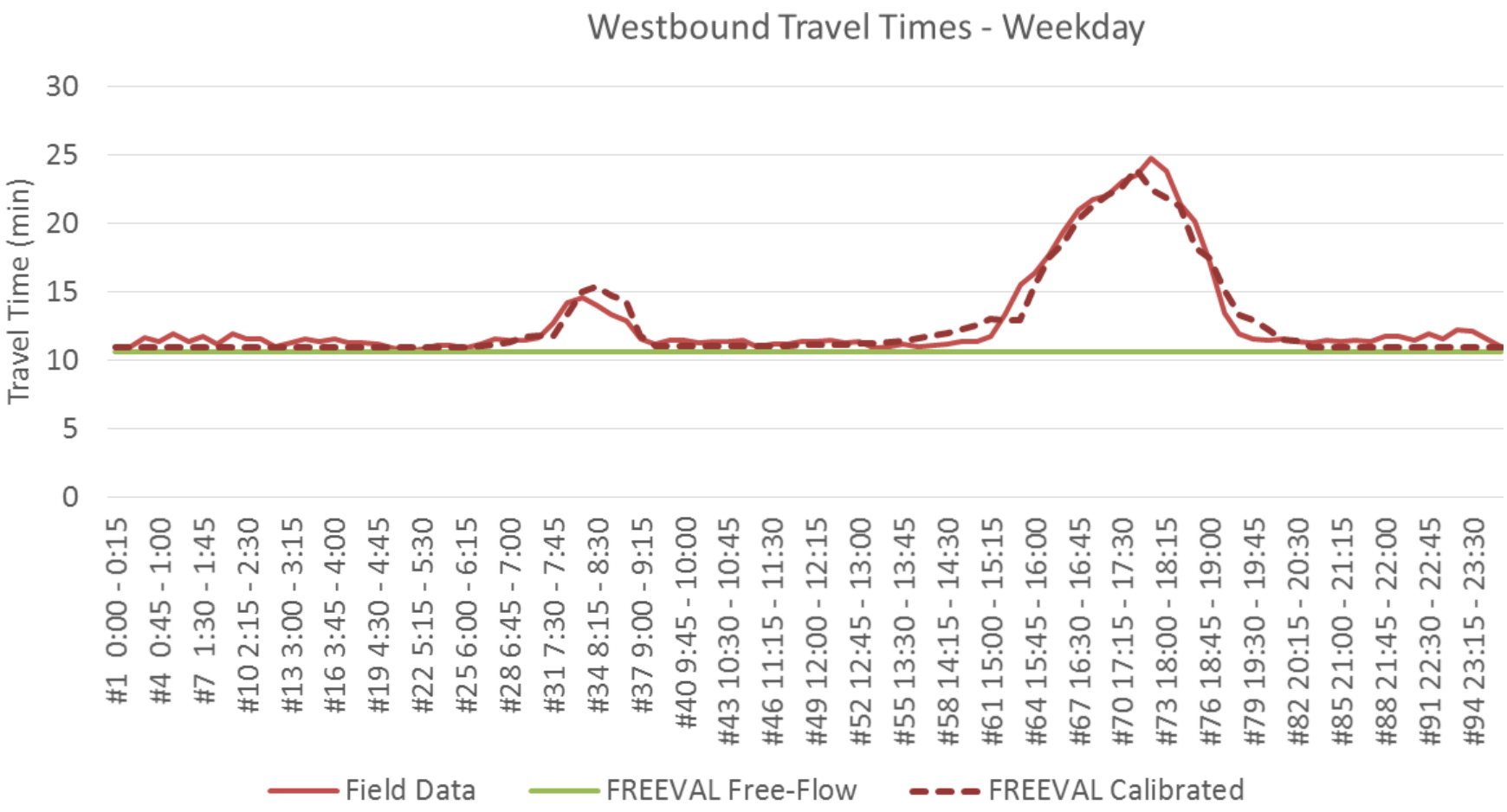


Field Data – Spring 2017 Speed Contours



FREEVAL Results – Spring 2017 Calibrated

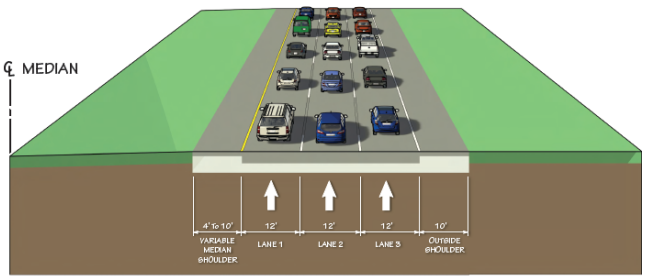
Westbound Calibration – Travel Times



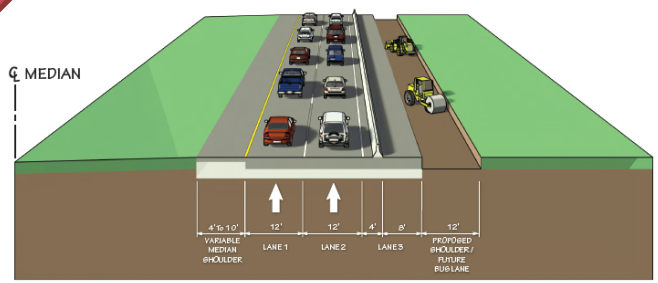
Case Study 3 – Lane Closure Schedules

3 to 2

- 56%



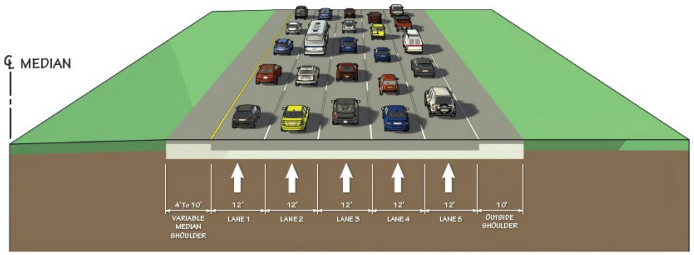
EXISTING
EXISTING PATTERN



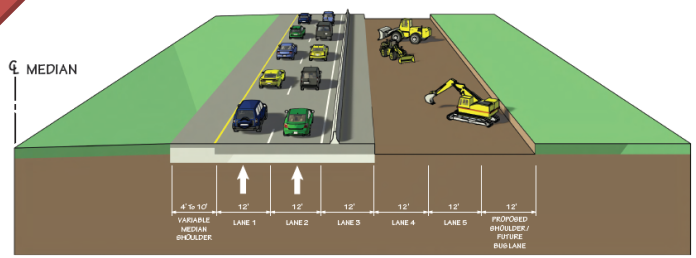
PHASE I
CONSTRUCT 12' PROPOSED OUTSIDE SHOULDER

5 to 2

- 73%



EXISTING
LANE 1 RESURFACING



PHASE I
CONSTRUCT LANE 4, LANE 5, AND PROPOSED OUTSIDE SHOULDER

Night-Time Lane Closure Schedule

Analysis Period	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 9	Seg. 10	Seg. 11	Seg. 12	Seg. 13	Seg. 14	Seg. 15	Seg. 16	Seg. 17	Seg. 18	Seg. 19	Seg. 20	Seg. 21	Seg. 22	Seg. 23	Seg. 24	Seg. 25	Seg. 26	Seg. 27	Seg. 28	Seg. 29	Seg. 30	Seg. 31	Seg. 32	Seg. 33	Seg. 34
#1 14:00 - 14:15	70	65	65	69	63	63	63	68	69	63	70	63	69	63	70	65	70	70	70	69	70	65	69	69	70	65	65	70	69	70	63	62	61	62
#2 14:15 - 14:30	69	65	65	69	63	63	63	68	69	63	70	63	69	63	70	65	69	70	70	68	70	65	69	68	70	65	65	70	68	70	63	60	60	60
#3 14:30 - 14:45	69	65	65	69	63	62	62	68	69	63	70	63	68	63	70	65	69	70	70	68	70	65	69	68	70	65	65	70	68	70	63	57	60	57
#4 14:45 - 15:00	69	65	65	69	62	62	62	68	69	63	70	63	68	63	70	65	69	70	70	68	70	65	69	68	70	65	64	70	68	70	62	55	59	55
#5 15:00 - 15:15	68	65	65	69	62	62	62	68	69	62	70	62	68	62	70	64	69	70	70	68	70	64	69	68	70	64	64	70	68	70	38	58	53	58
#6 15:15 - 15:30	67	65	65	69	62	62	62	68	69	62	70	62	68	62	70	64	69	70	70	68	70	64	69	68	70	64	64	70	68	70	21	58	48	58
#7 15:30 - 15:45	66	65	65	68	62	61	61	67	69	62	70	62	68	62	70	64	69	70	70	68	70	64	69	68	70	64	64	70	68	70	13	58	43	58
#8 15:45 - 16:00	66	65	65	68	62	61	61	67	69	61	70	61	68	61	70	64	69	70	70	68	70	64	69	68	70	64	64	69	68	70	8	58	39	58
#9 16:00 - 16:15	65	65	65	67	61	61	61	67	69	61	70	61	68	61	70	64	69	70	70	68	70	64	69	68	70	64	64	57	33	14	7	58	35	58
#10 16:15 - 16:30	64	64	65	67	61	61	61	67	69	61	70	61	68	61	70	64	69	70	70	68	70	64	69	46	27	20	17	20	14	12	7	58	32	58
#11 16:30 - 16:45	64	64	65	66	61	61	61	67	69	61	70	61	68	61	70	64	69	70	48	33	19	11	9	11	10	11	13	21	15	15	7	58	29	58
#12 16:45 - 17:00	64	64	65	66	61	60	60	67	69	61	70	61	68	61	55	32	23	11	8	9	8	9	10	13	12	13	15	21	15	15	7	58	27	58
#13 17:00 - 17:15	64	64	65	66	61	60	60	67	69	61	69	37	28	12	9	9	8	7	7	11	9	9	10	13	12	13	15	22	15	15	7	58	25	58
#14 17:15 - 17:30	66	65	65	67	62	61	61	66	52	16	10	7	11	10	10	12	10	9	10	14	10	11	11	16	12	11	15	22	15	15	7	58	24	58
#15 17:30 - 17:45	67	65	65	69	54	54	44	44	21	12	13	9	12	10	11	12	8	7	7	10	10	9	10	13	12	13	15	21	16	15	7	58	24	58
#16 17:45 - 18:00	68	65	65	68	45	35	20	20	12	9	11	8	12	9	11	12	11	11	8	11	10	10	11	14	12	13	15	21	16	15	7	58	25	58
#17 18:00 - 18:15	69	65	65	68	49	43	20	20	14	10	12	9	12	10	10	10	7	8	8	14	11	10	11	15	12	12	15	22	16	15	7	58	26	58
#18 18:15 - 18:30	70	65	65	69	63	63	51	51	18	9	10	7	11	11	10	11	9	8	8	12	10	11	12	16	13	14	16	21	17	15	7	58	27	58
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#20 18:45 - 19:00	70	65	65	69	64	64	64	68	70	56	41	39	46	15	11	11	11	10	9	13	12	10	12	16	14	13	17	22	16	15	7	58	32	58
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#22 19:15 - 19:30	70	65	65	69	64	64	64	68	70	65	70	65	69	65	70	66	70	63	31	24	19	13	12	17	14	13	14	22	17	16	7	58	43	58
#23 19:30 - 19:45	70	65	65	69	64	64	64	68	70	65	70	65	69	65	70	66	70	70	70	69	70	66	69	43	30	26	21	25	16	16	7	58	51	58
#24 19:45 - 20:00	70	65	65	69	64	64	64	68	70	66	70	66	69	66	70	66	70	70	70	69	70	66	69	69	70	66	66	70	37	28	7	58	65	58
#25 20:00 - 20:15	70	65	65	69	64	64	64	68	70	66	70	66	69	66	70	66	70	70	70	69	70	66	69	69	70	66	66	70	69	70	18	58	70	58
#26 20:15 - 20:30	70	65	65	69	64	64	64	68	70	66	70	66	69	66	70	66	70	70	70	69	70	66	69	69	70	66	66	70	69	70	68	70	67	70
#27 20:30 - 20:45	70	65	65	69	64	64	64	68	70	66	70	66	69	66	70	66	70	70	70	69	70	66	69	69	70	66	66	70	69	70	66	70	65	70
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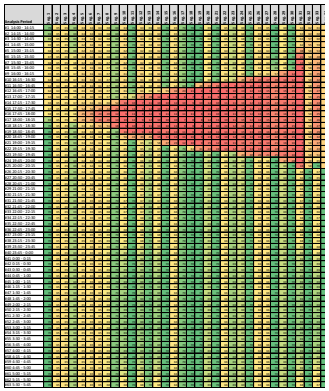
Analysis Segment

Seg. 1 – Seg. 34

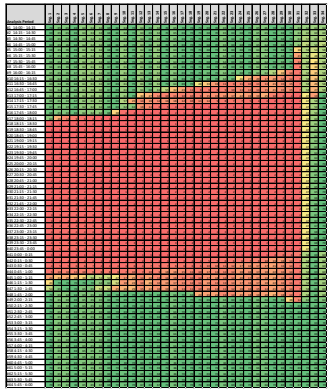
Time

2pm – 6am

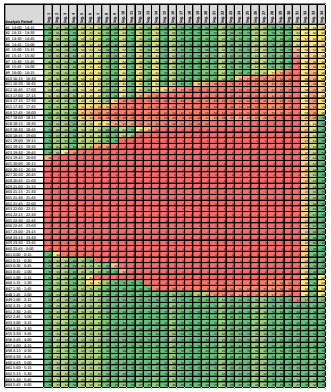
Night-Time Lane Closure Schedule



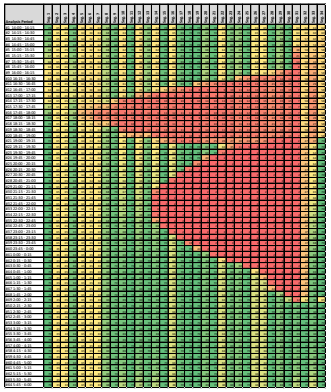
Base Case
(No Work Zone)



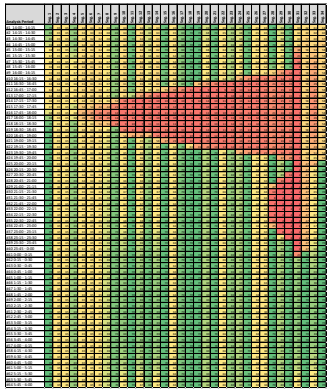
5:00 pm Lane Closure



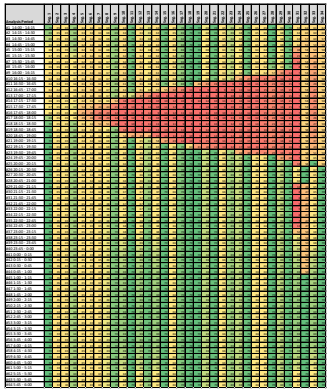
6:00 pm Lane Closure



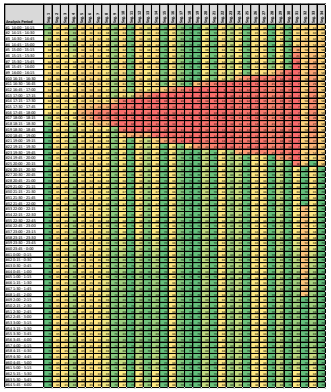
7:00 pm Lane Closure



8:00 pm Lane Closure



9:00 pm Lane Closure

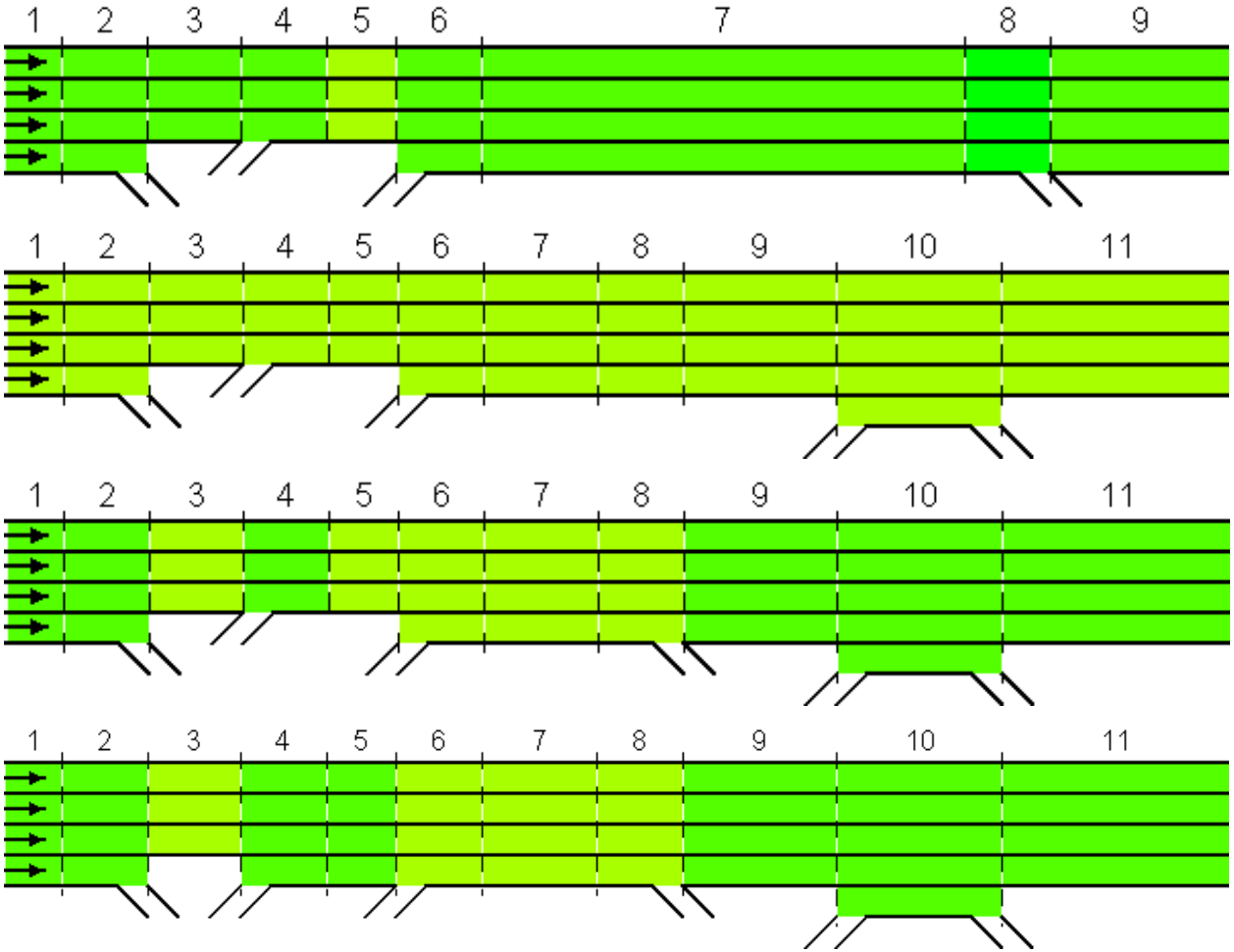


10:00 pm Lane Closure

Case Study 4: Interchange Evaluation

- 4-Mile Freeway Facility
- Evaluation Done as Part of an Interchange Evaluation
- FREEVAL Scenarios
  - 2011 No-Build
  - 2020 No-Build
  - 2020 Alternative 1
  - 2020 Alternative 2a
  - 2020 Alternative 2b (Derived after Initial FREEVAL Run!)

Facility Geometry and Scenarios



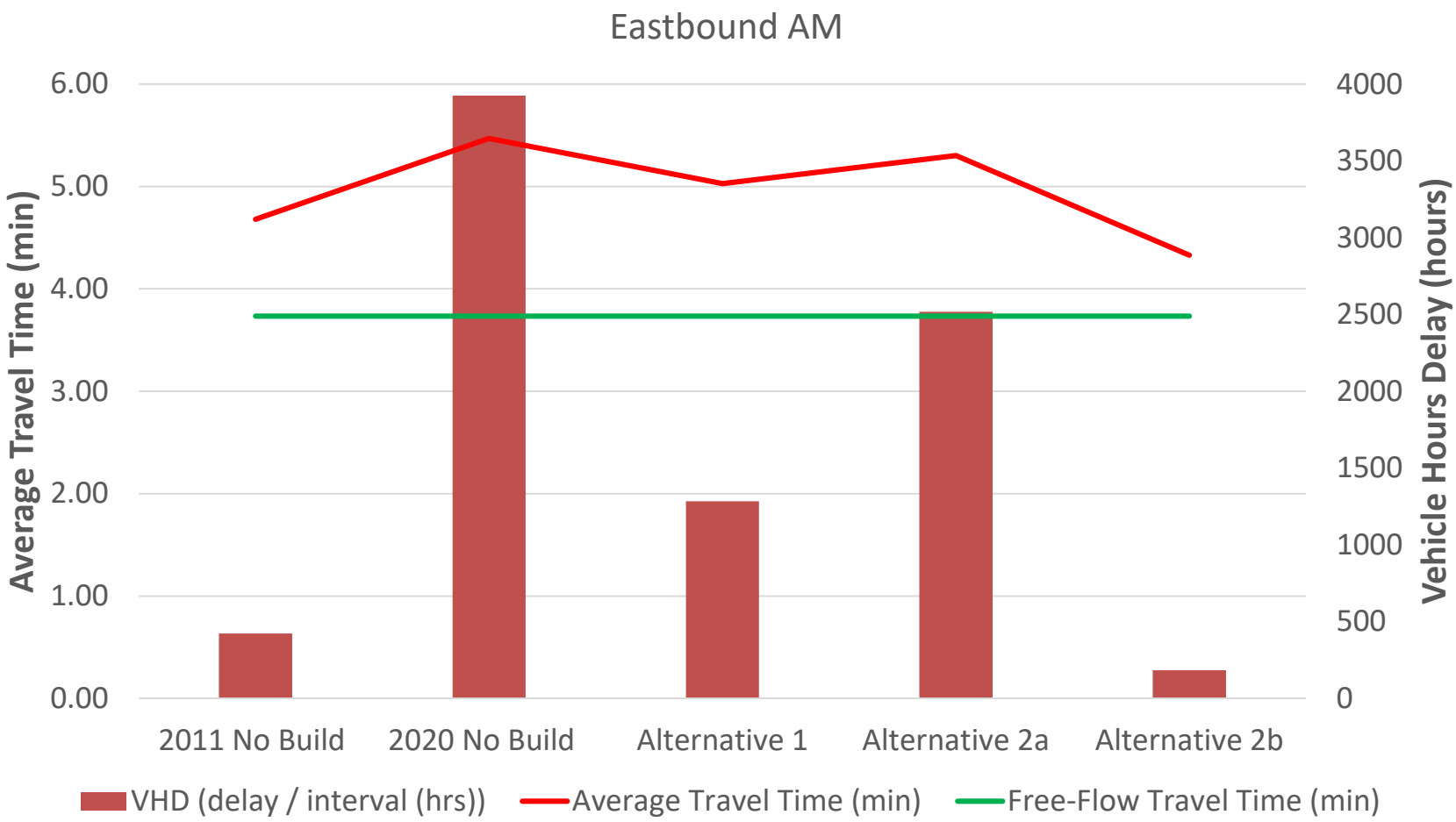
No-Build

Alt. 1

Alt. 2a

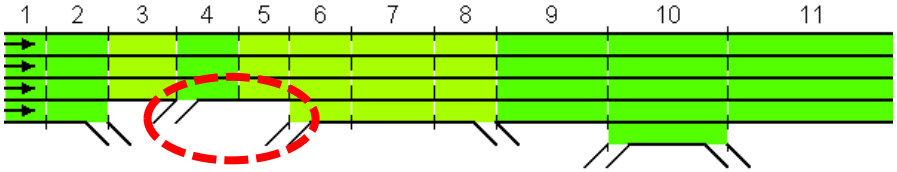
Alt. 2b

Analysis Results



How FREEVAL Helped Arrive at Alternative 2b

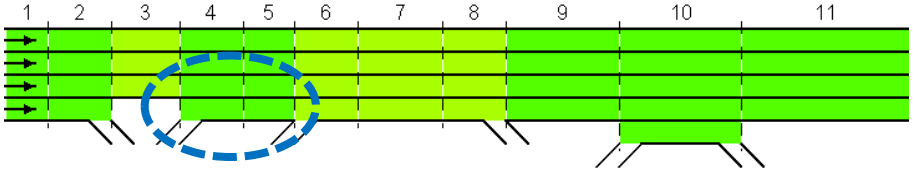
Alt. 2a



Demand to capacity ratio

Analysis Period	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 9	Seg. 10	Seg. 11
#1 6:00 - 6:15	0.49	0.49	0.57	0.64	0.64	0.54	0.54	0.54	0.54	0.56	0.51
#2 6:15 - 6:30	0.52	0.52	0.60	0.67	0.67	0.57	0.57	0.57	0.57	0.59	0.53
#3 6:30 - 6:45	0.52	0.52	0.60	0.67	0.67	0.57	0.57	0.57	0.57	0.59	0.53
#4 6:45 - 7:00	0.54	0.54	0.63	0.70	0.70	0.60	0.60	0.60	0.60	0.62	0.56
#5 7:00 - 7:15	0.72	0.72	0.84	0.93	0.93	0.80	0.80	0.80	0.80	0.82	0.74
#6 7:15 - 7:30	0.76	0.76	0.88	0.98	0.98	0.84	0.84	0.84	0.84	0.87	0.78
#7 7:30 - 7:45	0.76	0.76	0.88	0.98	0.98	0.84	0.84	0.84	0.84	0.87	0.78
#8 7:45 - 8:00	0.80	0.80	0.93	1.03	1.03	0.88	0.88	0.88	0.88	0.91	0.82
#9 8:00 - 8:15	0.82	0.82	0.96	1.06	1.06	0.91	0.91	0.91	0.91	0.94	0.85
#10 8:15 - 8:30	0.78	0.78	0.91	1.01	1.01	0.87	0.87	0.87	0.87	0.89	0.81
#11 8:30 - 8:45	0.78	0.78	0.91	1.01	1.01	0.87	0.87	0.87	0.87	0.89	0.81
#12 8:45 - 9:00	0.74	0.74	0.87	0.96	0.96	0.82	0.82	0.82	0.82	0.85	0.77

Alt. 2b



Demand to capacity ratio

Analysis Period	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 9	Seg. 10	Seg. 11
#1 6:00 - 6:15	0.49	0.49	0.60	0.49	0.49	0.56	0.56	0.56	0.49	0.50	0.51
#2 6:15 - 6:30	0.52	0.52	0.63	0.52	0.52	0.59	0.59	0.59	0.51	0.53	0.53
#3 6:30 - 6:45	0.52	0.52	0.63	0.52	0.52	0.59	0.59	0.59	0.51	0.53	0.53
#4 6:45 - 7:00	0.54	0.54	0.66	0.55	0.55	0.62	0.62	0.62	0.54	0.56	0.56
#5 7:00 - 7:15	0.72	0.72	0.87	0.72	0.72	0.82	0.82	0.82	0.71	0.73	0.74
#6 7:15 - 7:30	0.76	0.76	0.92	0.76	0.76	0.86	0.86	0.86	0.75	0.77	0.78
#7 7:30 - 7:45	0.76	0.76	0.92	0.76	0.76	0.86	0.86	0.86	0.75	0.77	0.78
#8 7:45 - 8:00	0.80	0.80	0.97	0.80	0.80	0.91	0.91	0.91	0.79	0.81	0.82
#9 8:00 - 8:15	0.82	0.82	1.00	0.83	0.83	0.94	0.94	0.94	0.82	0.84	0.85
#10 8:15 - 8:30	0.78	0.78	0.94	0.78	0.78	0.89	0.89	0.89	0.78	0.80	0.81
#11 8:30 - 8:45	0.78	0.78	0.95	0.78	0.78	0.89	0.89	0.89	0.78	0.80	0.81
#12 8:45 - 9:00	0.74	0.74	0.90	0.75	0.75	0.85	0.85	0.85	0.74	0.76	0.77

SESSION #2

How to Create a Single-Day Analysis in FREEVAL-NC

Class Outline

Time	Topic		Session Type
9:00a - 9:15a	Welcome, Introductions, Agenda, Learning Outcomes		Discussion
9:15a – 9:45a	Session #1	Introduction to the Single-Day Freeway Analysis, including work zone effects	Lecture
9:45a – 10:30a	**Session #2**	**How to Perform a Single Day Analysis in FREEVAL-NC**	**Demo/Hands-on**
10:30a – 10:45a	Break		
10:45a – noon	Session #3	How to Create, Review, Revise and Interpret FREEVAL-NC Single Day Analyses Results	Hands-on
noon – 1:30p	Lunch Break (Lunch not provided)		
1:30p - 2:00p	Session #4	Introduction to Freeway Reliability Analysis	Lecture
2:00p - 2:45p	Session #5	How to Perform a Reliability analysis in FREEVAL-NC	Demo/Hands-on
2:45p - 3:00p	Break		
3:00p - 3:45p	Session #6	How to Create, Review, Revise, and Interpret FREEVAL-NC Reliability Analyses Results	Hands-on
3:45p – 4:00p	Questions and Closing Discussions		Discussion

Demo Examples

- **Demo Outline:**
  - Create FREEVAL-NC analysis (Segmentation DB & Map Based)
  - Enter/Alter demand data
  - Model work zone, incident, and severe weather conditions
  - Model Active Traffic Management Strategy (HSR, RM, etc.)
  - Compare operation results of FREEVAL-NC analysis
  - Create PDF report

- **Participants are encouraged to follow the demo examples on their computers!**

SESSION #3

How to Review, Revise, and Interpret FREEVAL-NC Single-Day Analysis Results

Class Outline

Time	Topic		Session Type
9:00a - 9:15a	Welcome, Introductions, Agenda, Learning Outcomes		Discussion
9:15a – 9:45a	Session #1	Introduction to the Single-Day Freeway Analysis, including work zone effects	Lecture
9:45a – 10:30a	Session #2	How to Perform a Single Day Analysis in FREEVAL-NC	Demo/Hands-on
10:30a – 10:45a	Break		
10:45a – noon	**Session #3**	**How to Create, Review, Revise and Interpret FREEVAL-NC Single Day Analyses Results**	**Hands-on**
noon – 1:30p	Lunch Break (Lunch not provided)		
1:30p - 2:00p	Session #4	Introduction to Freeway Reliability Analysis	Lecture
2:00p - 2:45p	Session #5	How to Perform a Reliability analysis in FREEVAL-NC	Demo/Hands-on
2:45p - 3:00p	Break		
3:00p - 3:45p	Session #6	How to Create, Review, Revise, and Interpret FREEVAL-NC Reliability Analyses Results	Hands-on
3:45p – 4:00p	Questions and Closing Discussions		Discussion

Three Hands-on Examples

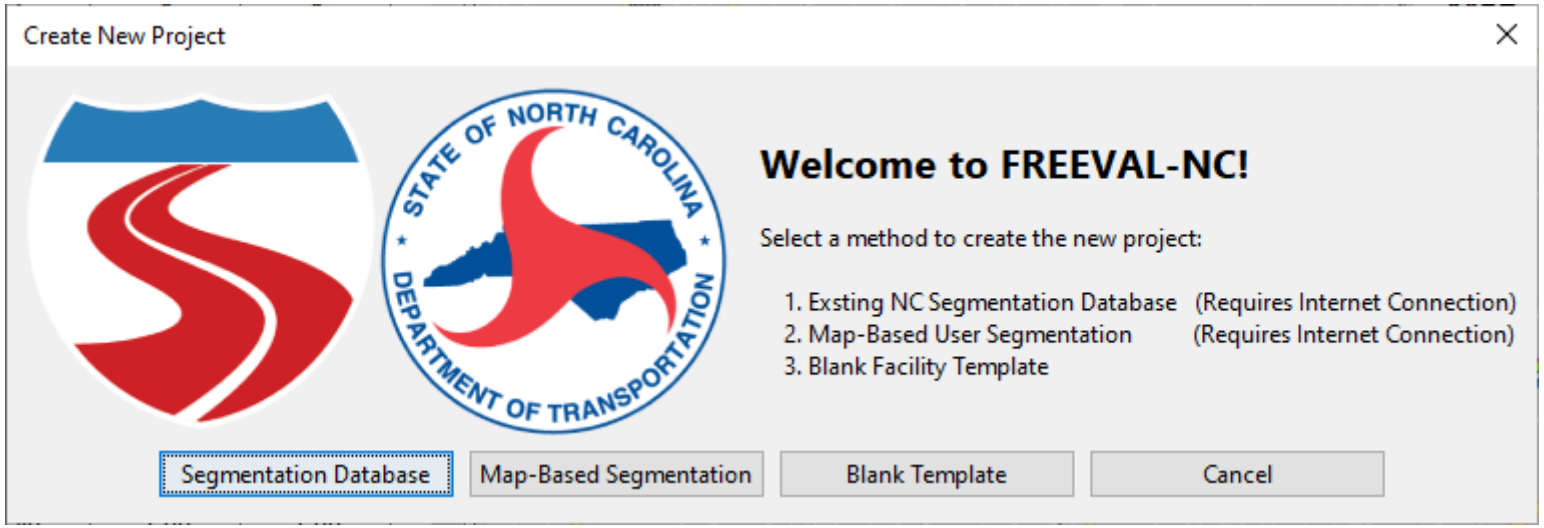
- **Hands-on Example #1**
  - Create FREEVAL-NC analysis from segmentation database
- **Hands-on Example #2**
  - Scenario Analyses
    - Model work zone
    - Model traffic diversion
    - Evaluate the impact of an interchange improvement
- **Hands-on Example #3** *(Time Permitting)*
  - Create FREEVAL-NC analysis from mapping tools.

Hands-on Example #1

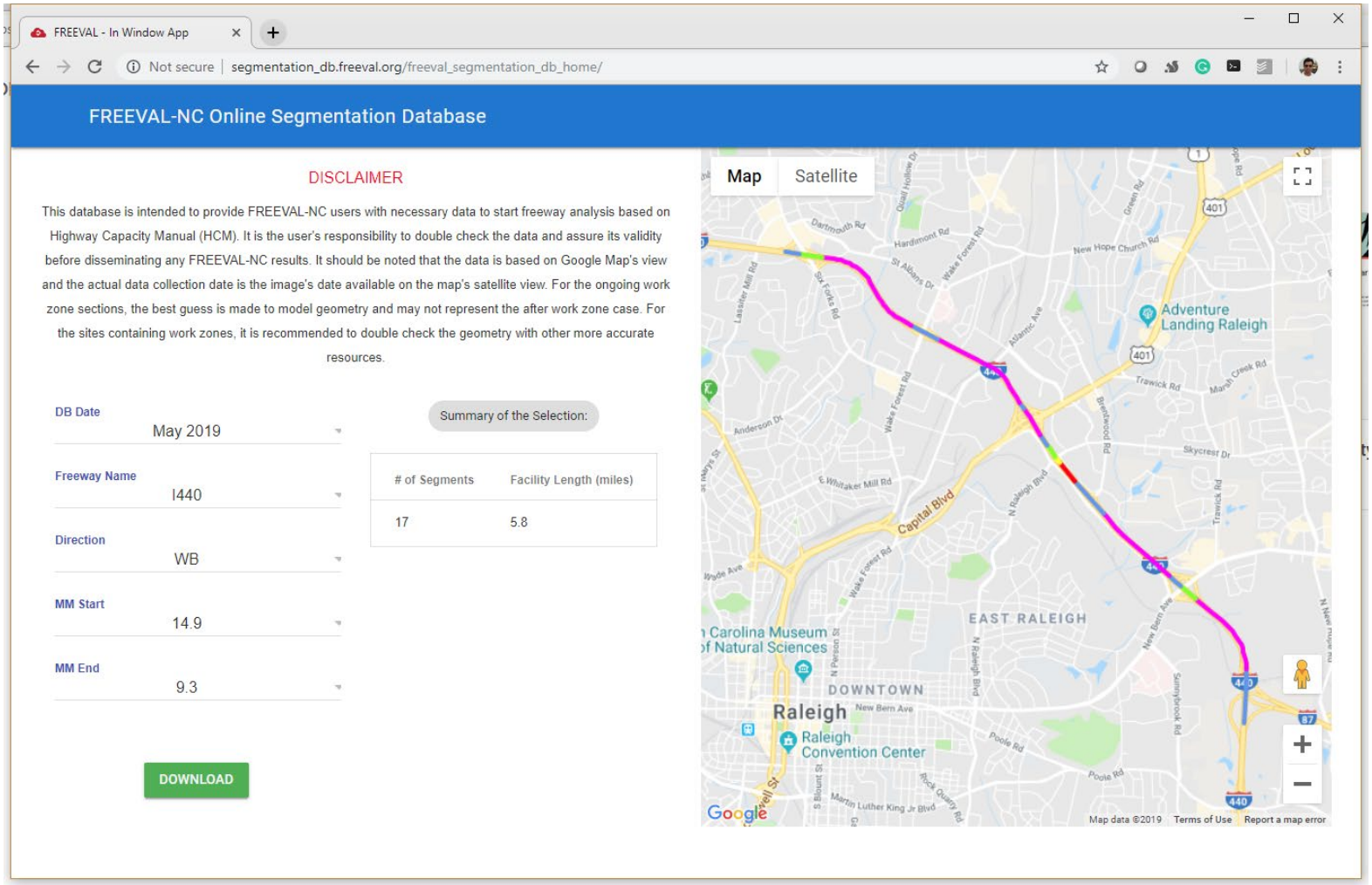
- We want to create FREEVAL analysis for I-440 WB between MM 14.9 and MM 9.3.
  - Use the segmentation database to pull geometric and demand information.
- Set analysis study period to 24 hours.
- Use facility specific hourly demand profile if applicable.
- Check the calibration status based on data provided from one of Probe Data Sources (e.g. HERE.COM, or Google Maps).

Step 1: Create New FREEVAL-NC file

- Click on “Project” menu, then select “New Project”, or click on Ctrl+N
- Then select “Segmentation Database” to access NC freeways segmentation database.



Step 2: Select Your Freeway



Step 3: Confirm Global Information

Project Properties

General Information

Project Name	I440 WB	Number Of HCM Segments	22
Study Period Start Time (hh:mm)	00 00	Study Period End Time (hh:mm)	00 00
Seed Calibartion Date	Nov 6, 2018	Jam Density (pc/mi/ln)	190.0
Capacity Drop due to Breakdown (%)	7	GP Vehicle Occupancy (p/veh)	1.0
Area Type	(●) Urban ( ) Rural		

Analysis Options

- [x] Free Flow Speed Known
- [ ] Managed Lanes Analysis

Fill Global Values

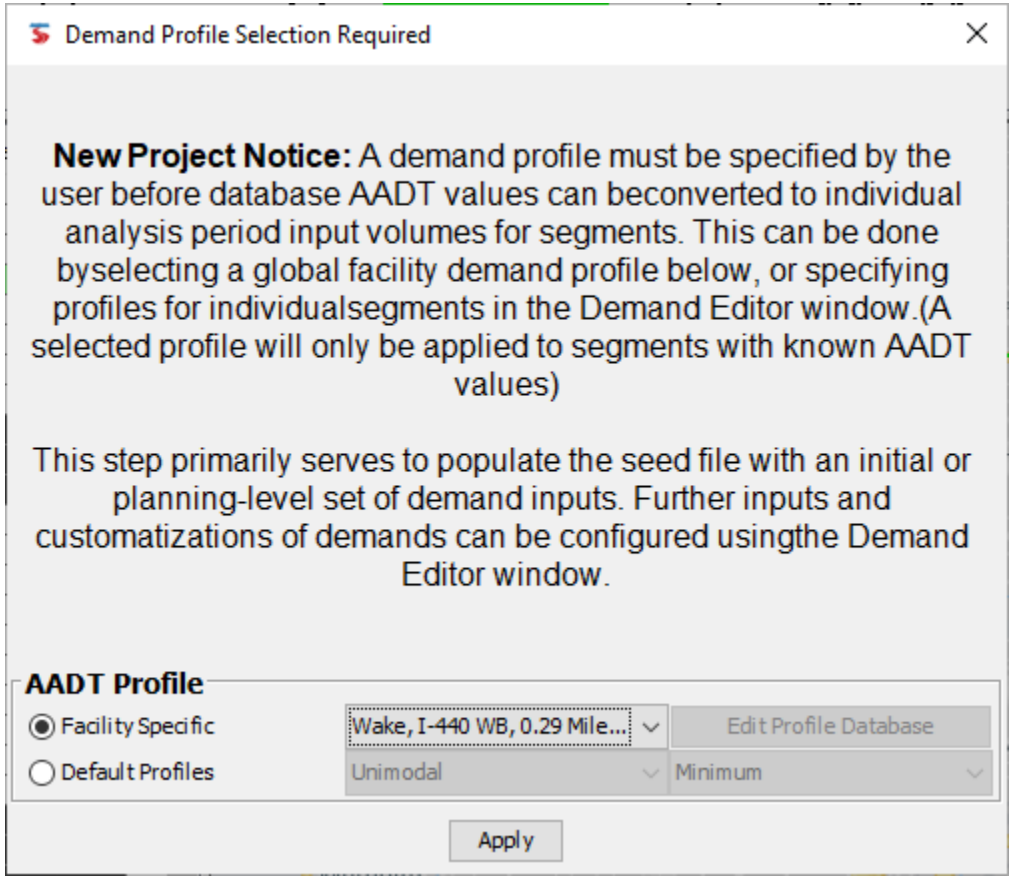
General Purpose Segments

- [ ] General Terrain
- [ ] Current Truck PCE
- Look-up Tables
- [ ] Num Of Mainline Lanes
- [ ] Mainline FFS (mph)
- [ ] Lane Width (ft)
- [ ] Lateral Clearance (ft)
- [ ] Num Of Ramp Lanes
- [ ] Ramp FFS (mph)
- [ ] Ramp Acc/Dec Length (ft)
- [ ] Ramp Metering Rate (veh/h)
- [ ] Single Unit Trucks and Buses (%)
- [ ] Tractor Trailers (%)
- [ ] Driver Population CAF
- [ ] Driver Population SAF

OK Cancel

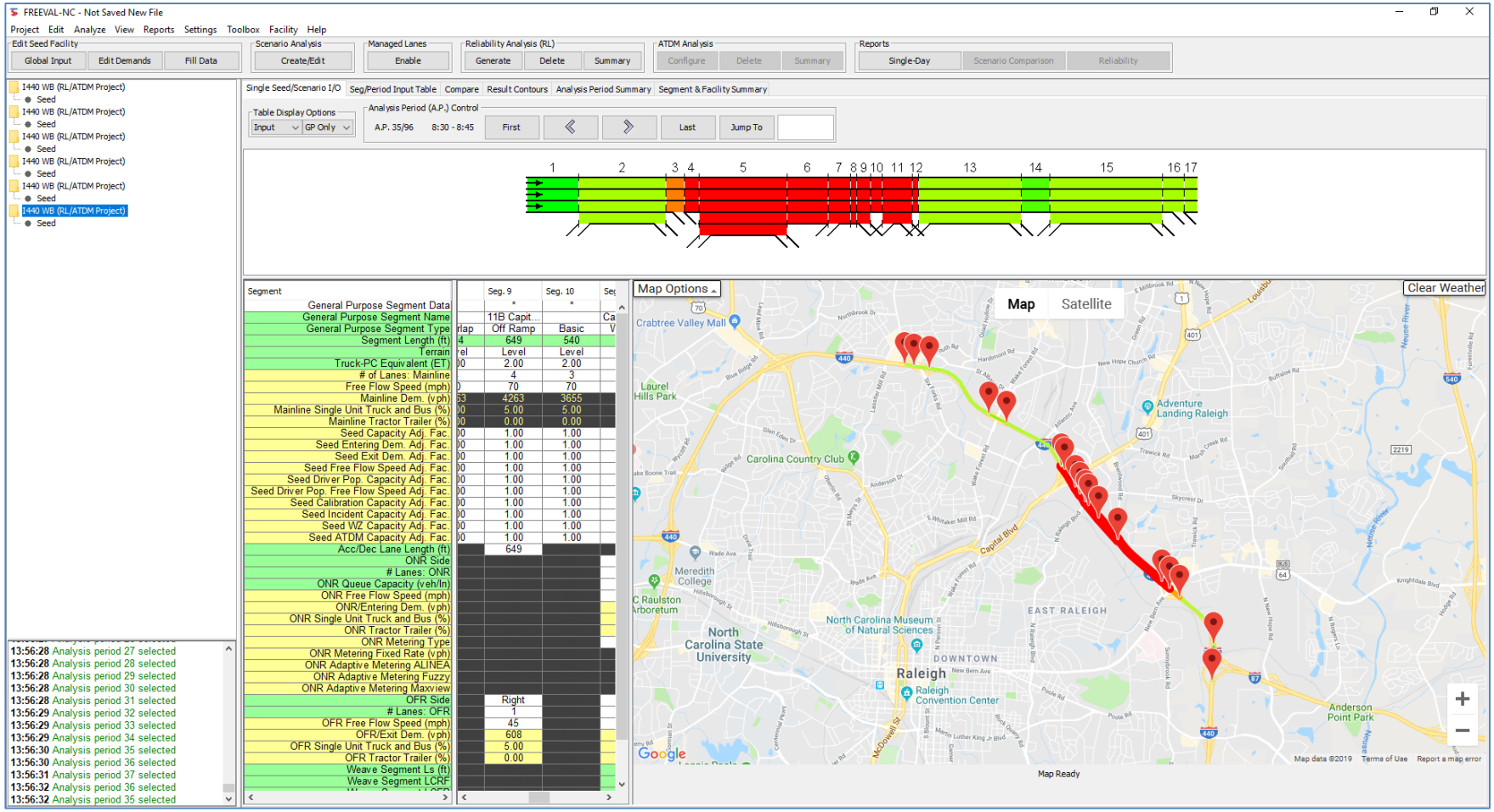
Step 4: Demand Profile Selection

- The demand profile should be selected by the user at the time of creation of the analysis.

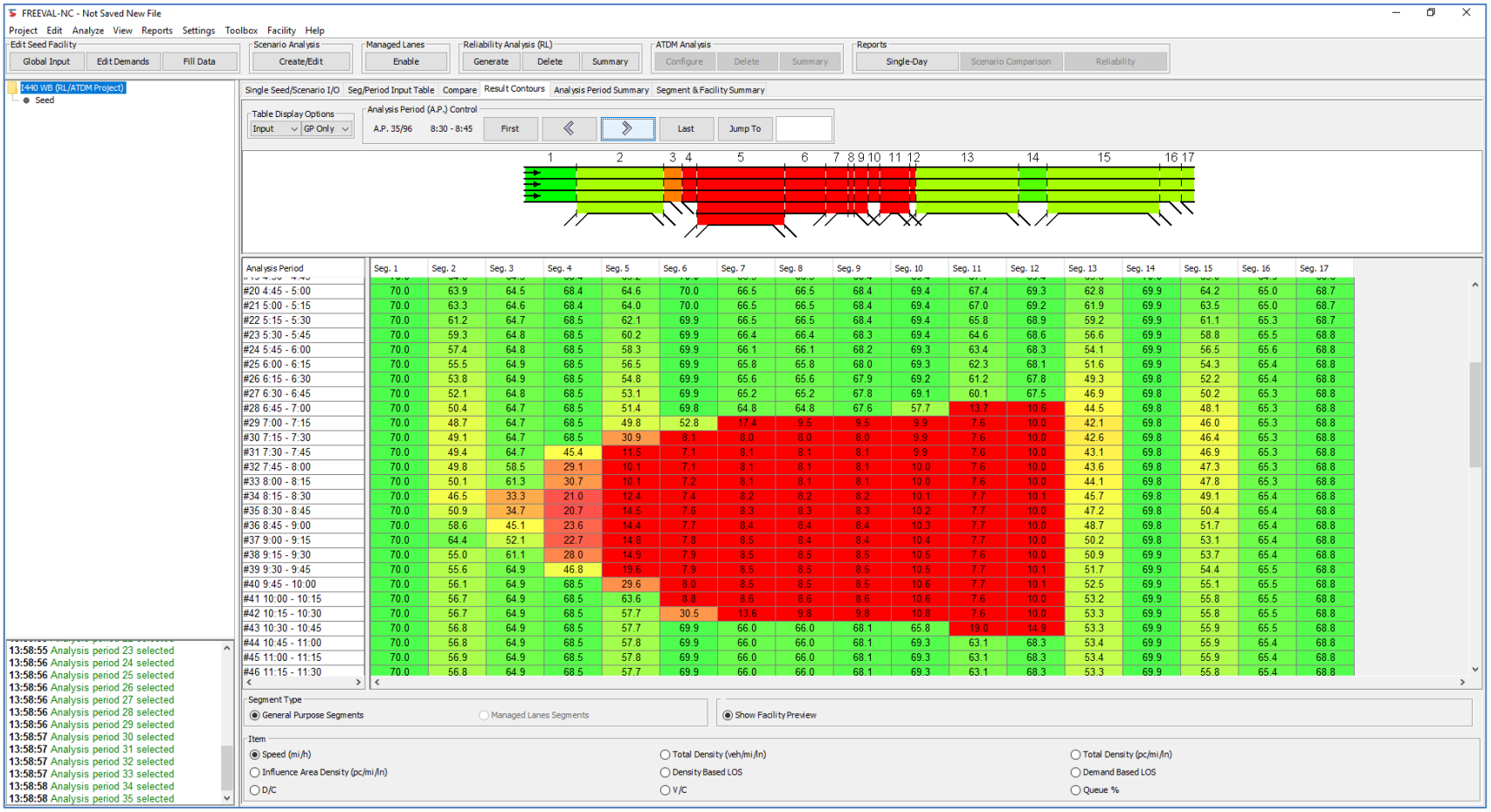


Check for Calibration Needs

Analysis Completed



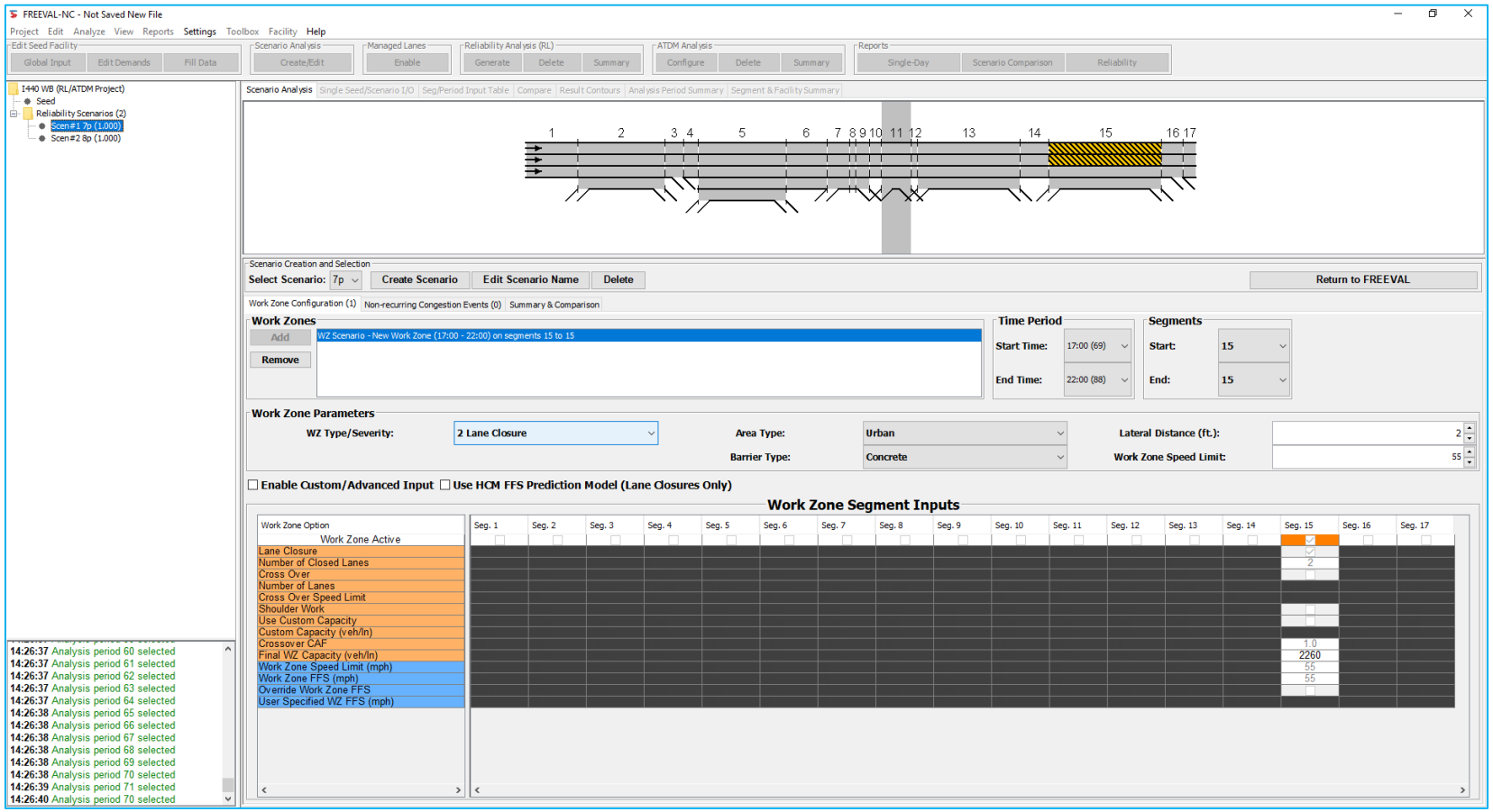
Analysis Completed



Hands-on Example #2

- We would like to model a work zone for Hands-on Example #1 and see how much delay the work zone will impose.
- The work zone will need to close two lanes on segment 15 from 7pm to 10pm. We will model “Concrete” as work zone barrier type.
- Repeat the Example with an hour late work zone start and end time.
- Evaluate how much delay gets imposed by work zone and create a PDF report.

Step 1: Click on Scenario Analysis "Create/Edit" Button, and Create the WZ



Step 2: Use Compare Feature

FREEVAL-NC - Not Saved New File

Project Edit Analyze View Reports Settings Toolbox Facility Help

Edit Seed Facility: Global Input | Edit Demands | Fill Data
Scenario Analysis: Create/Edit
Managed Lanes: Enable
Reliability Analysis (RL): Generate | Delete | Summary
ATDM Analysis: Configure | Delete | Summary
Reports: Single-Day | Scenario Comparison | Reliability

I440 WB (RL/ATDM Project)
- Seed
- Reliability Scenarios (2)
  - Scen#1 7p (1.000)
  - Scen#2 8p (1.000)

Single Seed/Scenario I/O | Seg/Period Input Table | Compare | Result Contours | Analysis Period Summary | Segment & Facility Summary

Scenarios
I440 WB - Reliability Scenario #2 [added at 14:25:31]
I440 WB - Reliability Scenario #1 [added at 14:25:34]
I440 WB - Seed [added at 14:25:39]

Remove Selected
Remove All

	I440 WB - Reliability Scenario #2	I440 WB - Reliability Scenario #1	I440 WB - Seed
Length (mi)	5.85	5.85	5.85
Average Travel Time (min)	8.36	9.08	8.34
VMTD (veh-miles / interval)	316,474	316,474	316,474
VMTV (veh-miles / interval)	316,367	316,367	316,367
PMTD (p-miles / interval)	316,474	316,474	316,474
PMTV (p-miles / interval)	316,367	316,367	316,367
VHT (travel / interval (hrs))	7,527	8,228	7,506
VHD (delay / interval (hrs))	32,818	36,879	32,797
Space Mean Speed (mph)	42.0	38.4	42.2
Reported Density (pc/mi/ln)	14.5	16.0	14.3
Max D/C	1.52	1.52	1.52
Max V/C	1.00	1.00	1.00
Total User Cost ($)	1,671,064.8	1,877,829.9	1,669,993.8

14:26:37 Analysis period 62 selected
14:26:37 Analysis period 63 selected
14:26:37 Analysis period 64 selected
14:26:38 Analysis period 65 selected
14:26:38 Analysis period 66 selected
14:26:38 Analysis period 67 selected
14:26:38 Analysis period 68 selected
14:26:38 Analysis period 69 selected
14:26:38 Analysis period 70 selected
14:26:39 Analysis period 71 selected
14:26:40 Analysis period 70 selected
14:27:44 Default folder location loaded from file

Step 3: Create Report

Create Scenario Comparison Analysis Report

Project and User Information

Analyst Name	Behzad	Project Name	I440 WB	Edit
Scenario Name	WZ - Hands-on Example 1	Facility Name	I440	Edit
		Start Mile Marker	13.8	Edit
Organization Name	ITRE	End Mile Marker	5.5	Edit

Scenario Comparison Report Options

Use the checkboxes to include or exclude desired report options:

User-Specified Scenarios and Work Zones

- [x] Scenario Comparison Summary Table
- [x] Travel Time Comparison Chart
- [x] Scenario Details

Facility Geometry and Inputs

- [x] Facility Map
- [x] Mainline Entering Demand Summary
- [x] Mainline Entering Demand Plot
- [x] Segment Geometry Info Table
- [x] Segment Demand Info Tabe

Output Contours

- [x] Speed
- [x] Density (veh/hr/ln)
- [x] Density (pc/hr/ln)
- [x] Influence Area Density
- [x] Density Based LOS
- [x] Demand Based LOS
- [x] D/C Ratio
- [ ] V/C Ratio
- [x] Queue Percentage

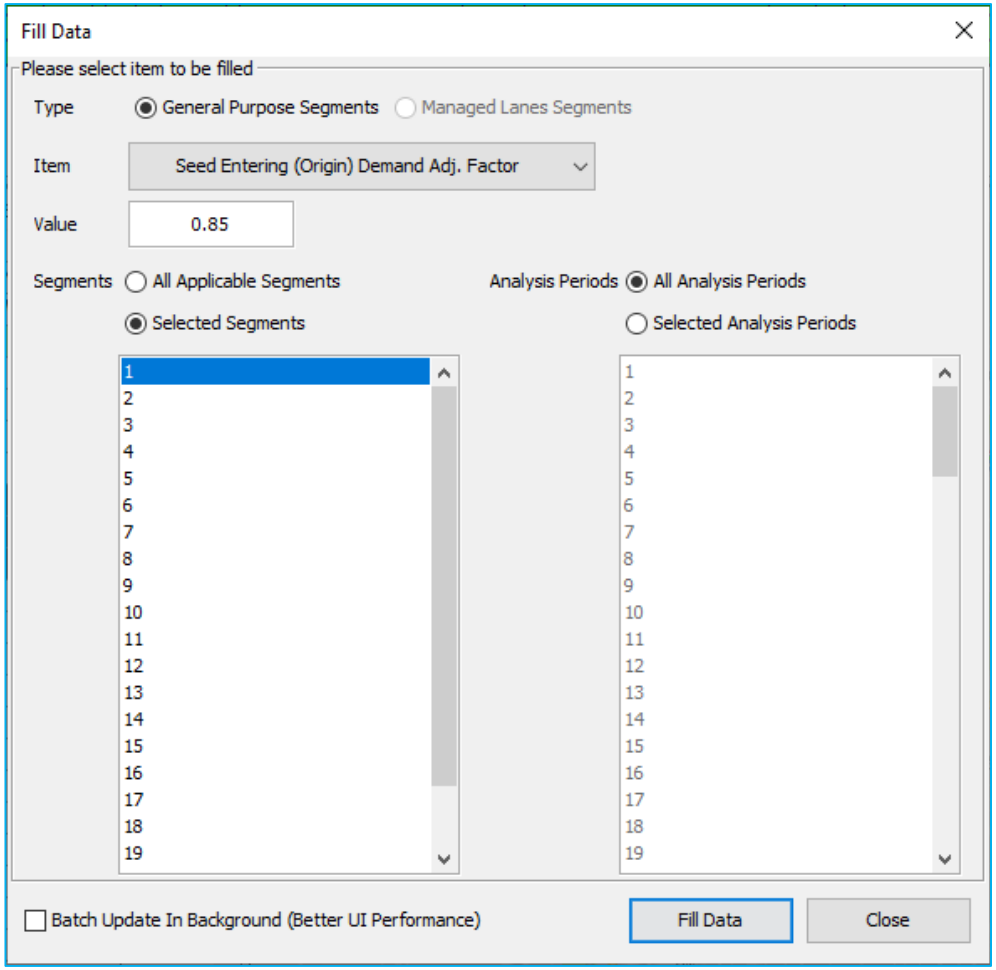
Print Cancel

Hands-on Example #2 (cont.)

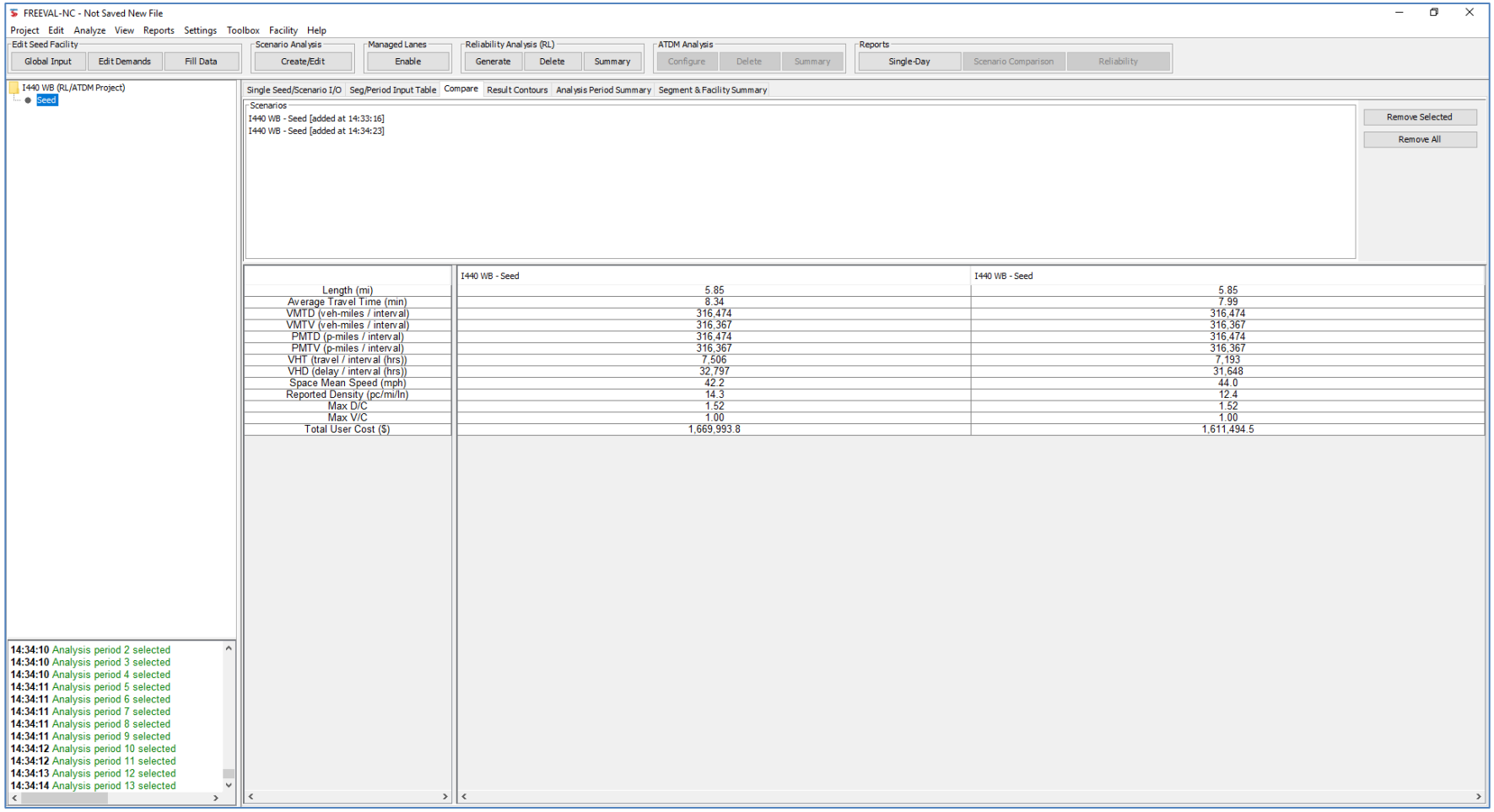
- Model a 15% traffic diversion at the upstream segment. This can be achieved via different means such as VMS (Variable Message Signs).
- Redo the analysis and evaluate the impact of work zone in terms of delay and users costs.

Step 1: Reduce Demand on Segment #1

- Using “Fill Data” feature, you can override any variable that you can see in FREEVAL in a batch mode.
- The change can be set to affect a subset of Analysis Periods as well as Segments.
- Here, we have selected “Entry Demand Adjustment Factor” and set its value to 0.85.



Step 2: Use Compare Feature



	I440 WB - Seed	I440 WB - Seed
Length (mi)	5.85	5.85
Average Travel Time (min)	8.34	7.99
VMTD (veh-miles / interval)	316,474	316,474
VMTV (veh-miles / interval)	316,367	316,367
PMTD (p-miles / interval)	316,474	316,474
PMTV (p-miles / interval)	316,367	316,367
VHT (travel / interval (hrs))	7,506	7,193
VHD (delay / interval (hrs))	32,797	31,648
Space Mean Speed (mph)	42.2	44.0
Reported Density (pc/mi/ln)	14.3	12.4
Max D/C	1.52	1.52
Max V/C	1.00	1.00
Total User Cost ($)	1,669,993.8	1,611,494.5

Step 3: Create Report

Create Scenario Comparison Analysis Report

Project and User Information

Analyst Name	Behzad	Project Name	I440 WB	Edit
Scenario Name	WZ - Hands-on Example 1	Facility Name	I440	Edit
		Start Mile Marker	13.8	Edit
Organization Name	ITRE	End Mile Marker	5.5	Edit

Scenario Comparison Report Options

Use the checkboxes to include or exclude desired report options:

User-Specified Scenarios and Work Zones

- [x] Scenario Comparison Summary Table
- [x] Travel Time Comparison Chart
- [x] Scenario Details

Facility Geometry and Inputs

- [x] Facility Map
- [x] Mainline Entering Demand Summary
- [x] Mainline Entering Demand Plot
- [x] Segment Geometry Info Table
- [x] Segment Demand Info Tabe

Output Contours

- [x] Speed
- [x] Density (veh/hr/ln)
- [x] Density (pc/hr/ln)
- [x] Influence Area Density
- [x] Density Based LOS
- [x] Demand Based LOS
- [x] D/C Ratio
- [ ] V/C Ratio
- [x] Queue Percentage

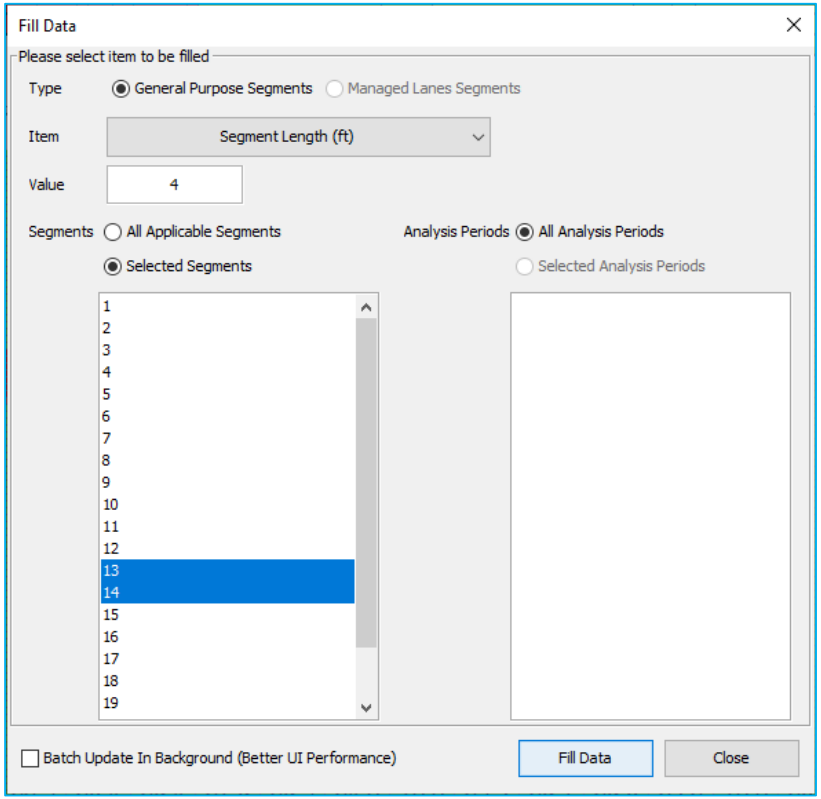
Print Cancel

Hands-on Example #2 (Cont.)

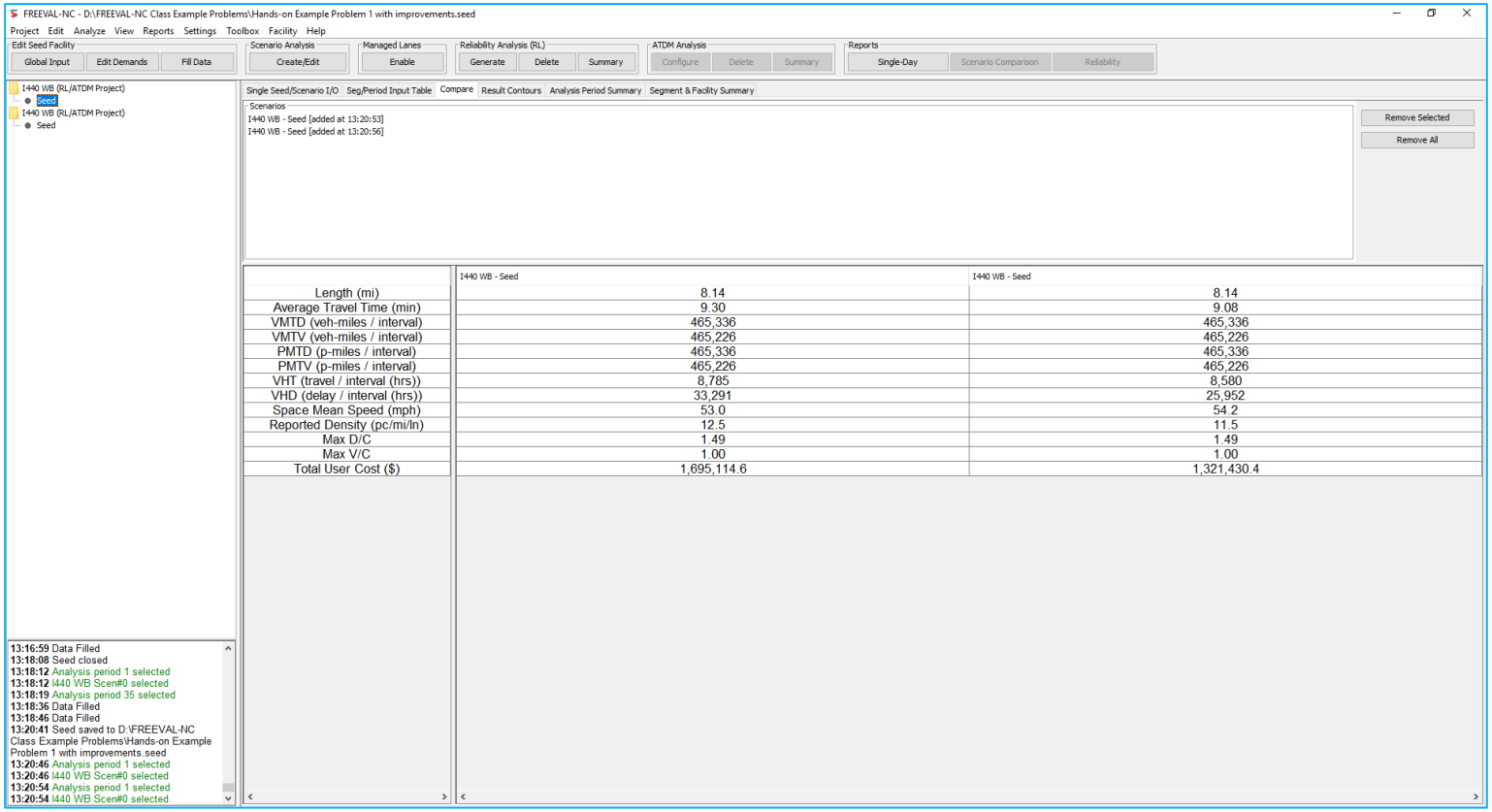
- An interchange improvement is anticipated to improve the operational conditions on this facility. Do not consider the work zone and diversion scenarios.
- This improvement will add one lane to the mainline lanes on Segments #13 through #17.
- Evaluate the impact of this change in terms of users delay costs.

Step 1: Increase the # of Lanes

- Using “Fill Data” feature, you can override any variable that you can see in FREEVAL in a batch mode.
- The change can be set to affect a subset of Analysis Periods as well as Segments.



Step 2: Use Compare Feature



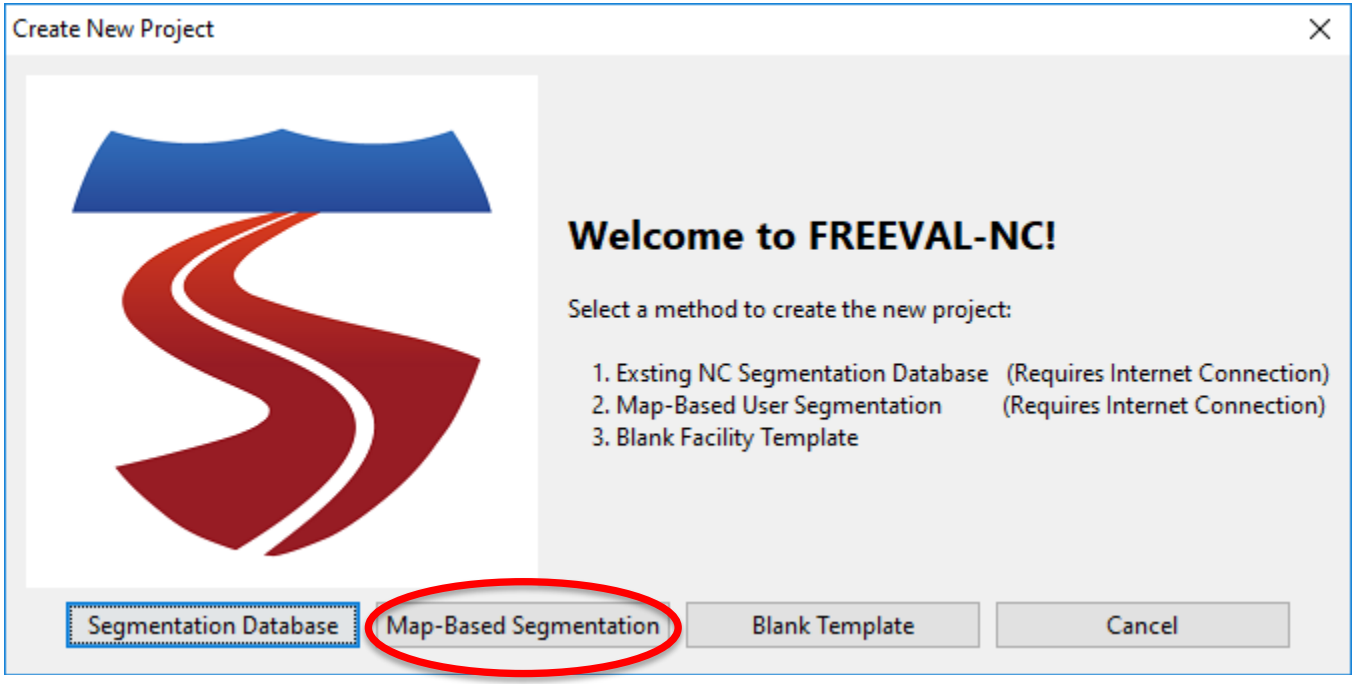
	I440 WB - Seed	I440 WB - Seed
Length (mi)	8.14	8.14
Average Travel Time (min)	9.30	9.08
VMTD (veh-miles / interval)	465,336	465,336
VMTV (veh-miles / interval)	465,226	465,226
PMTD (p-miles / interval)	465,336	465,336
PMTV (p-miles / interval)	465,226	465,226
VHT (travel / interval (hrs))	8,785	8,580
VHD (delay / interval (hrs))	33,291	25,952
Space Mean Speed (mph)	53.0	54.2
Reported Density (pc/mi/ln)	12.5	11.5
Max D/C	1.49	1.49
Max V/C	1.00	1.00
Total User Cost ($)	1,695,114.6	1,321,430.4

Hands-on Example #3 (Time Permitting)

- We want to create FREEVAL analysis for I-540WB between MM 17 and 7
  - Use mapping tools and create the HCM segmentation
- Set analysis study period to 24 hours.
- The area is identified as a rural area in terms of traffic demand profile.
- Check the calibration status based on data provided from one of Probe Data Sources (e.g. HERE.COM).

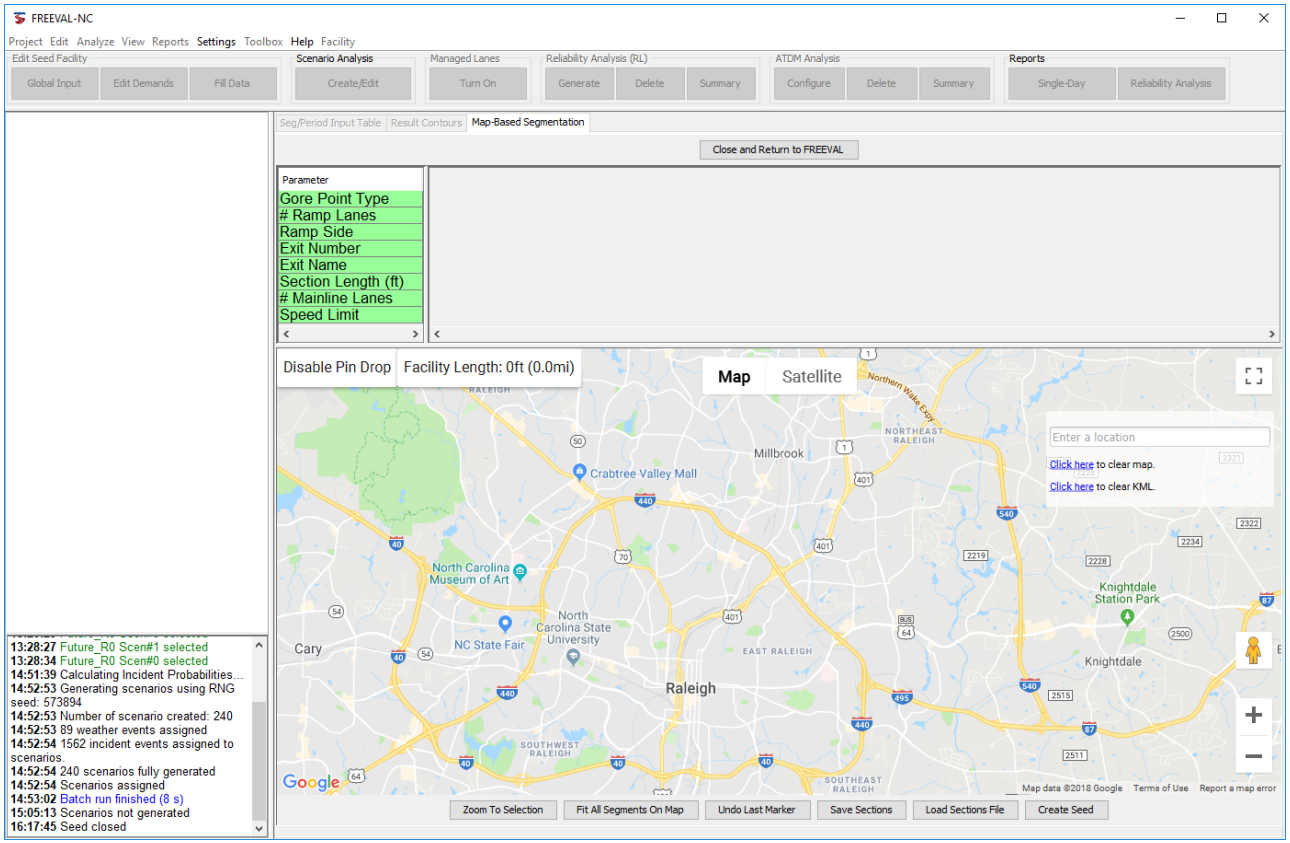
Step 1: Select Map-Based Segmentation

- Click on “Project” menu, then select “New Project”, or click on Ctrl+N
- Then select “Map-Based Segmentation”.

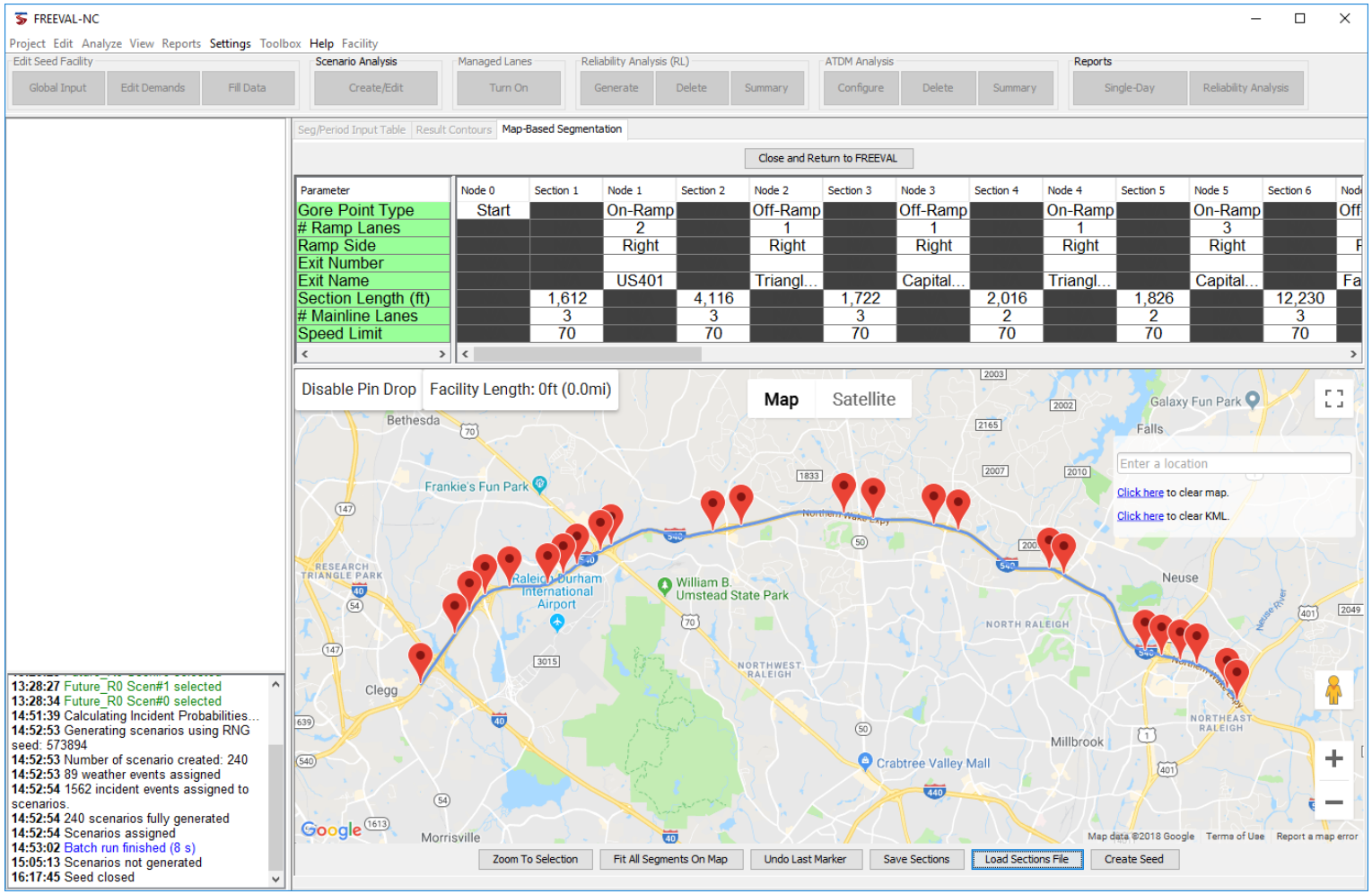


Step 2: Internet Connectivity

- Make sure your computer has access to the internet and you are able to see the following screen:

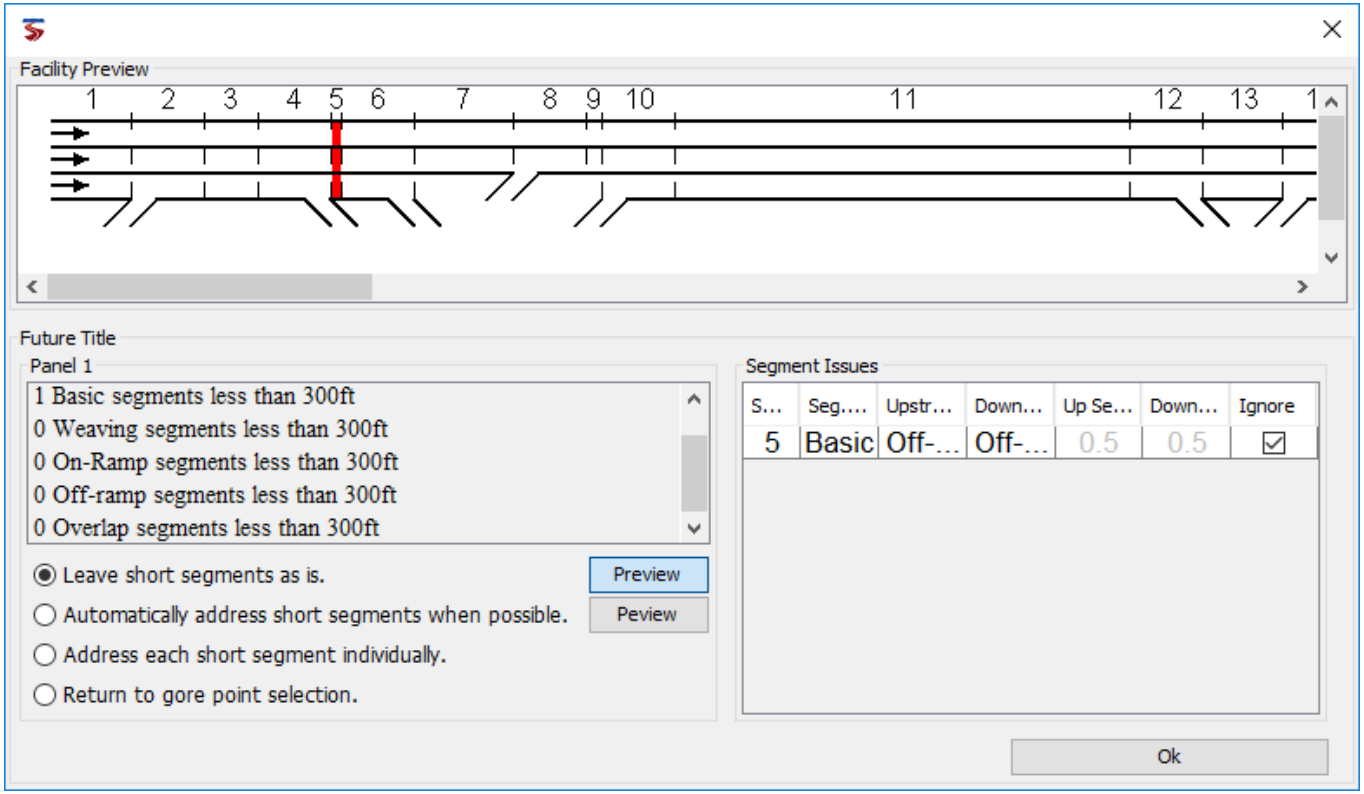


Step 3:Define Sections on the Map



Step 4: Create the Seed

- FREEVAL may ask a few clarifications on how you want to pursue with segmentation. Examples are “how to tackle with very short segments”.



Step 5: Define Other Details of the Analysis

Project Properties

General Information

Project Name	New Project 1	Number Of HCM Segments	40
Study Period Start Time (hh:mm)	17 / 00	Study Period End Time (hh:mm)	18 / 00
Seed Calibartion Date	Nov 7, 2017	Jam Density (pc/mi/ln)	190
Capacity Drop due to Breakdown (%)	7	GP Vehicle Occupancy (p/veh)	1.0
Area Type	(●) Urban ( ) Rural		

Analysis Options

- [x] Free Flow Speed Known
- [ ] Managed Lanes Analysis

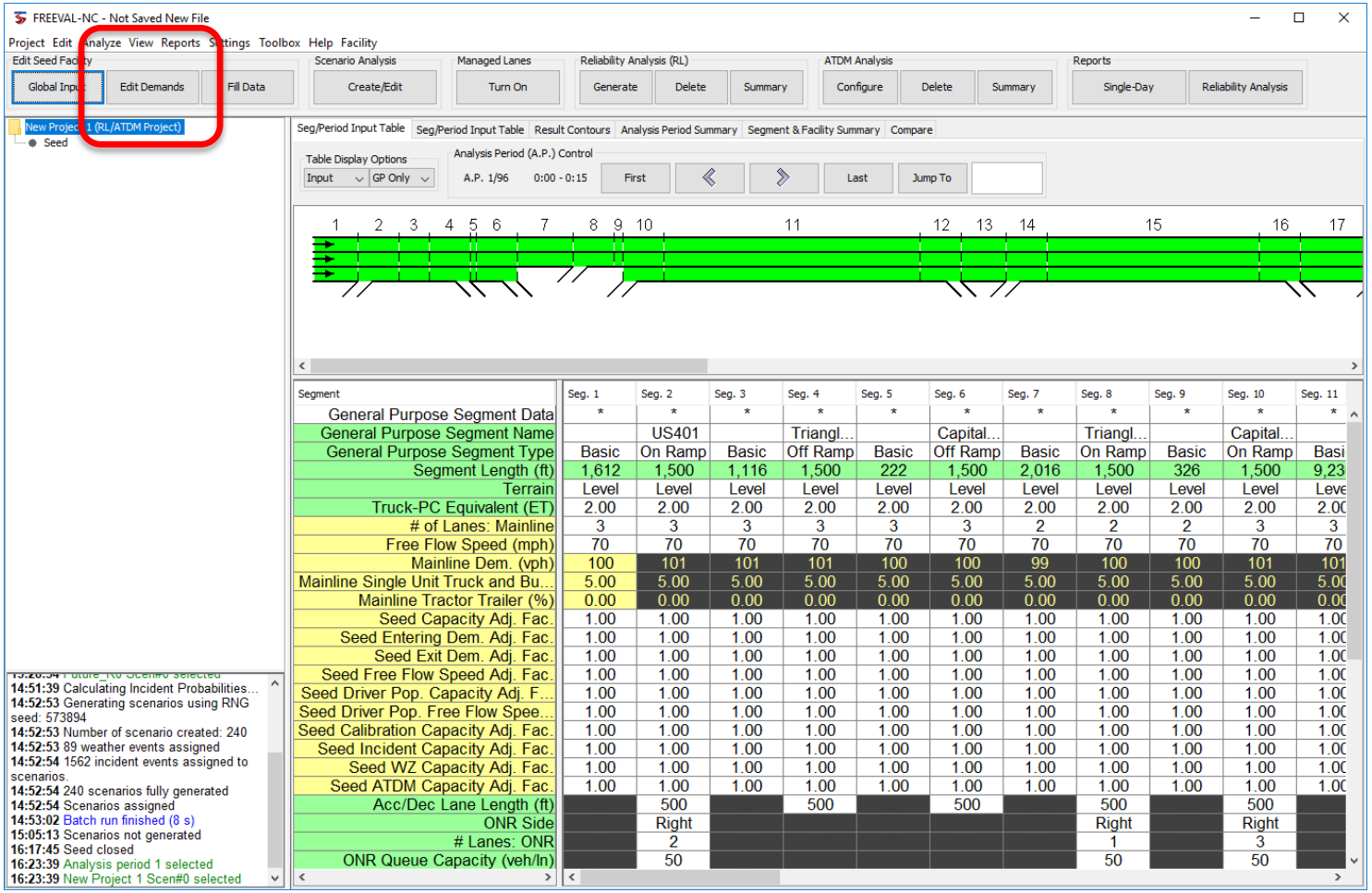
Prefill Global Values

General Purpose Segments

[x] General Terrain	Level (Default=2.0)	[x] Current Truck PCE	2.0 Look-up Tables
[x] Num Of Mainline Lanes	3	[x] Mainline FFS (mph)	70
[ ] Lane Width (ft)		[ ] Lateral Clearance (ft)	
[x] Num Of Ramp Lanes	1	[x] Ramp FFS (mph)	45
[x] Ramp Acc/Dec Length (ft)	500	[ ] Ramp Metering Rate (veh/h)	
[x] Single Unit Trucks and Buses (%)	5	[x] Tractor Trailers (%)	0
[x] Driver Population CAF	1	[x] Driver Population SAF	1

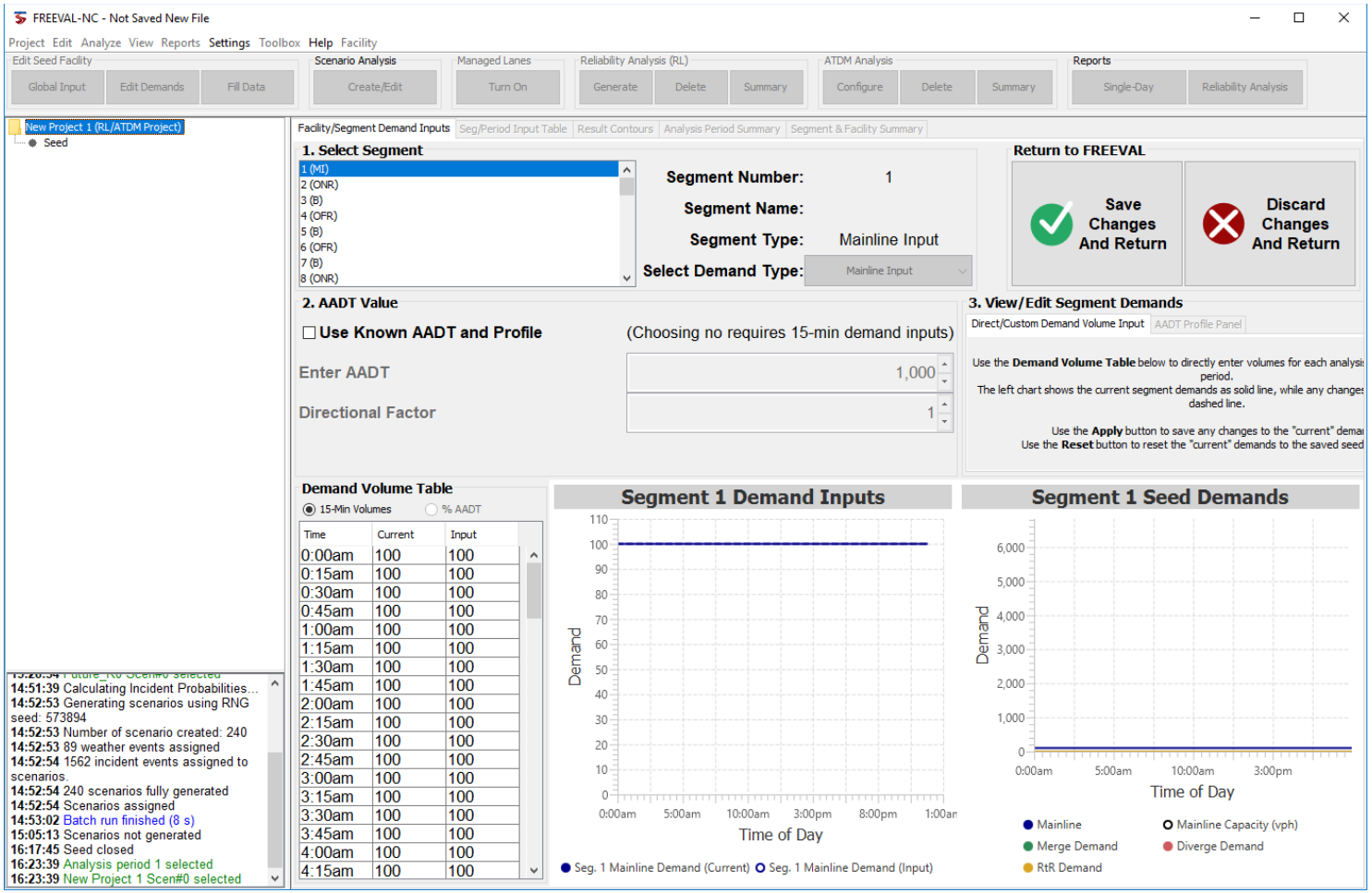
OK

Step 6: Enter Demand



Segment	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 9	Seg. 10	Seg. 11
General Purpose Segment Data	*	*	*	*	*	*	*	*	*	*	*
General Purpose Segment Name		US401		Triangl...		Capital...		Triangl...		Capital...	
General Purpose Segment Type	Basic	On Ramp	Basic	Off Ramp	Basic	Off Ramp	Basic	On Ramp	Basic	On Ramp	Basi
Segment Length (ft)	1,612	1,500	1,116	1,500	222	1,500	2,016	1,500	326	1,500	9,23
Terrain	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level	Leve
Truck-PC Equivalent (ET)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
# of Lanes: Mainline	3	3	3	3	3	3	2	2	2	3	3
Free Flow Speed (mph)	70	70	70	70	70	70	70	70	70	70	70
Mainline Dem. (vph)	100	101	101	101	100	100	99	100	100	101	101
Mainline Single Unit Truck and Bu...	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Mainline Tractor Trailer (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seed Capacity Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Seed Entering Dem. Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Seed Exit Dem. Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Seed Free Flow Speed Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Seed Driver Pop. Capacity Adj. F...	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Seed Driver Pop. Free Flow Spee...	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Seed Calibration Capacity Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Seed Incident Capacity Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Seed WZ Capacity Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Seed ATDM Capacity Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Acc/Dec Lane Length (ft)		500		500		500		500		500	
ONR Side		Right						Right		Right	
# Lanes: ONR		2						1		3	
ONR Queue Capacity (veh/ln)		50						50		50	

Step 6: Enter Demand via AADT Data Entry



SESSION #4

Introduction to Freeway Reliability Analysis

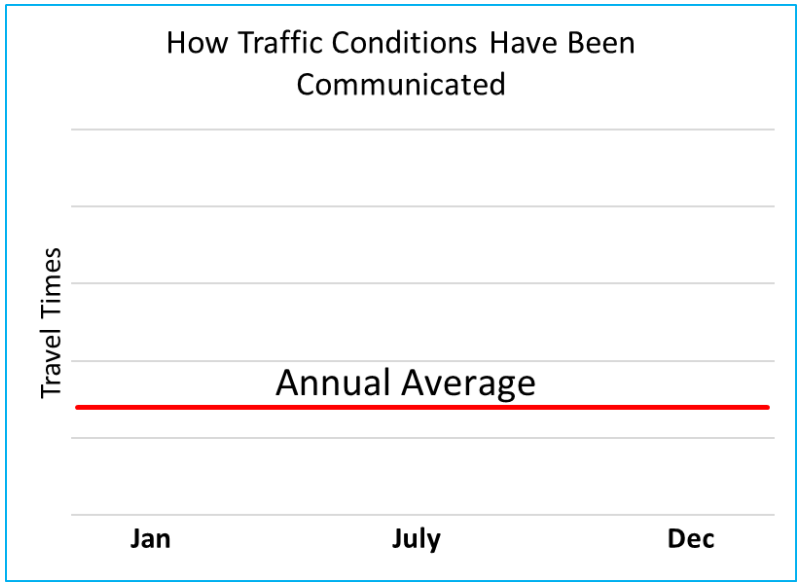
Class Outline

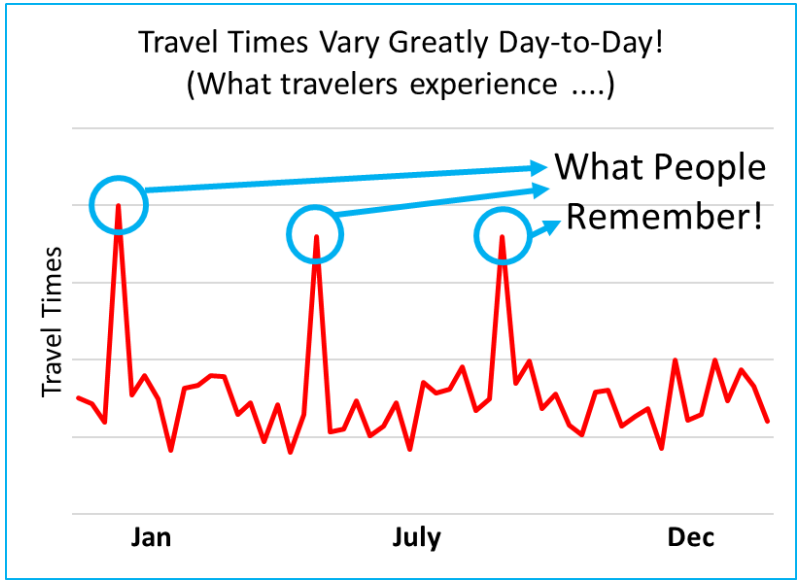
Time	Topic		Session Type
9:00a - 9:15a	Welcome, Introductions, Agenda, Learning Outcomes		Discussion
9:15a – 9:45a	Session #1	Introduction to the Single-Day Freeway Analysis, including work zone effects	Lecture
9:45a – 10:30a	Session #2	How to Perform a Single Day Analysis in FREEVAL-NC	Demo/Hands-on
10:30a – 10:45a	Break		
10:45a – noon	Session #3	How to Create, Review, Revise and Interpret FREEVAL-NC Single Day Analyses Results	Hands-on
noon – 1:30p	Lunch Break (Lunch not provided)		
1:30p - 2:00p	**Session #4**	**Introduction to Freeway Reliability Analysis**	**Lecture**
2:00p - 2:45p	Session #5	How to Perform a Reliability analysis in FREEVAL-NC	Demo/Hands-on
2:45p - 3:00p	Break		
3:00p - 3:45p	Session #6	How to Create, Review, Revise, and Interpret FREEVAL-NC Reliability Analyses Results	Hands-on
3:45p – 4:00p	Questions and Closing Discussions		Discussion

WHY DO WE ANALYZE THE AVERAGE DAY?

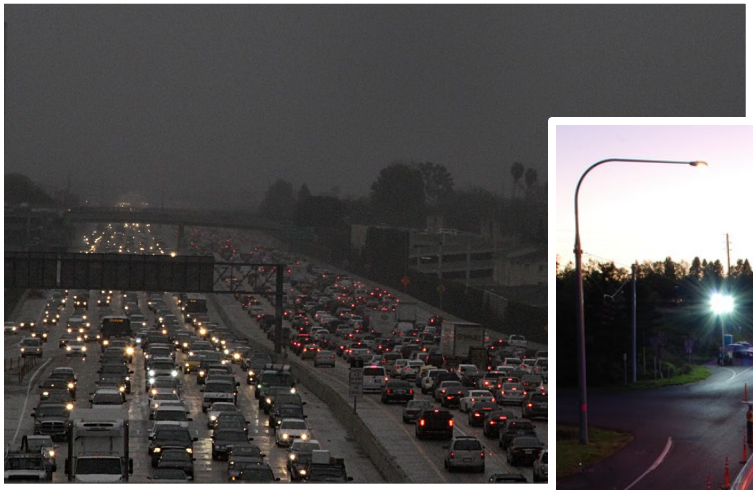
Introduction

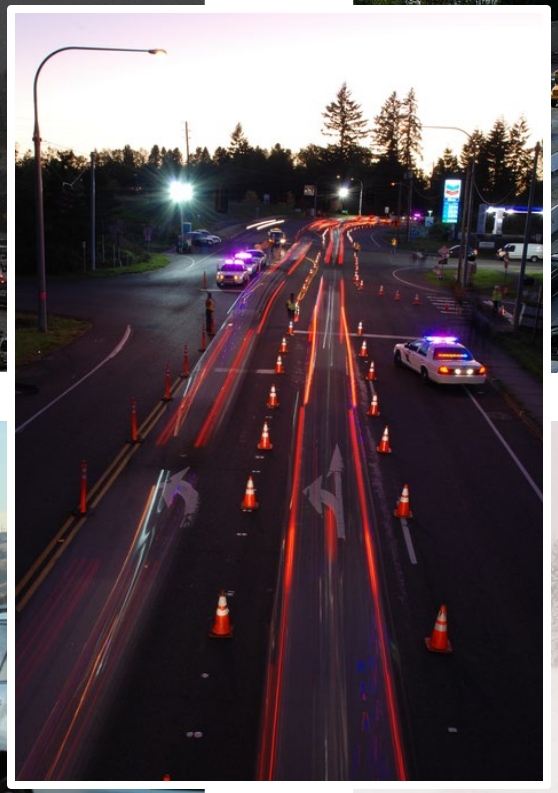
Reliability and ATDM

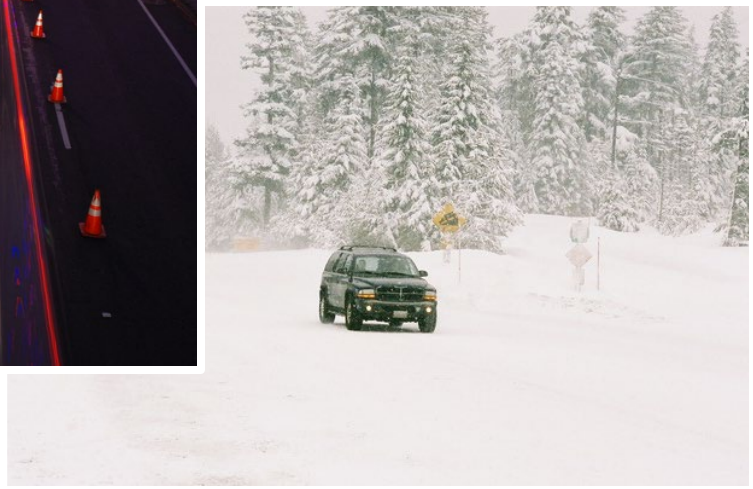




Sources of (Un)Reliable Travel

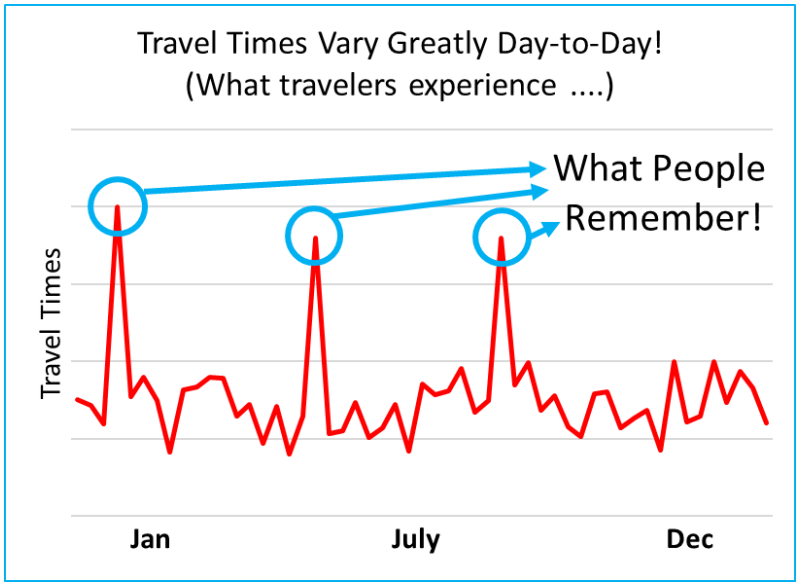






Sources of (Un)Reliability

- Traffic Demand Variations (TOD, DOW, etc.)
- Incidents (Crashes, Stalls, Debris, and etc.)
- Severe Weather Conditions
- Significant Work Zones
- Demand Surges (Special Events)



Reliability Analysis in the HCM

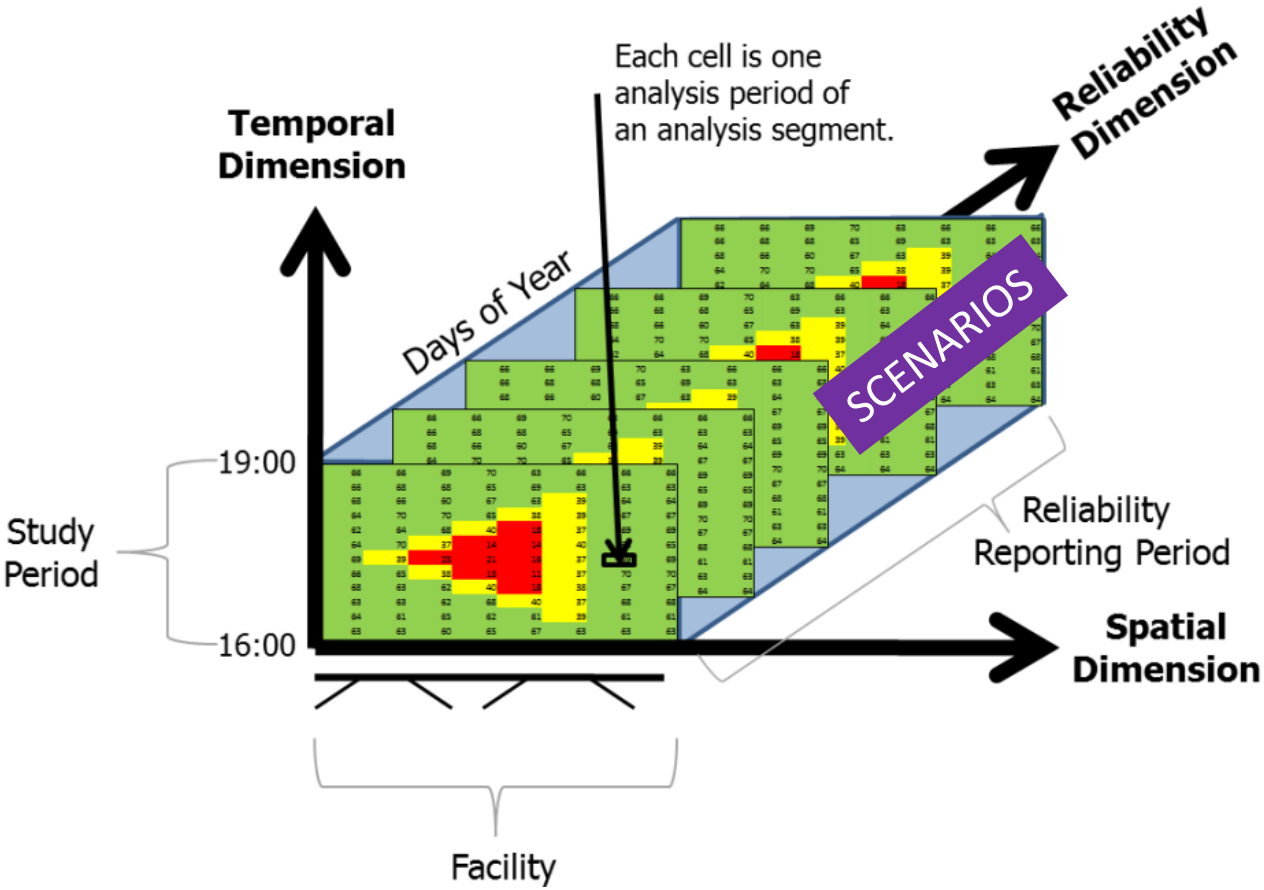


Exhibit 11-1
Schematic Representation of Freeway Reliability Analysis Time–Space Domain

Travel Time Distribution
for Reliability Analysis

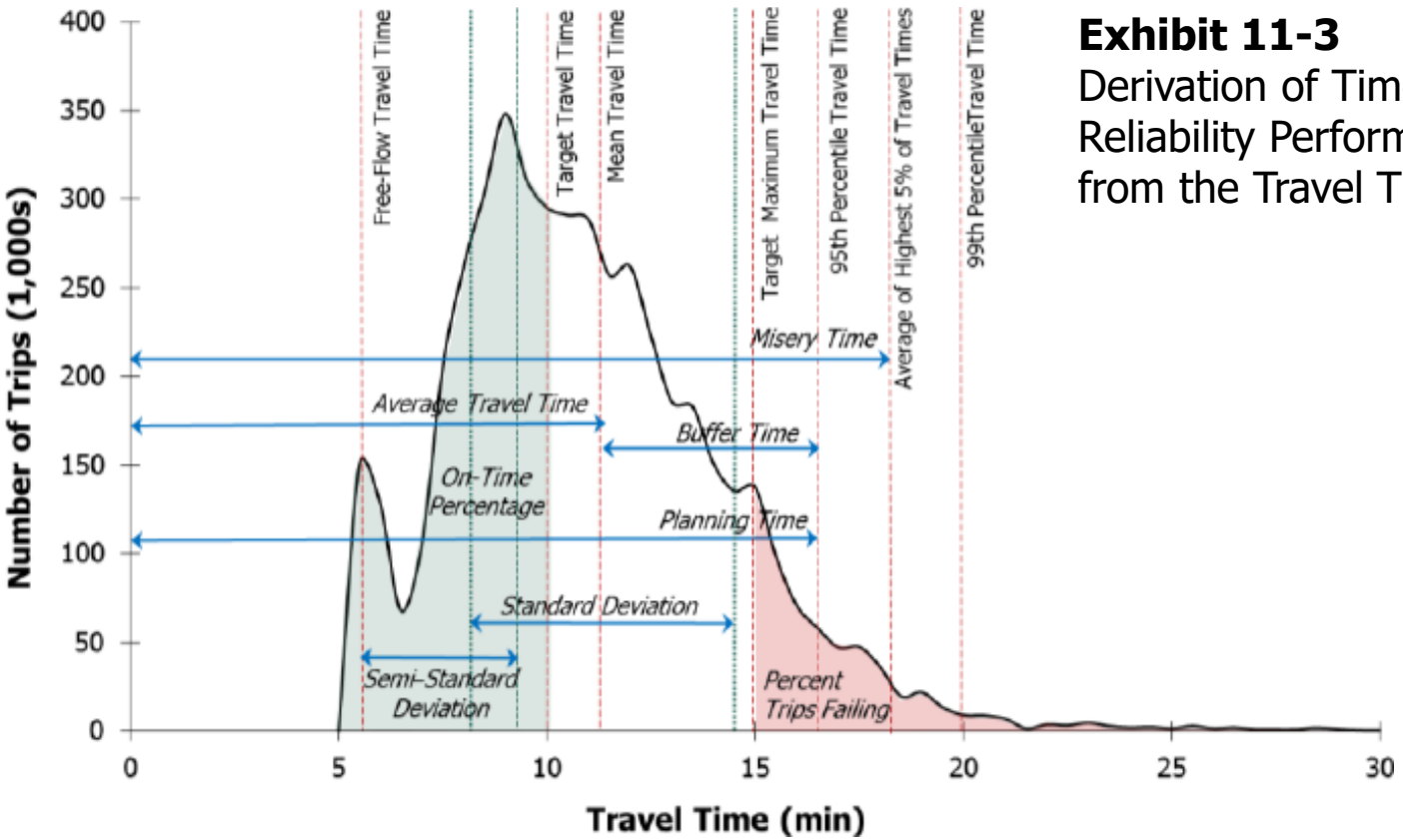
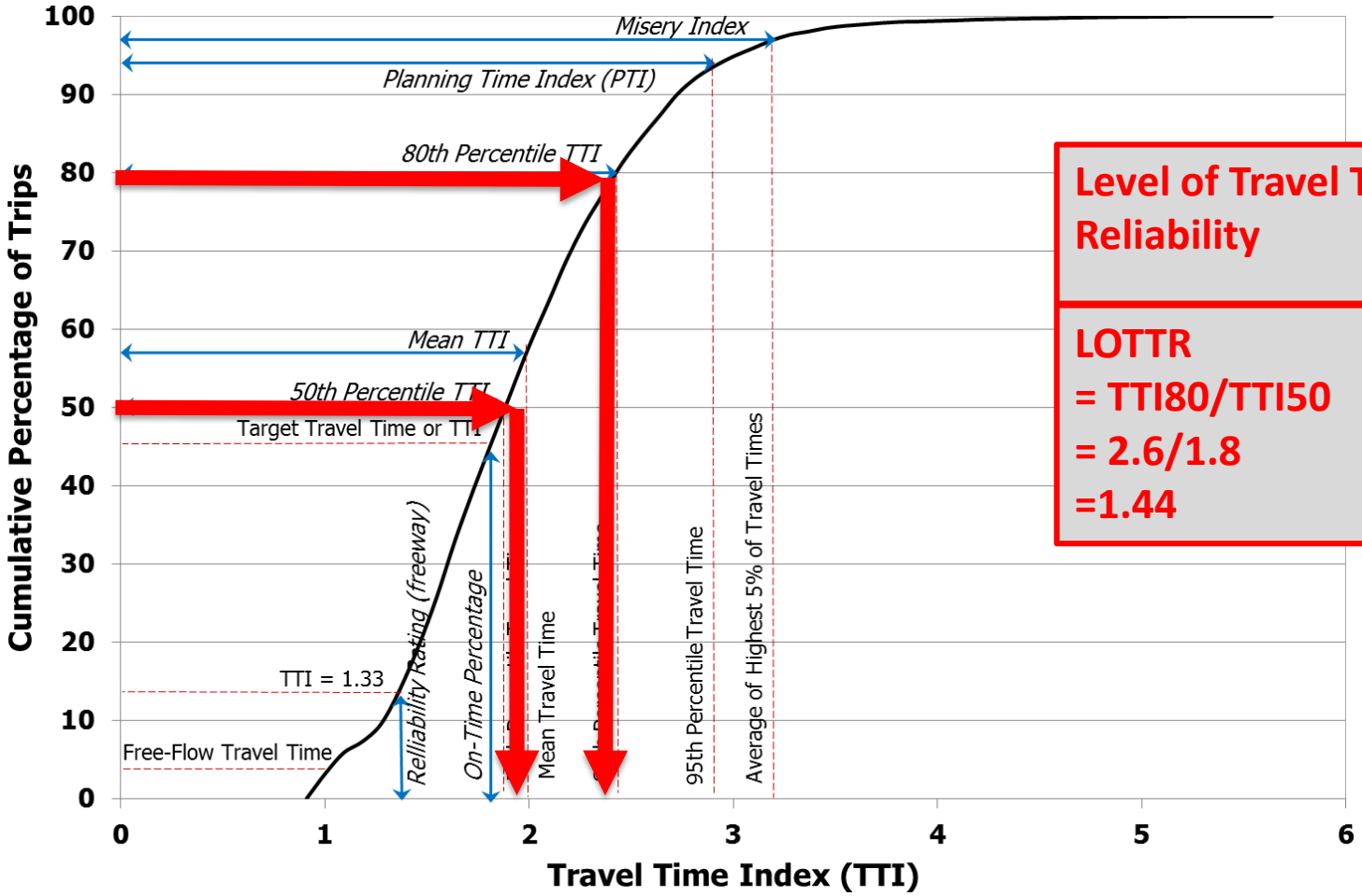


Exhibit 11-3
Derivation of Time-Based Reliability Performance Measures from the Travel Time Distribution

Reliability Performance Measure Examples

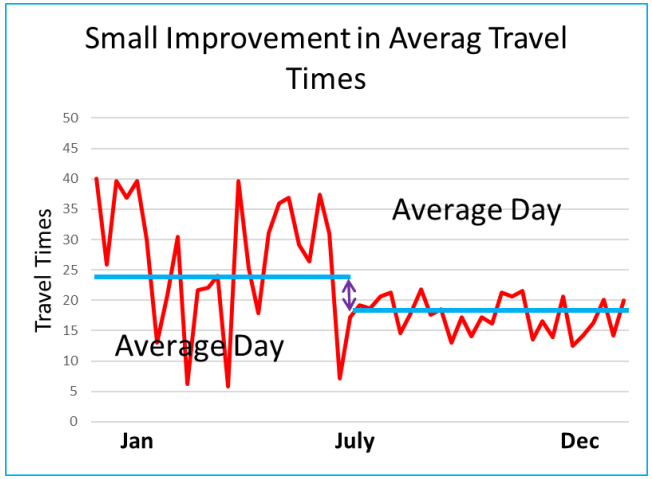


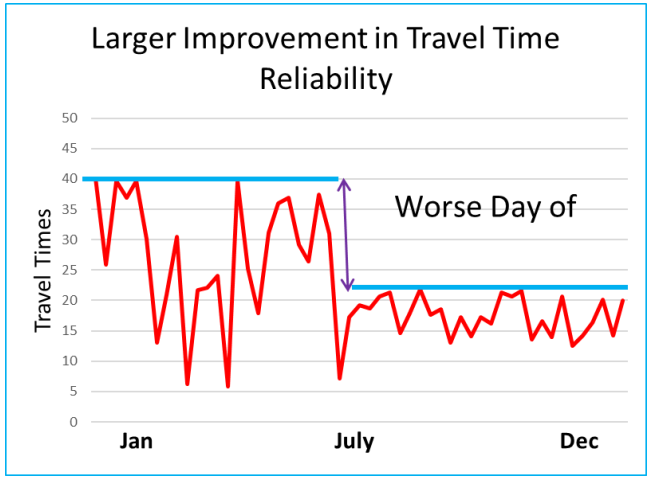
Level of Travel Time Reliability

LOTTR
= TTI80/TTI50
= 2.6/1.8
=1.44

Active Traffic Management

- HCM 2010 can evaluate the effect of the Active Transportation and Demand Management (ATDM) strategies on *average travel times –**NOT** individual trips* (or any other *average* performance measure).
- ATDM analysis in the *6th edition of HCM* provides a framework to evaluate reliability-level impacts of ATDM strategies.
- This is carried out as an extension to the travel time reliability methodology.





Recurring and Non-Recurring
Sources of Congestion

- What are the sources for variation in travel time?
  - Recurring Sources
    - Traffic Demand Cyclical Variations by TOD, DOW, MOY, etc.
  - Non-Recurring Sources
    - Incidents (Crashes, Stalls, and etc.)
    - Severe Weather Conditions
    - Work Zones
    - Demand Surges (Special Events)
- Demand is allowed to vary in each 15-minute analysis period.

Scenario Generation

- *The 6th edition of HCM* uses an enhanced scenario-generation approach compared to the SHRP2-L08 method.

- The revised method requires fewer scenarios (but of higher quality).
- The method uses both deterministic and stochastic modeling in an optimization scheme to generate scenarios.

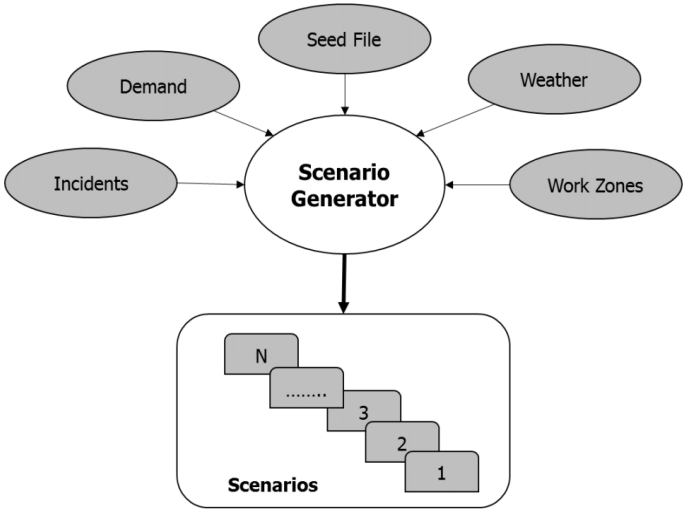


Exhibit 11-4
Schematic of the Freeway Scenario Generation Process and Impacting Factors

Replication of Scenarios

- The current scenario-generation approach sets a combination of a given weekday and month (e.g. Tuesday in April) as its base element, then replicates this combination several times.
- The recommended number of replications is a function of the duration of the reliability reporting period (RRP), typically one year.

Exhibit 11-9
Recommended Number of Replications for Scenario Generation

RRP Duration (months)	Number of Days Considered	Recommended Number of Replications	Resulting Number of Scenarios
1	5 (all weekdays)	48	240
2	5	24	240
4	5	12	240
6	5	8	240
9	5	6	270
12*	5	4*	240*
12	2 (weekend only)	10	240
12	7 (all days)**	3	252

Notes: RRP = reliability reporting period.
*Default value.
**Not desirable; separating weekday and weekend reliability analysis is preferred.

Representing Scenarios
in Facility Time-Space Domain

- Each Scenario (which is a day-month replication) may contain several non-recurring events.
- Overlap between different types of events is allowed.
- The following example shows a single scenario with the effects of a rain event (R) lasting 45 minutes, a two-lane closure incident (I-2) lasting one hour, and a shoulder-closure incident (I-S) lasting 15 minutes.

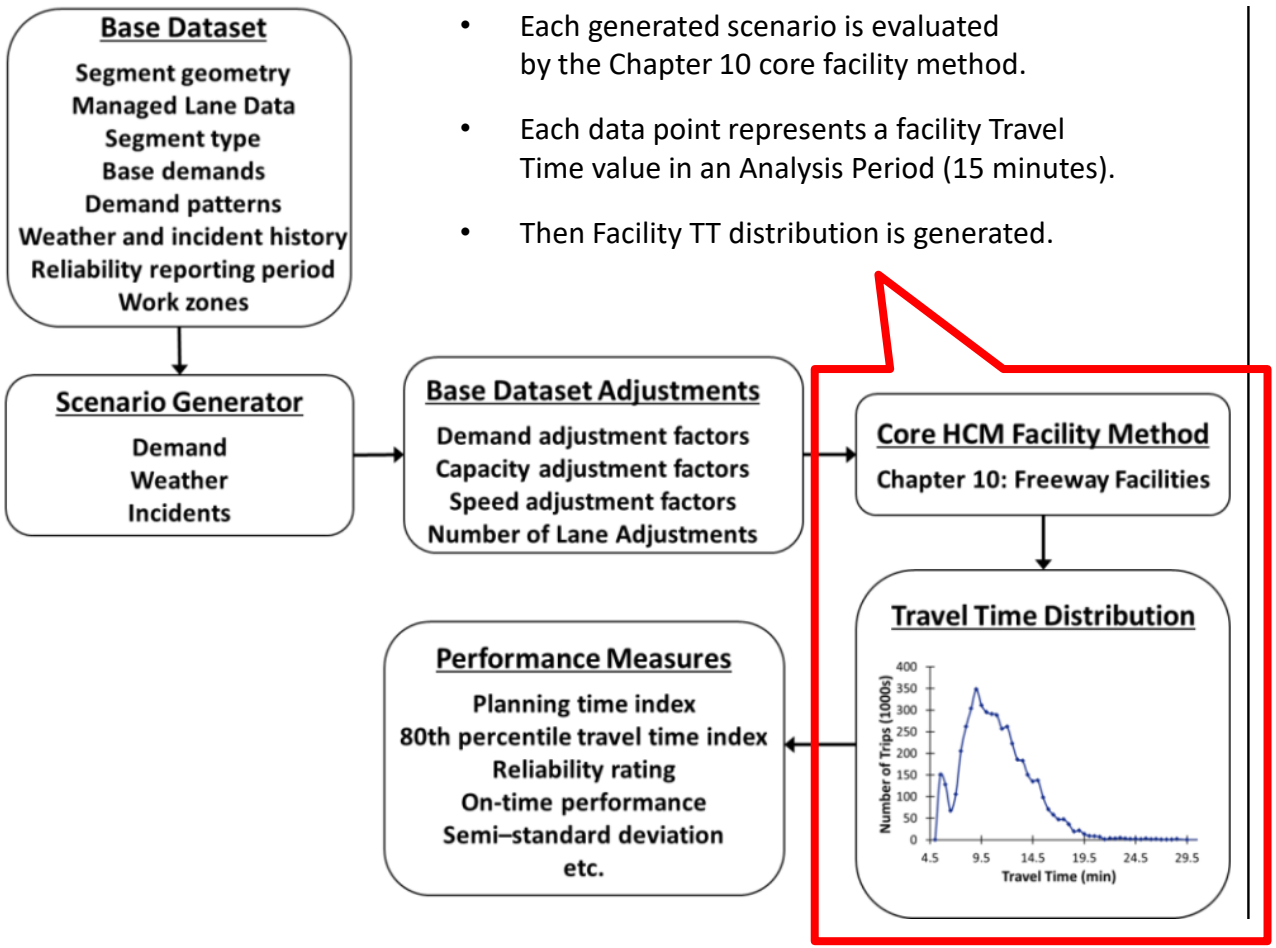
Analysis Period	Segment Number									
	1	2	3	4	5	6	7	8	9	10
1										
2										
3	R	R	R	R	R	R	R	R	R	R
4	R	R	R	R	R	R	R	R	R	R
5	R	R	R	R	R	R	R	R and I-2	R	R
6								I-2		
7								I-2		
8								I-2		
9										
10										
11			I-S							
12										

Exhibit 11-5
Scenario Illustrating Weather and Incident Events

Evaluation of Scenarios
and Methodology Outputs

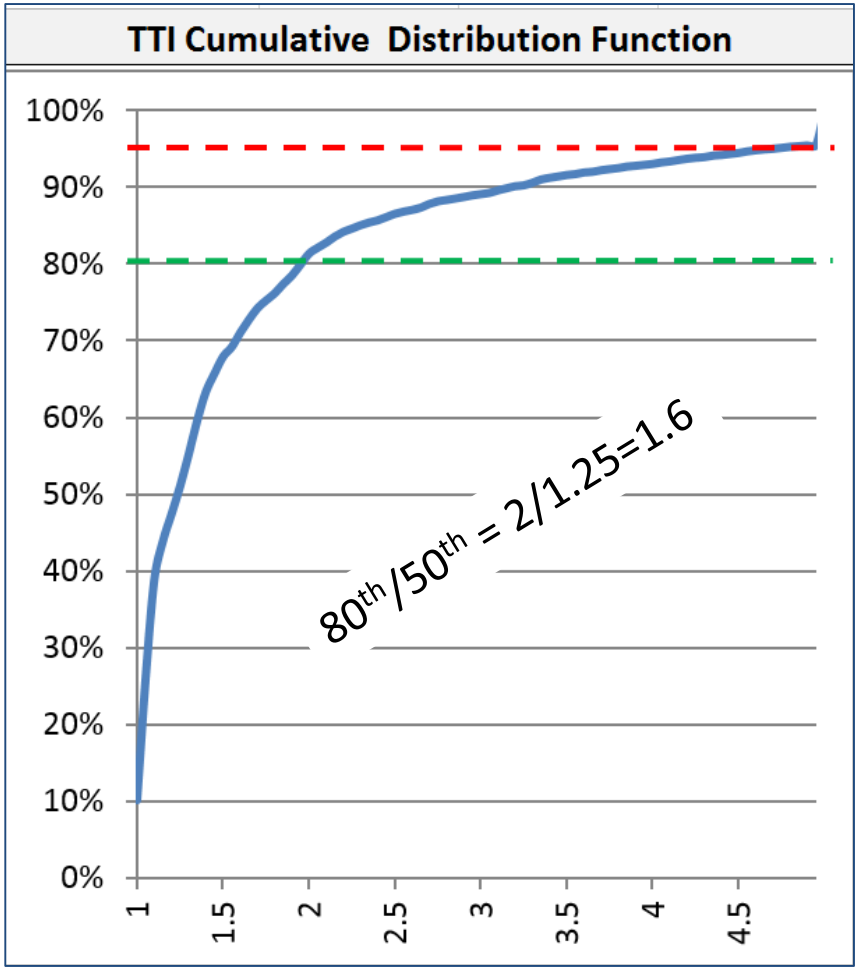
- Each generated scenario is evaluated by the Chapter 10 core facility method.
- Each data point represents a facility Travel Time value in an Analysis Period (15 minutes).
- Then Facility TT distribution is generated.

Exhibit 11-7
Freeway Reliability Methodology Framework



Reliability Performance Measures

- Reliability analysis produces **Reliability Performance Measures** that include the impact of recurring and non-recurring sources of congestion.
- All performance measures are based on the estimated travel time distribution.
- To normalize and enable comparisons across facilities, travel times are divided by the free flow travel time resulting in **Travel Time Index (TTI)** distribution.



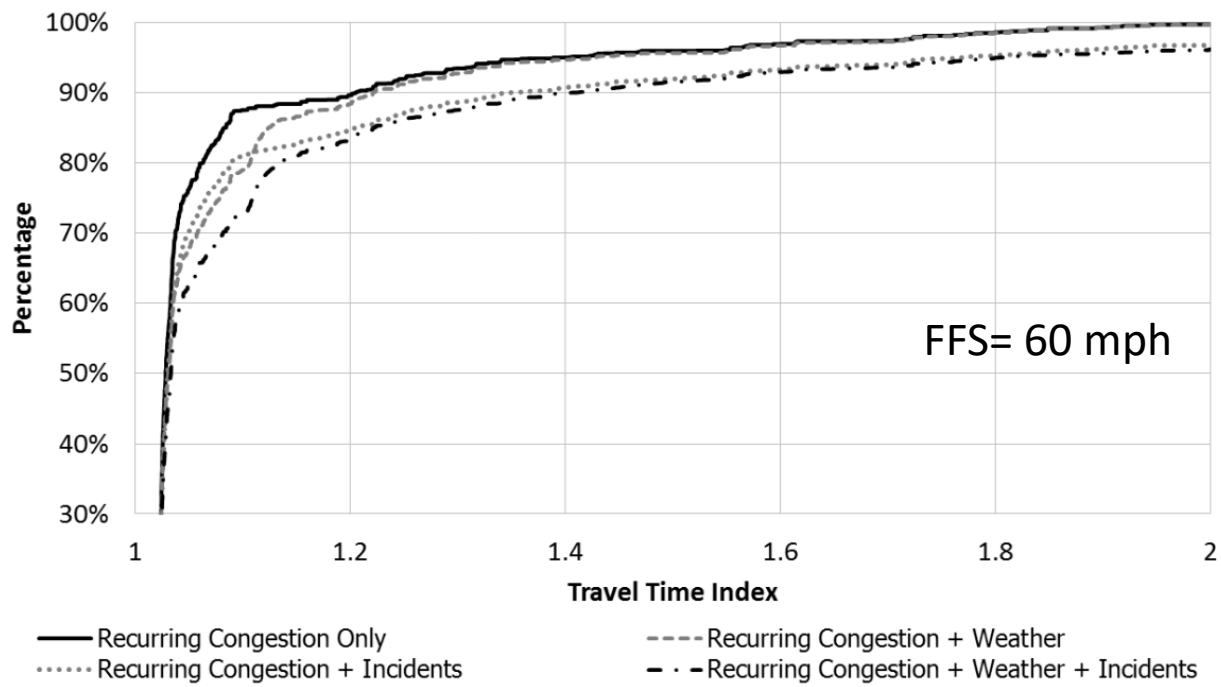
Reliability Performance Measures from the TTI Distribution

Key Reliability Performance Measures from the TT Distribution:

- Mean TTI
- 95th % TTI (Planning Time Index)
- 80th % TTI
- 50th % TTI (Median)
- Level of Travel Time Reliability (LOTTR)= 80th / 50th
- Reliability Rating – *how often the facility performs satisfactorily defined as the fraction of facility VMT operating below a TTI of 1.33*
- Failure and on-time measures (%)
- Misery Index - *average of the worse 5% TTI's*
- Semi-Standard Deviation– *standard deviation from TTI=1*
- Standard Deviation
- %VMT at TTI>2
  - » Percent vehicle-miles traveled at TTI greater than 2

The Effect of Different Sources of Reliability

Exhibit 11-14
Illustrative Effects of Different Non-Recurring Sources of Congestion on the TTI Distribution



SESSION #5

How to Create a Reliability Analysis in FREEVAL-NC

Class Outline

Time	Topic		Session Type
9:00a - 9:15a	Welcome, Introductions, Agenda, Learning Outcomes		Discussion
9:15a – 9:45a	Session #1	Introduction to the Single-Day Freeway Analysis, Including Work Zone Effects	Lecture
9:45a – 10:30a	Session #2	How to Perform a Single Day Analysis in FREEVAL-NC	Demo/Hands-on
10:30a – 10:45a	Break		
10:45a – noon	Session #3	How to Create, Review, Revise and Interpret FREEVAL-NC Single Day Analyses Results	Hands-on
noon – 1:30p	Lunch Break (Lunch not provided)		
1:30p - 2:00p	Session #4	Introduction to Freeway Reliability Analysis	Lecture
2:00p - 2:45p	**Session #5**	**How to Perform a Reliability Analysis in FREEVAL-NC**	**Demo/Hands-on**
2:45p - 3:00p	Break		
3:00p - 3:45p	Session #6	How to Create, Review, Revise, and Interpret FREEVAL-NC Reliability Analyses Results	Hands-on
3:45p – 4:00p	Questions and Closing Discussions		Discussion

Demo Examples

- **Demo Outline:**
  - Create FREEVAL-NC reliability analysis
  - Enter/Alter demand fluctuation data
  - Enter/Alter Incident, weather, and long-term work zone configuration.
  - Create PDF report

- **Participants are encouraged to follow the demo examples on their computers!**

SESSION #6

HOW TO REVIEW, REVISE, AND INTERPRET FREEVAL-NC RELIABILITY ANALYSES RESULTS

Class Outline

Time	Topic		Session Type
9:00a - 9:15a	Welcome, Introductions, Agenda, Learning Outcomes		Discussion
9:15a – 9:45a	Session #1	Introduction to the Single-Day Freeway Analysis, Including Work Zone Effects	Lecture
9:45a – 10:30a	Session #2	How to Perform a Single Day Analysis in FREEVAL-NC	Demo/Hands-on
10:30a – 10:45a	Break		
10:45a – noon	Session #3	How to Create, Review, Revise and Interpret FREEVAL-NC Single Day Analyses Results	Hands-on
noon – 1:30p	Lunch Break (Lunch not provided)		
1:30p - 2:00p	Session #4	Introduction to Freeway Reliability Analysis	Lecture
2:00p - 2:45p	Session #5	How to Perform a Reliability Analysis in FREEVAL-NC	Demo/Hands-on
2:45p - 3:00p	Break		
3:00p - 3:45p	**Session #6**	**How to Create, Review, Revise, and Interpret FREEVAL-NC Reliability Analyses Results**	**Hands-on**
3:45p – 4:00p	Questions and Closing Discussions		Discussion

Reliability Hands-on Examples

- **Hands-On Example #4**
  - Create the reliability analysis for hands-on example #1.
- **Hands-On Example #5 (Time Permitting)**
  - Evaluate the reliability impact of a long-term shoulder closure work zone.
  - How the dispatch of highway patrols would make this facility more reliable.

Hands-on Example #4

- Use the same single day analysis in hands-on example #1
- Perform a reliability analysis from Jan 1 to Dec 31
- Use Raleigh area defaults for weather and demand fluctuation
- Extract incident frequencies from segmentation database

Step 1: Invoke Reliability Scenario Generator

FREEVAL-NC - C:\Users\saghdashi.ITRE400\Documents\I-540WB 2018-09-17_V8 -- manually edited for no negative demands.seed

Project Edit Analyze View Reports Settings Toolbox Help Facility

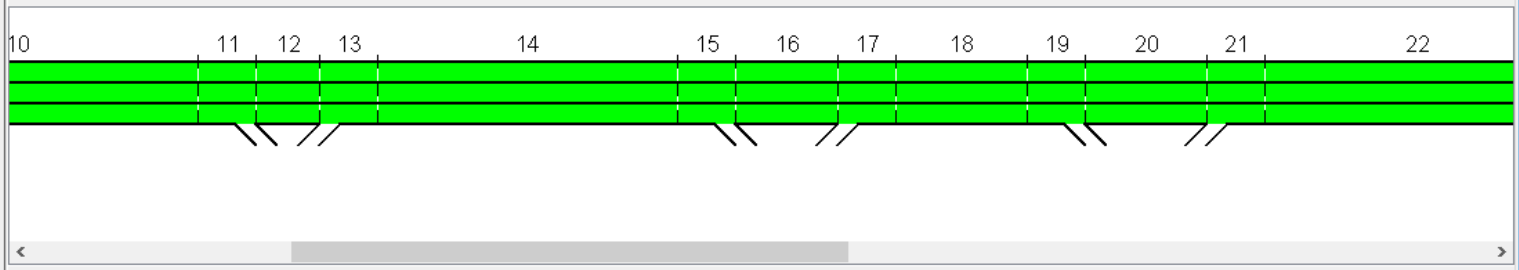
Edit Seed Facility: Global Input | Edit Demands | Fill Data
Scenario Analysis: Create/Edit
Managed Lanes: Turn On
Reliability Analysis (RL): Generate | Delete | Summary
ATDM Analysis: Configure | Delete | Summary
Reports: Single-Day | Reliability Analysis

Future_R0 (RL/ATDM Project)
- Seed
- Reliability Scenarios (1)
  - Scen#1 Hands-on Example 2 (1.000)

Seg/Period Input Table | Result Contours | Analysis Period Summary | Segment & Facility Summary | Compare

Table Display Options: Input | GP Only

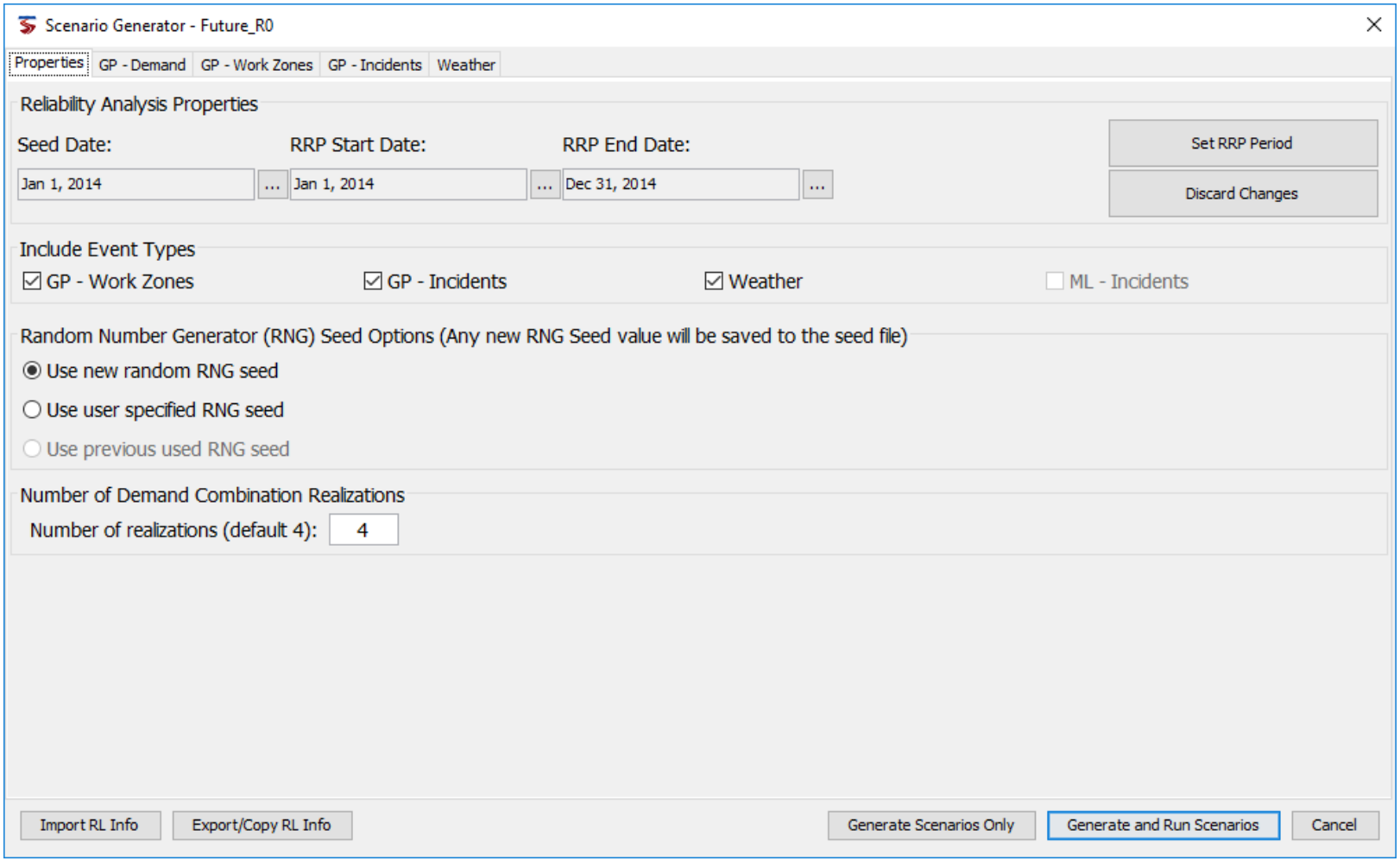
Analysis Period (A.P.) Control: A.P. 1/96 0:00 - 0:15 | First | Last | Jump To



Segment	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 9	Seg. 10	Seg. 11
General Purpose Segment Data	*	*	*	*	*	*	*	*	*	*	*
General Purpose Segment Name		US401			Capital...		Triangl...		Capital...		Falls
General Purpose Segment Type	Basic	On Ramp	Basic	Off Ramp	Off Ramp	Basic	On Ramp	Basic	On Ramp	Basic	Off Ra
Segment Length (ft)	1,612	1,500	1,116	1,500	1,722	2,016	1,500	326	1,500	9,230	1,50
Terrain	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level	Lev
Truck-PC Equivalent (ET)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.0
# of Lanes: Mainline	3	3	3	3	3	2	2	2	3	3	3
Free Flow Speed (mph)	70	70	70	70	70	70	70	70	70	70	70
Mainline Dem. (vph)	106	142	142	142	134	109	1109	1109	1168	1168	116
Mainline Single Unit Truck and Bu...	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.0
Mainline Tractor Trailer (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Seed Capacity Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.0
Seed Entering Dem. Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.0
Seed Exit Dem. Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.0
Seed Free Flow Speed Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.0

```
11:52:16 Default folder location loaded from file.
11:52:22 Analysis period 1 selected
11:52:22 Future_R0 Scen#0 selected
13:26:44 Future_R0 Scen#1 selected
13:28:23 Future_R0 Scen#0 selected
13:28:27 Future_R0 Scen#1 selected
13:28:34 Future_R0 Scen#0 selected
```

Step 2: Fill Global Information



Step 3: Demand Fluctuation & Excluded Dates

Scenario Generator - I440 WB

Properties | GP - Demand | GP - Work Zones | GP - Incidents | Weather

Days in RRP

- [x] Monday
- [x] Tuesday
- [x] Wednesday
- [x] Thursday
- [x] Friday
- [ ] Saturday
- [ ] Sunday

Select All

Select Weekdays

Select Weekends

Daily Demand Multipliers

	Monday	Tuesday	Wednesday	Thursday	Friday
January	0.9503541	0.88946265	0.7870099	0.97709626	1.0530909
February	0.99575865	0.9985338	0.879498	0.85340023	1.0677769
March	1.0049285	1.0102036	1.0613985	1.0919572	1.1467512
April	1.0340658	1.0515218	1.0746533	1.1341231	1.1384325
May	0.9815438	1.0730294	1.0992321	1.1217289	1.1845511
June	1.0724543	1.0875353	1.106681	1.1286337	1.1946545
July	1.0665691	1.0871065	1.108748	1.1419158	1.0814741
August	1.0594946	1.0840843	1.1064724	1.1409243	1.1903676
September	0.9914996	1.0774417	1.0861092	1.13154	1.1999905
October	1.0870693	1.0864822	1.114327	1.1583234	1.2183214
November	1.0324755	1.0701934	1.0738947	0.97062	1.0943072
December	1.0413173	1.053765	1.0093272	0.9600957	1.0884919

[x] Select Defaults | NC Urban Defaults | Saved Facility Specific | User Input Values

Exclude Specific Calendar Dates From RRP

Specific Date

Jul 4, 2018 ...

Add

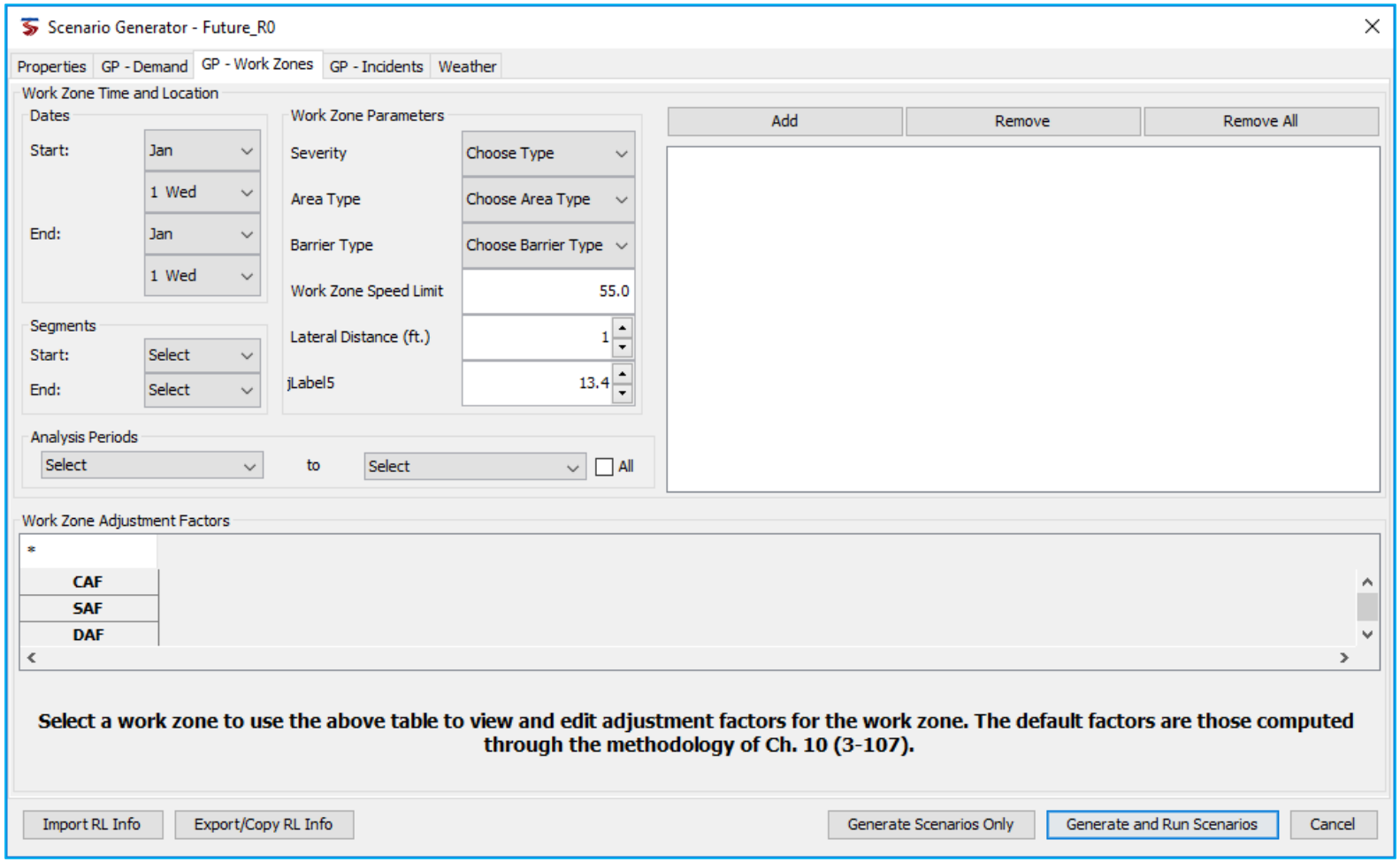
Remove

Remove All

Dates Excluded From RRP

Generate Scenarios Only | Generate and Run Scenarios | Cancel

Step 4: Long-Term Work Zone Modeling



Step 5: Configure Incidents

Scenario Generator - I440 WB

Properties | GP - Demand | GP - Work Zones | GP - Incidents | Weather

Incident Frequencies

Month	Frequency
Jan	1.14
Feb	1.14
Mar	1.14
Apr	1.14
May	1.14
Jun	1.14
Jul	1.14
Aug	1.14
Sep	1.14
Oct	1.14
Nov	1.14
Dec	1.14

Calculate Frequencies...

Reset to Saved Values

Compute from Database

Frequencies represent the number of incidents per study period per month.

A red background indicates that the frequency values have not be set or are very small (<0.01)

Incident Durations

Incident Severity	Distribution %	Mean Duration	Std. Dev.	Minimum Duration	Maximum Duration
Shoulder Closure	75.4	34.0	15.1	8.7	58.0
One Lane Closure	19.6	34.6	13.8	16.0	58.2
Two Lane Closure	3.1	53.6	13.9	30.5	66.9
Three Lane Closure	1.9	67.9	21.9	36.0	93.3
Four Lane Closure	0.0	67.9	21.9	36.0	93.3

Use National Default Data | Use Default Durations

Use Saved Seed File Distribution | Use Saved Seed File Durations

Incident Adjustment Factors | Advanced Incident Probailities

Capacity Adjustment Factors (CAFs)

Segment Lanes	Shoulder Closure	1 Lane Closure	2 Lane Closure	3 Lane Closure	4 Lane Closure
2	0.81	0.7			
3	0.83	0.74	0.51		
4	0.85	0.77	0.5	0.52	

FFS Adjustment Factors (SAFs)

Segment Lanes	Shoulder Closure	1 Lane Closure	2 Lane Closure	3 Lane Closure	4 Lane Closure
2	1.0	1.0			
3	1.0	1.0	1.0		
4	1.0	1.0	1.0	1.0	

Demand Adjustment Factors (DAFs)

Segment Lanes	Shoulder Closure	1 Lane Closure	2 Lane Closure	3 Lane Closure	4 Lane Closure
2	1.0	1.0			
3	1.0	1.0	1.0		
4	1.0	1.0	1.0	1.0	

Lane Adjustment Factors

Segment Lanes	Shoulder Closure	1 Lane Closure	2 Lane Closure	3 Lane Closure	4 Lane Closure
2	0	-1			
3	0	-1	-2		
4	0	-1	-2	-3	

Generate Scenarios Only | Generate and Run Scenarios | Cancel

Step 6: Configure Weather Events

Scenario Generator - Future_R0

Properties | GP - Demand | GP - Work Zones | GP - Incidents | Weather

Please enter probabilities, durations, and adjustment factors for weather events, or fill by specifying the nearest metropolitan area:

User the dropdown selection boxes to choose a region and city.

North Carolina

RALEIGH-DURHAM INTERNATIONAL AP,NC

Extract Historic Regional Weather Data

Use Values Stored In Seed

Import from File

Export to File

	Med Rain	Heavy Rain	Light Snow	LM Snow	MH Snow	Heavy Snow	Severe Cold	Low Vis	Very Low Vis	Min Vis	Normal Weather
January	0.6%	0.1%	1.3%	0.1%	0.0%	0.0%	0.0%	1.1%	1.6%	1.0%	94.3%
February	0.5%	0.1%	1.3%	0.1%	0.0%	0.0%	0.0%	1.3%	0.5%	0.3%	95.8%
March	1.0%	0.2%	0.4%	0.0%	0.0%	0.0%	0.0%	0.6%	0.5%	0.3%	96.9%
April	0.9%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.1%	0.1%	97.9%
May	0.9%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.2%	0.1%	98.1%
June	0.6%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	98.7%
July	0.4%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.2%	0.0%	98.8%
August	0.4%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.2%	0.1%	98.6%
September	1.1%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%	0.4%	97.1%
October	0.6%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.4%	0.1%	98.5%

	Med Rain	Heavy Rain	Light Snow	LM Snow	MH Snow	Heavy Snow	Severe Cold	Low Vis	Very Low Vis	Min Vis	Normal Weather
Avg Dur (min)	80.20	73.92	165.16	72.00	60.00	0.00	0.00	119.33	178.59	139.01	
CAF	0.93	0.86	0.96	0.91	0.89	0.78	0.92	0.90	0.88	0.90	1.00
SAF	0.93	0.92	0.87	0.86	0.84	0.83	0.93	0.94	0.92	0.92	1.00
DAF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Import RL Info | Export/Copy RL Info | Generate Scenarios Only | Generate and Run Scenarios | Cancel

Step 7: Interpret Results

Reliability Analysis Result Summary

General Information

Project Name	I440 WB	# of Segments	17	# of A.P.	96	# of Scenarios	240
Facility Length (mi)	5.8	Seed File Date	2018-11-06	RRP Start Date	2018-01-01	RRP End Date	2018-12-31

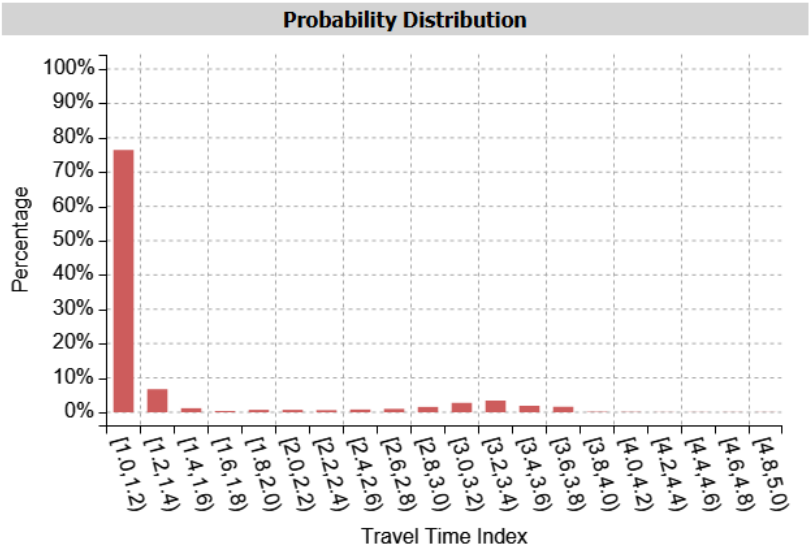
Facility Reliability Performance Measures

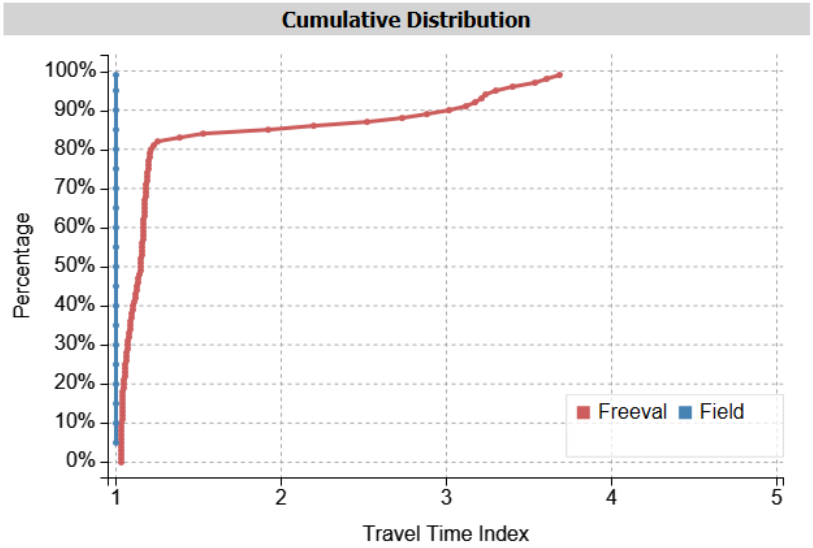
Mean TTI	1.45	50th % TTI	1.15	80th % TTI	1.22	95th % TTI	3.30
Misery Index	4.06	Semi-STD	1.17	Reliability Rating	82.74%	VMT % at TTI > 2	14.70%

Reliability Analysis Summary Charts | Scenario Summaries Table | Incident Charts | Weather Charts

Performance Measure Type: TTI

Chart Data Loaded: 100%





Export Raw Result Data ... | Show TTI Percentile Detail | Show Scenario Event Summary | RL Component Analysis | Close

Step 7: Interpret Results

Reliability Analysis Result Summary

General Information

Project Name	I440 WB	# of Segments	17	# of A.P.	96	# of Scenarios	240
Facility Length (mi)	5.8	Seed File Date	2018-11-06	RRP Start Date	2018-01-01	RRP End Date	2018-12-31

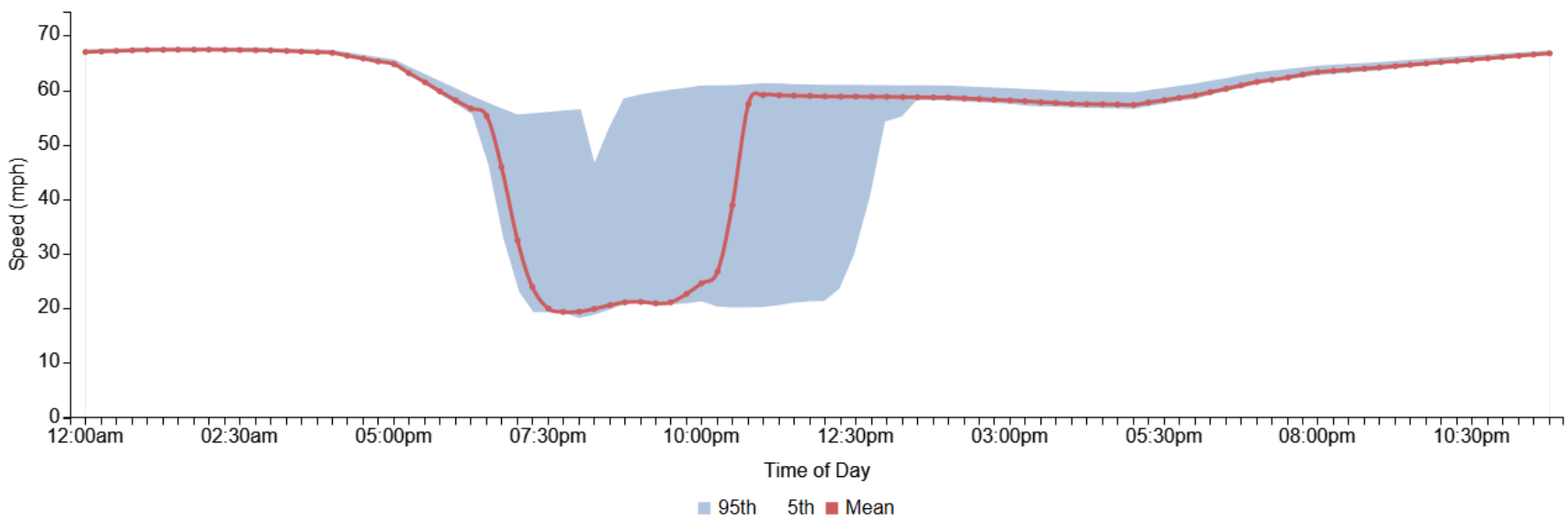
Facility Reliability Performance Measures

Mean TTI	1.45	50th % TTI	1.15	80th % TTI	1.22	95th % TTI	3.30
Misery Index	4.06	Semi-STD	1.17	Reliability Rating	82.74%	VMT % at TTI > 2	14.70%

Reliability Analysis Summary Charts | Scenario Summaries Table | Incident Charts | Weather Charts

Performance Measure Type: Speed Band

Chart Data Loaded: 100%



Export Raw Result Data ... | Show TTI Percentile Detail | Show Scenario Event Summary | RL Component Analysis | Close

Hands-on Example #5

- Use the reliability example #4
- Model a shoulder closure work zone across the entire freeway facility for entire month of January.
- Model work zone speed limit as 55 mph, and the barrier type as concrete.

Step 1: Model Work Zone

Scenario Generator - I440 WB

Properties | GP - Demand | GP - Work Zones | GP - Incidents | Weather

Work Zone Time and Location

Dates
- Start: Jan, 1 Mon
- End: Jan, 31 Wed

Segments
- Start: 1
- End: 17

Work Zone Parameters
- Severity: Shoulder Closure
- Area Type: Urban
- Barrier Type: Concrete
- Work Zone Speed Limit: 55.0
- Lateral Distance (ft.): 1
- WZ Capacity Drop %: 13.4

Add | Remove | Remove All

Shoulder Closure: Jan 1 Mon - Jan 31 Wed (Seg. 1 - 17) (Per. 1 - 96)

Analysis Periods: 1 (0:00) to 96 (24:00) ☑ All

Work Zone Adjustment Factors

*
CAF
SAF
DAF

Select a work zone to use the above table to view and edit adjustment factors for the work zone. The default factors are those computed through the methodology of Ch. 10 (3-107).

Generate Scenarios Only | Generate and Run Scenarios | Cancel

Step 2: Interpret Results

Reliability Analysis Result Summary

General Information

Project Name	I440 WB	# of Segments	17	# of A.P.	96	# of Scenarios	240
Facility Length (mi)	5.8	Seed File Date	2018-11-06	RRP Start Date	2018-01-01	RRP End Date	2018-12-31

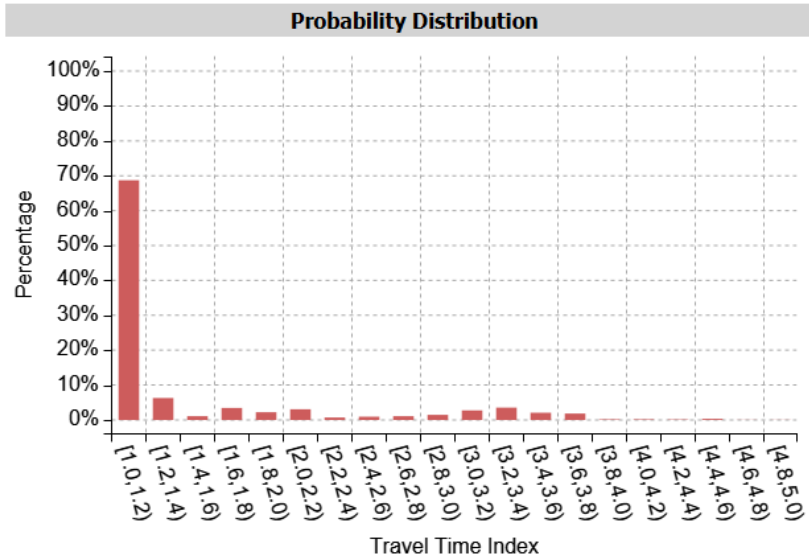
Facility Reliability Performance Measures

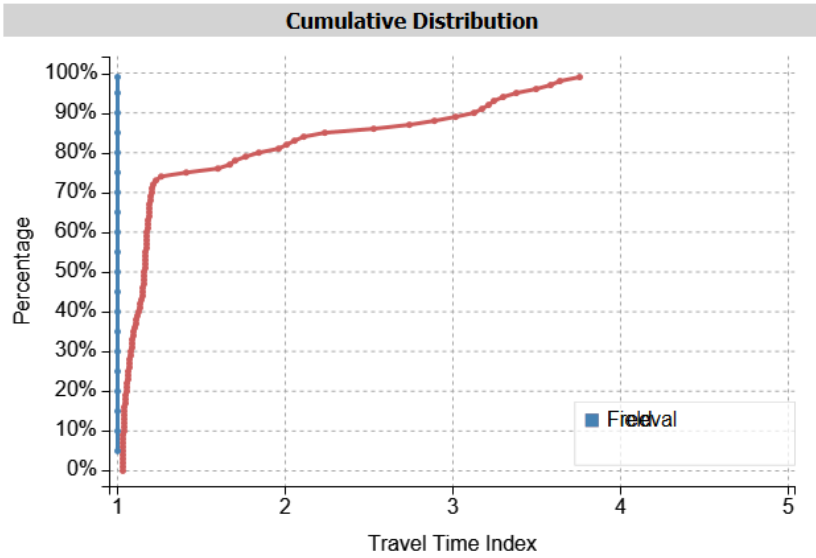
Mean TTI	1.53	50th % TTI	1.16	80th % TTI	1.84	95th % TTI	3.38
Misery Index	4.15	Semi-STD	1.30	Reliability Rating	74.60%	VMT % at TTI > 2	18.30%

Reliability Analysis Summary Charts | Scenario Summaries Table | Incident Charts | Weather Charts

Performance Measure Type: TTI

Chart Data Loaded: 100%





Export Raw Result Data ... | Show TTI Percentile Detail | Show Scenario Event Summary | RL Component Analysis | Close

Hands-on Example #5 (Cont.)

- Assume no work zone case (Example problem #5).
- The dispatch of highway patrols will reduce the mean duration and frequency of incidents by 50% and 30%.
- How much benefits from travel time reliability perspective this facility will gain? And why?

Step 1: Adjust Incident durations

Scenario Generator - I440 WB

Properties | GP - Demand | GP - Work Zones | GP - Incidents | Weather

Incident Frequencies

Month	Frequency
Jan	0.80
Feb	0.80
Mar	0.80
Apr	0.80
May	0.80
Jun	0.80
Jul	0.80
Aug	0.80
Sep	0.80
Oct	0.80
Nov	0.80
Dec	0.80

Calculate Frequencies...

Reset to Saved Values

Compute from Database

Frequencies represent the number of incidents per study period per month.

A red background indicates that the frequency values have not be set or are very small (<0.01)

Incident Durations

Incident Severity	Distribution %	Mean Duration	Std. Dev.	Minimum Duration	Maximum Duration
Shoulder Closure	75.4	15.0	15.1	8.7	58.0
One Lane Closure	19.6	15.0	13.8	16.0	58.2
Two Lane Closure	3.1	30.0	13.9	30.5	66.9
Three Lane Closure	1.9	30.0	21.9	36.0	93.3
Four Lane Closure	0.0	40.0	21.9	36.0	93.3

Use National Default Data | Use Default Durations

Use Saved Seed File Distribution | Use Saved Seed File Durations

Incident Adjustment Factors | Advanced Incident Probabilities

Capacity Adjustment Factors (CAFs)

Segment Lanes	Shoulder Closure	1 Lane Closure	2 Lane Closure	3 Lane Closure	4 Lane Closure
2	0.81	0.7			
3	0.83	0.74	0.51		
4	0.85	0.77	0.5	0.52	

FFS Adjustment Factors (SAFs)

Segment Lanes	Shoulder Closure	1 Lane Closure	2 Lane Closure	3 Lane Closure	4 Lane Closure
2	1.0	1.0			
3	1.0	1.0	1.0		
4	1.0	1.0	1.0	1.0	

Demand Adjustment Factors (DAFs)

Segment Lanes	Shoulder Closure	1 Lane Closure	2 Lane Closure	3 Lane Closure	4 Lane Closure
2	1.0	1.0			
3	1.0	1.0	1.0		
4	1.0	1.0	1.0	1.0	

Lane Adjustment Factors

Segment Lanes	Shoulder Closure	1 Lane Closure	2 Lane Closure	3 Lane Closure	4 Lane Closure
2	0	-1			
3	0	-1	-2		
4	0	-1	-2	-3	

Generate Scenarios Only | Generate and Run Scenarios | Cancel

Step 2: Interpret Results

Reliability Analysis Result Summary

General Information

Project Name	I440 WB	# of Segments	17	# of A.P.	96	# of Scenarios	240
Facility Length (mi)	5.8	Seed File Date	2018-11-06	RRP Start Date	2018-01-01	RRP End Date	2018-12-31

Facility Reliability Performance Measures

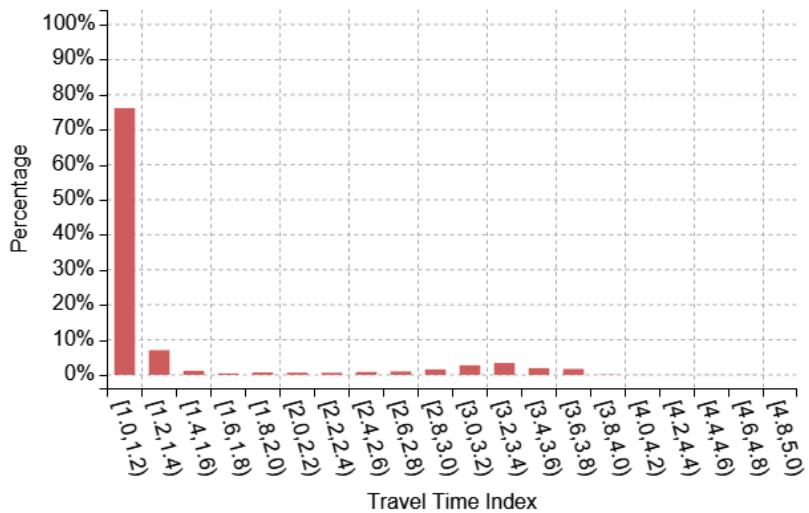
Mean TTI	1.43	50th % TTI	1.15	80th % TTI	1.22	95th % TTI	3.29
Misery Index	3.81	Semi-STD	1.03	Reliability Rating	82.79%	VMT % at TTI > 2	14.50%

Reliability Analysis Summary Charts | Scenario Summaries Table | Incident Charts | Weather Charts

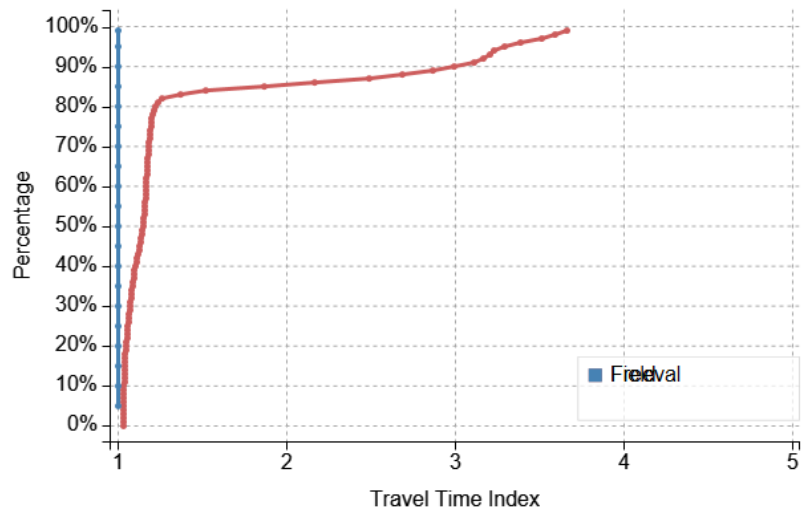
Performance Measure Type: TTI

Chart Data Loaded: 100%

Probability Distribution



Cumulative Distribution



Export Raw Result Data ... | Show TTI Percentile Detail | Show Scenario Event Summary | RL Component Analysis | Close

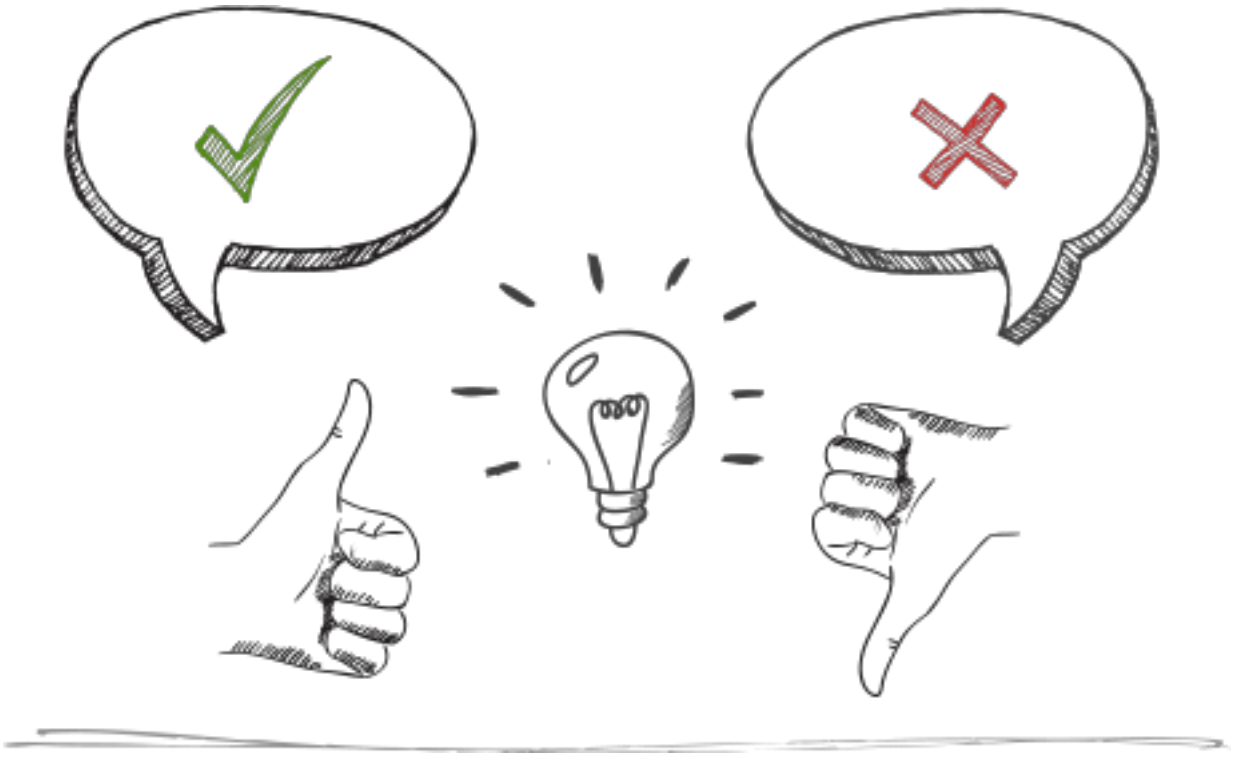
FINAL WRAP-UP

QUESTIONS AND CLOSING DISCUSSION

Review of Learning Outcomes

- How to set up a FREEVAL-NC Analysis
- How to review and edit a FREEVAL-NC file
- How to interpret results from:
  - A single-day analysis
  - A reliability (longer-term) analysis
- How to assess the impact of
  - Work zones
  - Severe weather conditions
  - Incidents
  - Special events
  - Other sources of non-recurring congestion

Review of Important Resources

- Class Handout
  - Includes detailed examples.
- FREEVAL-NC User Guide
  - Detailed descriptions of FREEVAL-NC's features and functions help you operate the tool.
- http://freeval.org
  - Download the latest version of FREEVAL-NC.
  - Download the user guide.
  - Access the segmentation database.
- YouTube Videos (http://go.ncsu.edu/freeval)
  - Short videos give you a big-picture idea what different FREEVAL analyses are about.

Feedback