

Using a 24-Hour VISSIM Analysis

NCITE Intersection Traffic Control Committee

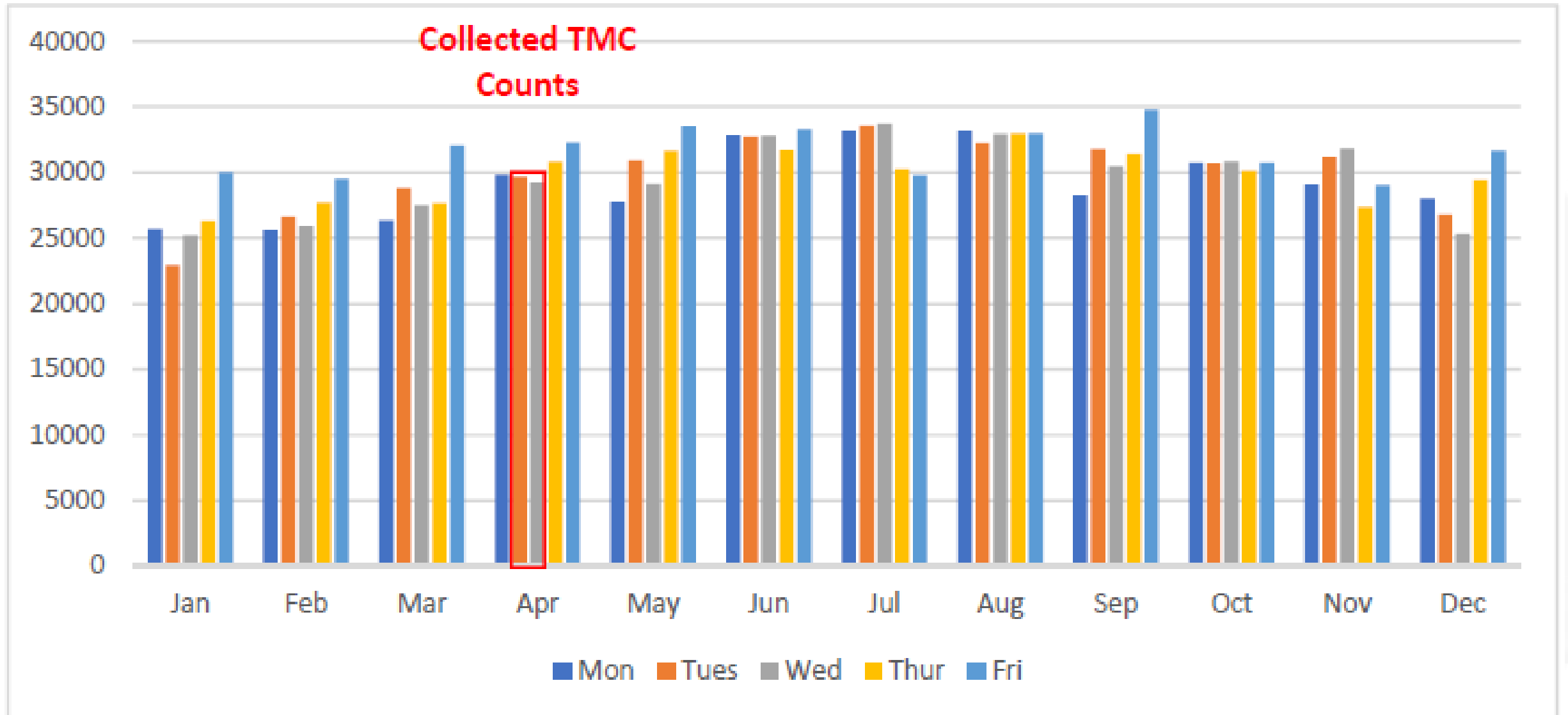
Joe DeVore, PE, PTOE, RSP2
8/19/2021



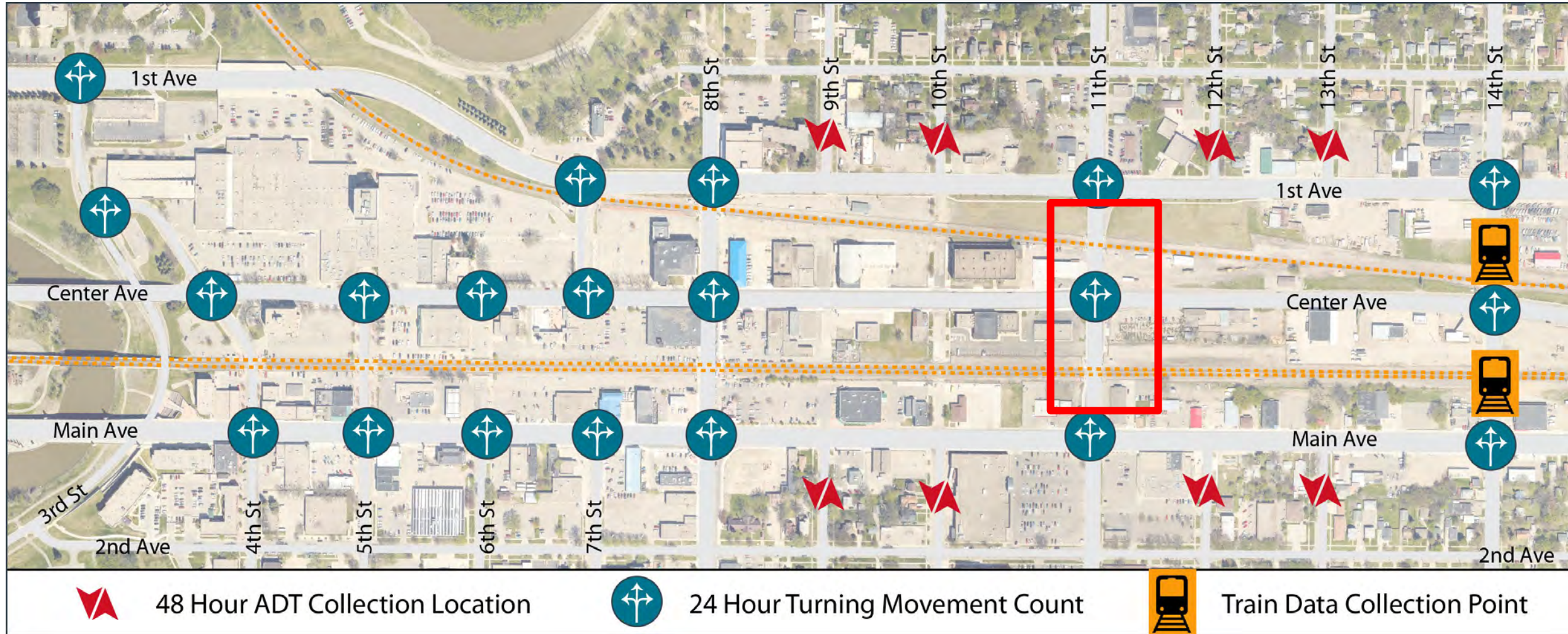
ENGINEERING, REIMAGINED

Seasonal Peaks

Figure 13 – Yearly Volume Changes (Bismarck Expy S of I-94)



2019 Actual Data Collection



➤ 20 Turning Movement Counts

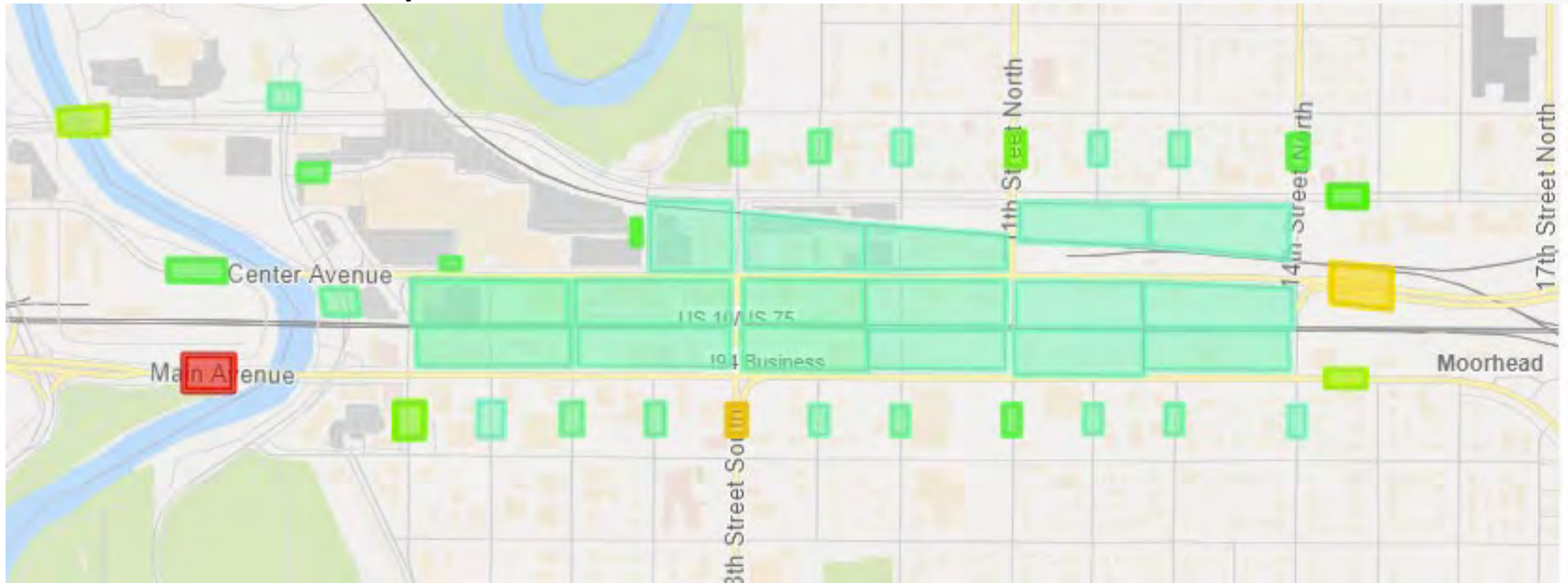
➤ 8 Daily Counts

➤ 2 Train Counts

ENGINEERING, REIMAGINE

Streetlight Origin-Destination Data

- Streetlight Zones used for all roadways and block groups
- 50x50 Origin-Destination Matrix created
- Middle Filter Analysis for 8th, 11th, and 14th.



Balancing to Turning Movements

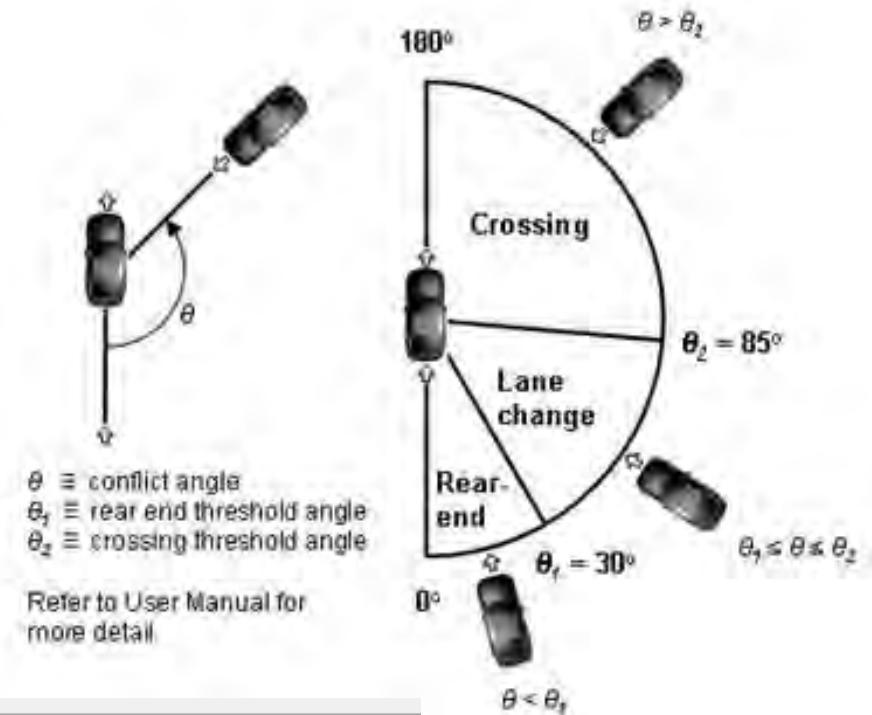
- Start with Inputs and Outputs from TM Counts
- Use connectors as turning movements with link sequence
- Check OD to TM by using Link Sequence

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2	Origin	Destination										
3	100	100	100-100	10039	10075	10193	10422	10188	10085	10390		
4	100	104	100-104	10082								
5	100	106	100-106	10387	10392	10093						
6	100	107	100-107	10387	10392	10396	10398	10100				
7	100	108	100-108	10387	10392	10396	10398	10101				
8	100	109	100-109	10387	10392	10396	10398	10402	10156			
9	100	110	100-110	10387	10392	10396	10398	10402	10404	10119		
10	100	111	100-111	10387	10392	10396	10398	10402	10404	10406	10129	
11	100	112	100-112	10387	10392	10396	10398	10402	10404	10406	10409	10134
12	100	113	100-113	10387	10392	10396	10398	10402	10404	10406	10409	10411
13	100	150	100-150	10387	10392	10396	10398	10402	10404	10406	10409	10411
14	100	204	100-204	10039	10075	10281	10280					

3	VISSIM Vehicle Static Routing																			
4	2019_Build 85%_24 Hour				To Update: Press 'Reapply Filter' Located in Data>Sort & Filter															
5																				
6					Inputs to VISSIM															
7	VehRoutDec	Link	Direct	NodeN	Code	T	07:0	08:0	09:0	10:0	11:0	12:0	13:0	14:0	15:0					
8		10077	NBL	104	104NBL	TRUE	28	17	20	7	22	17	22	32	37					
9		10388	NBT	104	104NBT	TRUE	10	3	8	9	8	3	9	18	26					
10		10079	NBR	104	104NBR	TRUE	5	3	9	10	7	11	7	9	15					
11		10078	SBL	104	104SBL	TRUE	5	7	9	15	21	24	24	15	22					
12		10389	SBT	104	104SBT	TRUE	17	18	19	18	40	59	55	86	86					
13		10081	SBR	104	104SBR	TRUE	13	13	10	17	29	20	14	8	17					
14		10075	EBL	104	104EBL	TRUE	25	18	20	21	27	27	25	20	32					
15		10387	EBT	104	104EBT	TRUE	287	368	377	445	499	576	508	566	664					
16		10082	EBR	104	104EBR	TRUE	109	126	117	121	128	150	132	154	203					
17		10076	WBL	104	104WBL	TRUE	14	25	27	46	46	44	46	36	53					
18		10390	WBT	104	104WBT	TRUE	719	538	452	445	486	593	582	652	610					
19		10080	WBR	104	104WBR	TRUE	22	9	19	11	22	30	14	18	23					
20		10086	NBL	105	105NBL	TRUE	203	179	132	97	122	165	142	134	147					
21		10391	NBT	105	105NBT	TRUE	82	53	37	46	46	51	63	55	64					
22		10083	NBR	105	105NBR	TRUE	22	46	63	55	66	90	70	69	75					
23		10088	SBL	105	105SBL	TRUE	3	7	18	20	23	35	31	39	46					
25		10085	SBR	105	105SBR	TRUE	10	13	19	27	31	43	40	29	47					
26		10087	EBL	105	105EBL	TRUE	7	14	16	13	18	22	34	24	23					
27		10392	EBT	105	105EBT	TRUE	290	368	369	445	513	588	499	569	676					
30		10393	WBT	105	105WBT	TRUE	558	374	353	389	417	510	482	553	501					
31		10084	WBR	105	105WBR	TRUE	12	14	23	12	23	29	24	24	26					
32		10091	NBL	106	106NBL	TRUE	14	11	14	5	12	19	11	16	21					
33		10394	NBT	106	106NBT	TRUE	2	4	10	1	4	6	10	8	8					
34		10094	NBR	106	106NBR	TRUE	6	2	3	10	18	16	16	13	14					
35		10090	SBL	106	106SBL	TRUE	17	23	31	29	48	49	48	41	39					
36		10395	SBT	106	106SBT	TRUE	3	1	7	5	7	7	6	14	13					
37		10096	SBR	106	106SBR	TRUE	11	14	15	14	14	31	27	19	29					
38		10089	EBL	106	106EBL	TRUE	5	9	10	10	13	17	20	20	20					
39		10396	EBT	106	106EBT	TRUE	290	384	402	470	547	646	557	626	719					
40		10093	EBR	106	106EBR	TRUE	14	17	12	22	17	25	15	19	33					
41		10092	WBL	106	106WBL	TRUE	5	7	10	19	13	20	19	11	22					
42		10397	WBT	106	106WBT	TRUE	534	369	338	375	407	466	462	531	464					
43		10095	WBR	106	106WBR	TRUE	23	23	22	23	31	29	39	28	38					
		Volumes Paste	Vehicle Routes		Vehicle Inputs		OD Routes		Partial Routing		Sheet1		Early AM		1	AM Peak				

SSAM Conflict Basics

- Crossing Type
 - Crossing
 - Lane Change
 - Rear End
- Severity
 - Time to Collision (TTC)
- Vehicle Type
 - Ped/Bike/Transit Analysis



Conflict Thresholds

Maximum time-to-collision (TTC):

Maximum post-encroachment time (PET):

Conflict angle thresholds: [Click here for Conflict Angle Diagram](#)

Rear end angle:

Crossing angle:



ENGINEERING, REIMAGINED

SSAM Model Validation

- Compared SSAM to 11 Intersection and Interchange Designs
- Conflict to Crash Ratio of 20,000:1
- Similar Correlation with Existing Crash Data

$$\frac{\text{Crashes}}{\text{Year}} = 0.119 * \left(\frac{\text{Conflicts}}{\text{Hour}} \right)^{1.419}$$

$$\frac{5 \text{ Crashes}}{\text{Year}} = 0.119 * \left(\frac{14 \text{ Conflicts}}{1 \text{ Hour}} \right)^{1.419}$$

Our Data

$$\frac{11.9 \text{ Crashes}}{\text{Year}} = 0.119 * \left(\frac{359 \text{ Conflicts}}{14 \text{ Hour}} \right)^{1.419}$$

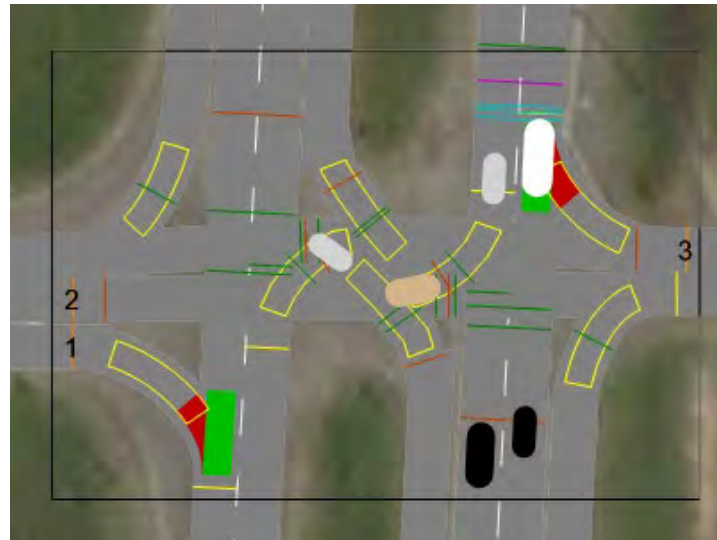
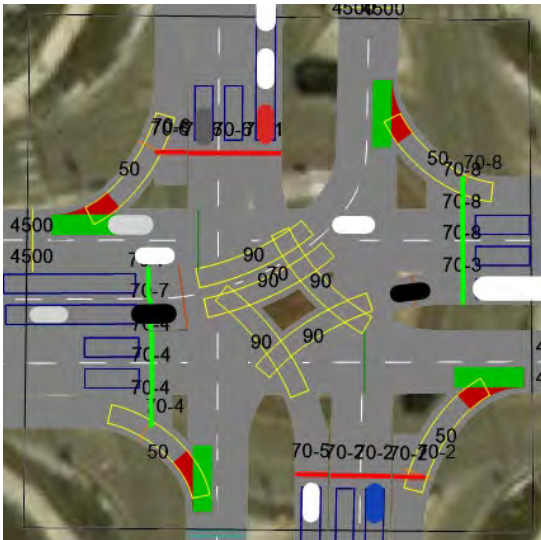
Actual 8.2 Crashes/Year!



ENGINEERING, REIMAGINED

VISSIM Model Parameters

- Consistent Parameters
 - Priority Rules for Lefts
 - Conflict Areas for Rights
- Realistic VISSIM Calibration
- Evaluation Outputs



Evaluation Configuration

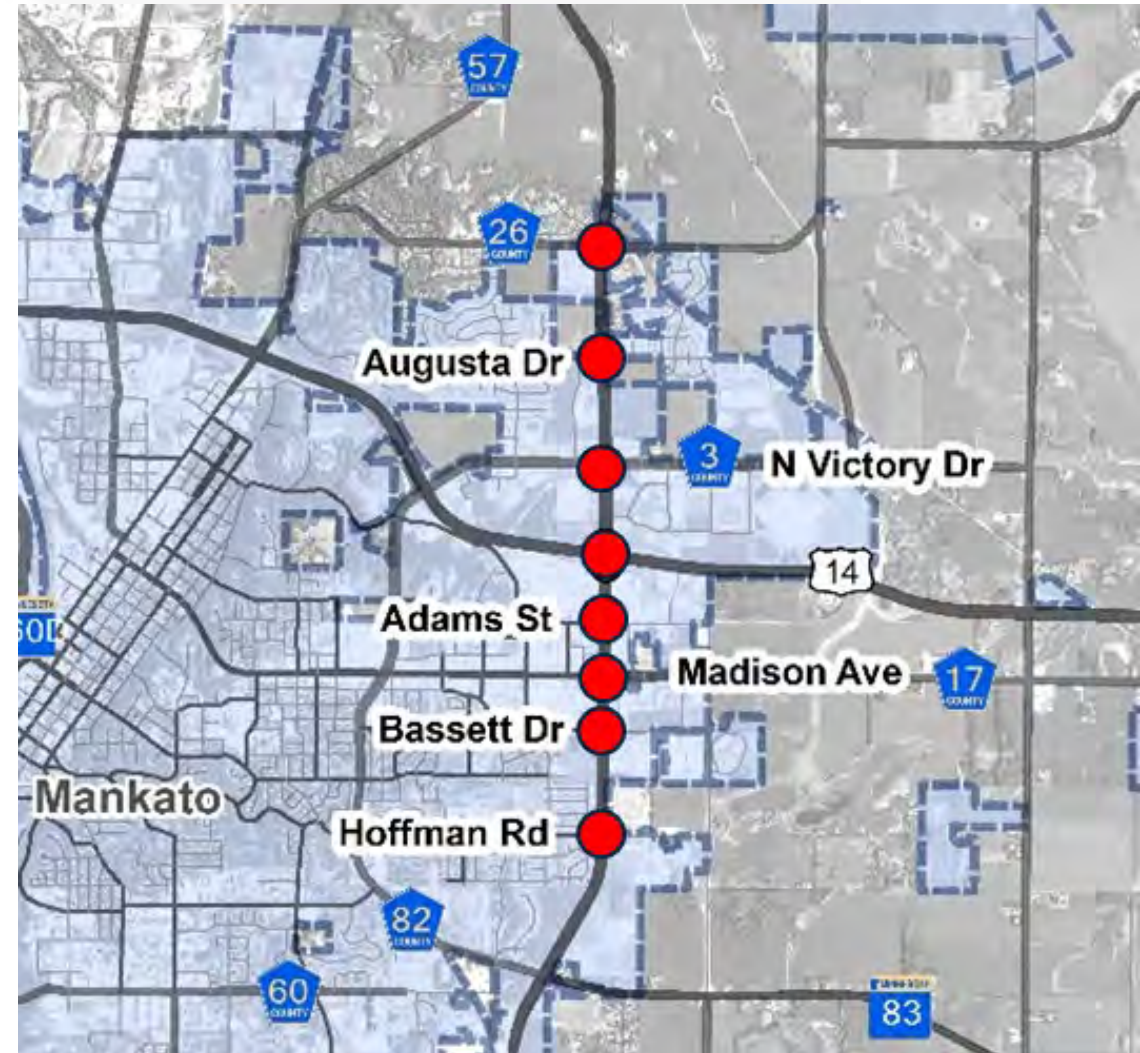
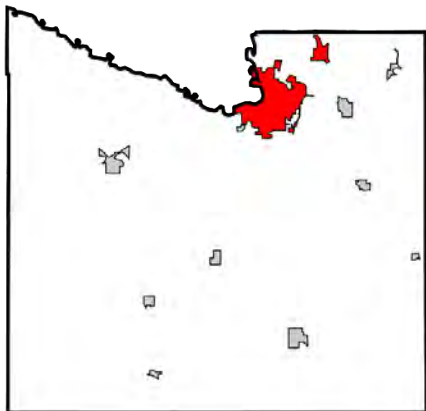
Evaluation output directory: E:\VISSIM\TH 22\2045_Build Traffic Signals_24 Hours\

Result Management Result Attributes Direct Output

	Write to file	Write database	From-time	To-time	
Area measurements (raw data)	☐		0	99999	
Convergence	☐				
Data collection (raw data)	☐		0	99999	
Discharge record	☐		0	99999	
Green time distribution	☐		0	99999	
Lane changes	☐		900	4500	More...
Managed lanes	☐				
Nodes (raw data)	☐	☐	0	99999	More...
Pedestrian record	☐	☐	0	99999	More...
Pedestrian travel times (OD data)	☐		0	99999	More...
Pedestrian travel times (raw data)	☐		0	99999	
Public transport waiting times	☐				
Signal changes	☐	☐			
Signal control detector record	☐				
SSAM	☒				
Vehicle input data	☐				
Vehicle record	☐	☐	0	99999	More...
Vehicle travel times (raw data)	☐	☐	0	99999	

Mankato, MN - TH 22

- 6 Critical Crash Intersections
- RAB or Signal Corridor?
- Peak Hour vs 24 Hour



No Build



Traffic Signals



Roundabouts



TH 22 – Operations Results

2030 Comparison	Signals	Roundabout Corridor		
Avg Delay (# of Vehicles)	47.1 s/veh	22.6 s/veh (-52%)		
Avg NB Travel Time	6.4 m/veh	6.7 m/veh (+5%)		
Avg SB Travel Time	6.7 m/veh	6.8 m/veh (+2%)		
2045 Comparison	Signals	Roundabout Corridor	RAB with Meters	
Avg Vehicle Delay	54.4 s/veh	53.1 s/veh (-2%)	35.1 s/veh (-35%)	
Avg NB Travel Time	6.6 m/veh	7.0 m/veh (+6%)	7.4 m/veh (+12%)	
Avg SB Travel Time	7.1 m/veh	7.1 m/veh (+0%)	7.4 m/veh (+4%)	



ENGINEERING, REIMAGINED

TH 22 Safety Results

2030 Comparison	Traffic Signal Corridor	Roundabout Corridor
Daily Total Conflicts	-	(-8%)
Daily Crossing Conflicts	-	(-15%)
Daily Rear-End Conflicts	-	(-18%)
Daily Lane Change Conflicts	-	(+44%)

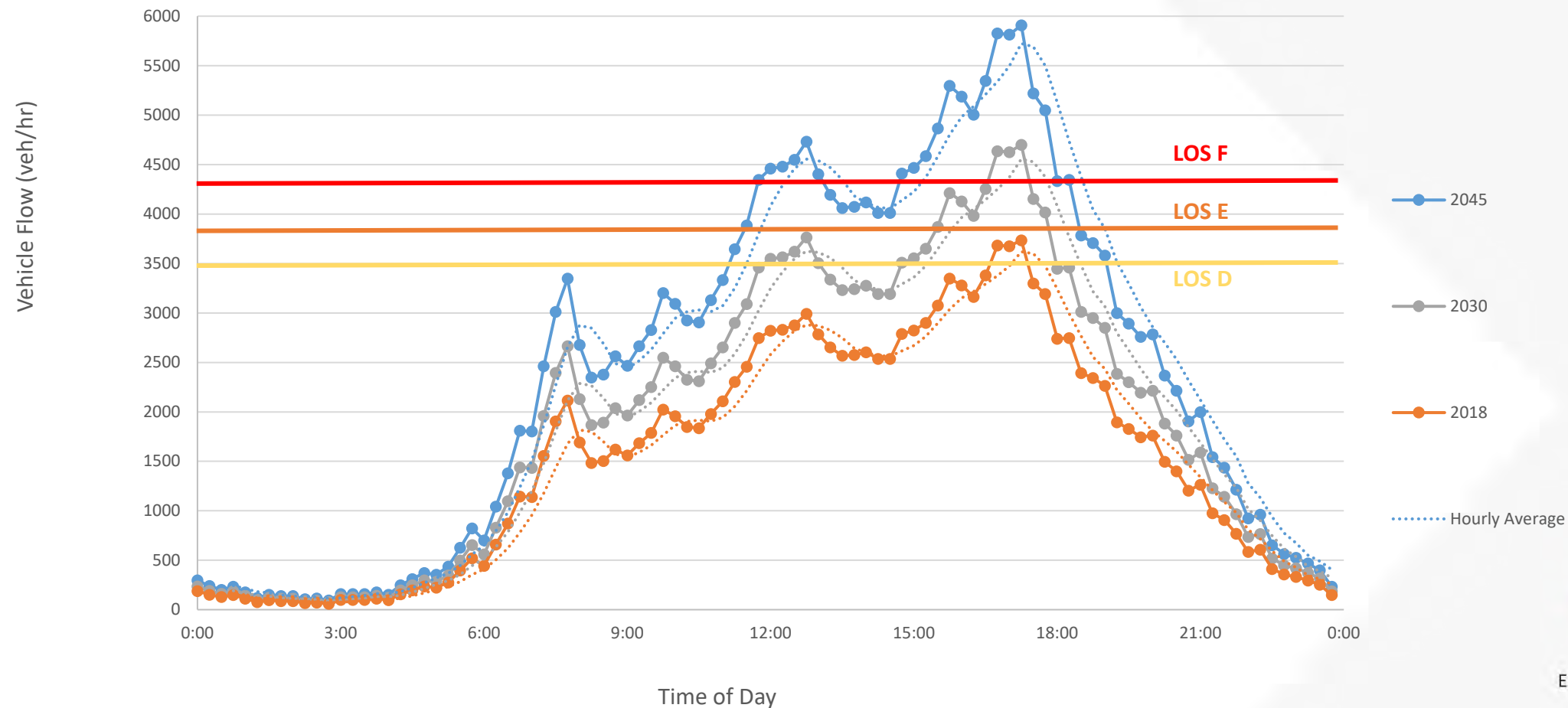
2045 Comparison	Traffic Signal Corridor	Roundabout Corridor	RAB with Meters
Daily Total Conflicts	-	(+11%)	(+39%)
Daily Crossing Conflicts	-	(-33%)	(-53%)
Daily Rear-End Conflicts	-	(+12%)	(+109%)
Daily Lane Change Conflicts	-	(+89%)	(+84%)



ENGINEERING, REIMAGINED

High Level Comparison

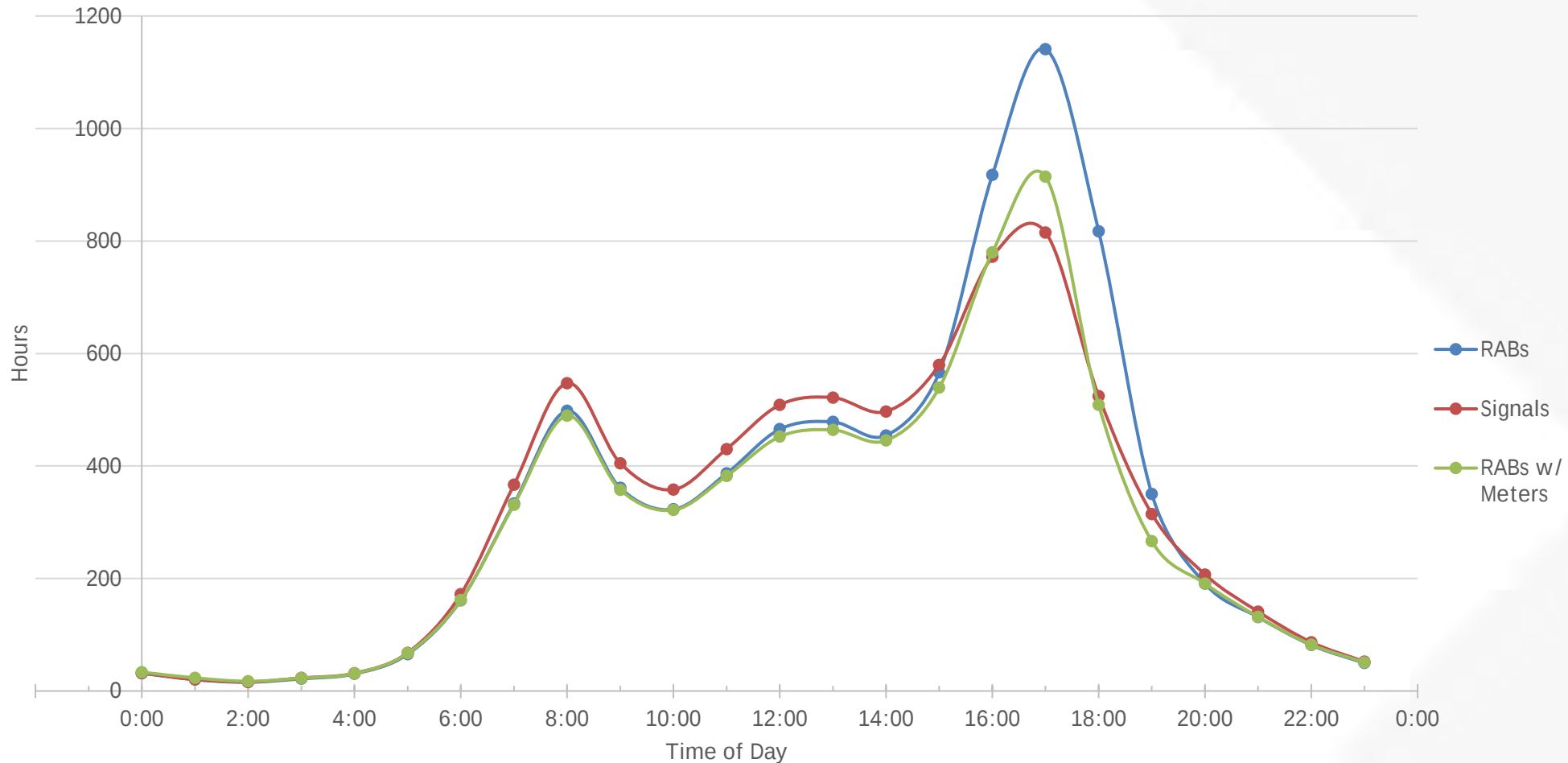
Adams Street and TH 22



ENGINEERING, REIMAGINED

Network Benefits vs Intersection Benefits

Year 2045 Daily Network Delay/Vehicle



ENGINEERING, REIMAGINED

TH 22 – PM Peak Operations Results

PM Build Alternatives	SSAM Results (# of Conflicts)				Travel Time Results (s)				Network Results				
	Total	Crossing	Rear End	Lane Change	NB TH 22 Hoffman Road to CSAH 26	NB TH 22 Hoffman Road to US 14	SB TH 22 CSAH 26 to Hoffman Road	SB TH 22 CSAH 26 to US 14	Total Vehicles	Total Travel Time (h)	Total Delay (h)	Average Del / Veh (s)	Latent Demand
2030 No Build PM	10,265	1,169	7,197	1,900	464	234	430	196	11,127	710	364	111	1,122
2045 No Build PM	15,448	1,632	11,300	2,515	559	284	471	198	12,790	975	573	149	2,542
2030 Roundabouts PM	13,059	926	9,619	2,514	459	222	691	381	12,087	653	247	69	0
2045 Roundabouts PM	21,372	1,340	15,772	4,259	520	272	1195	700	13,731	1,330	871	201	631
2045 Roundabouts Metered PM					667	415	1215	733	14,186	1,259	787	179	348
2030 Build Preferred PM	12,631	1,020	9,103	2,508	490	250	468	222	12,170	621	233	66	150
2045 Build Preferred PM	20,628	1,905	15,088	3,635	756	544	561	229	14,749	949	479	109	374
2030 Build Traffic Signals PM	10,392	976	8,131	1,285	474	247	483	221	12,357	589	222	62	0
2045 Build Traffic Signals PM	16,650	1,806	12,855	1,989	507	261	553	238	15,414	785	329	73	1



ENGINEERING, REIMAGINED

Case Study #2: US Hwy 12

- Rural 2-Lane highway at capacity
- High Fatality and Injury Rates
- US Highway 12 At-Grade vs Quadrant vs Interchange
- Evaluation included Node, Network, Travel Times, and SSAM
- Quantitative Benefit Cost Analysis



Queues in VISSIM, Not in Macrosimulation

- Roundabout calibrated to HCM 6th Edition
- Max Queues are 3-4x longer than Rodel
- Peak 15 minutes is over capacity but not the Peak Hour

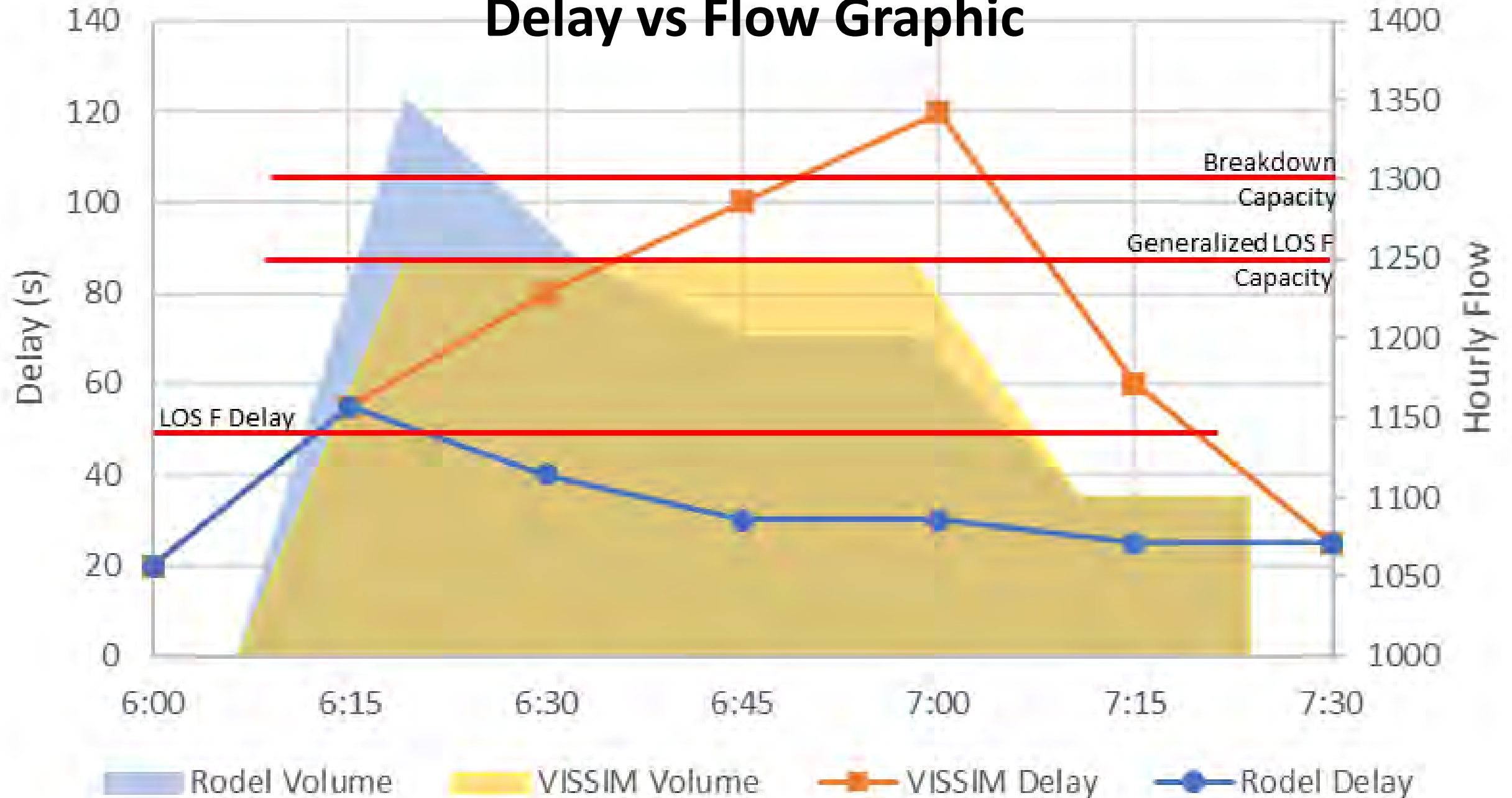


ENGINEERING, REIMAGINED

When Macro Simulation is over capacity

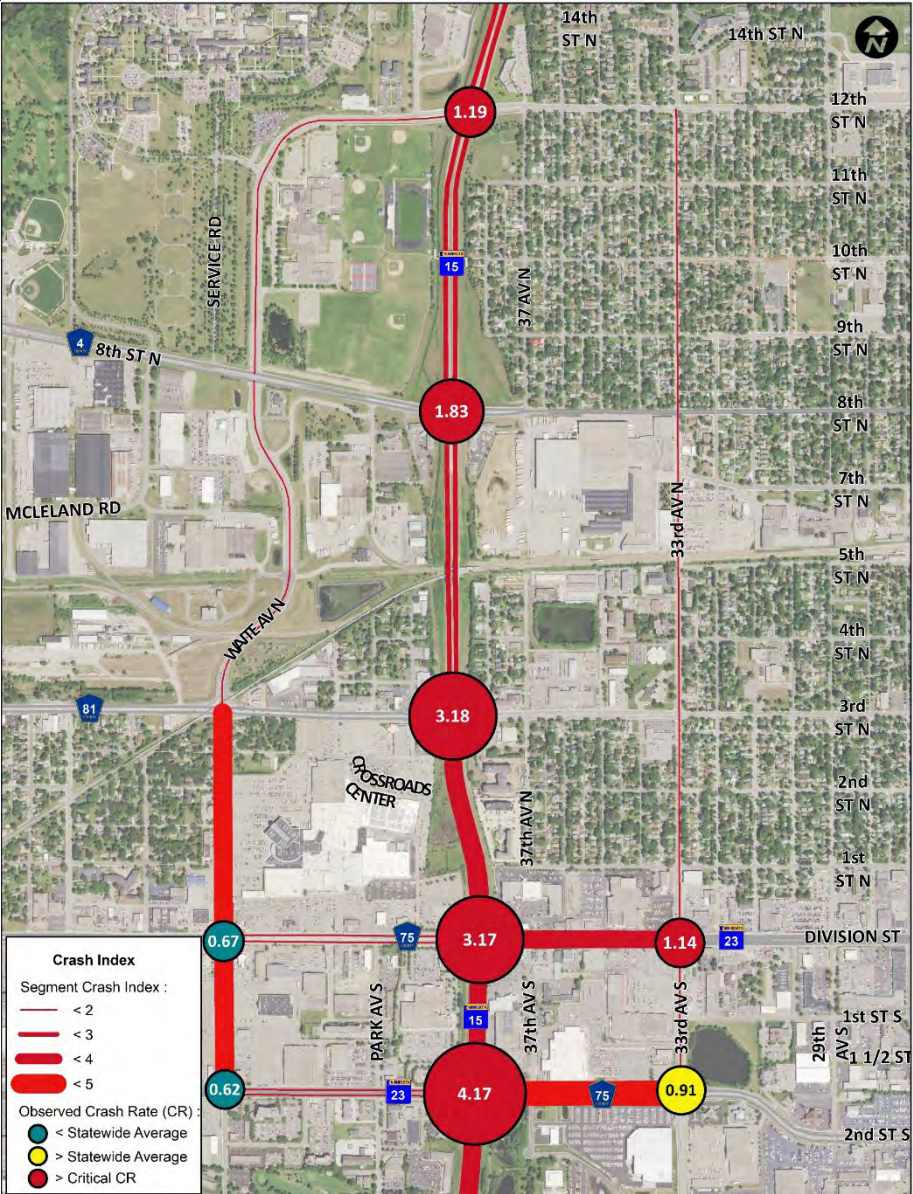
2019 Analysis			Modifiers		Turning Volumes (veh/hr)							Arrival Volume Ratios			Arrival Volume Times (min)			PHF
			Truck	Factor				U-Turn	Exit-2	Exit-1	Bypass	Ratio1	Ratio2	Ratio3	Time1	Time2	Time3	
1	EB TH 12		3.0	1.00				0	1096	15	0	1.150	0.980	0.935	0	15	30	
2	NB CSAH 92		3.0	1.00				0	21	0	99	1.040	1.130	0.925	0	15	30	
3	WB TH 12		3.0	1.00				0	47	0	0	1.040	1.130	0.925	0	15	30	

Delay vs Flow Graphic

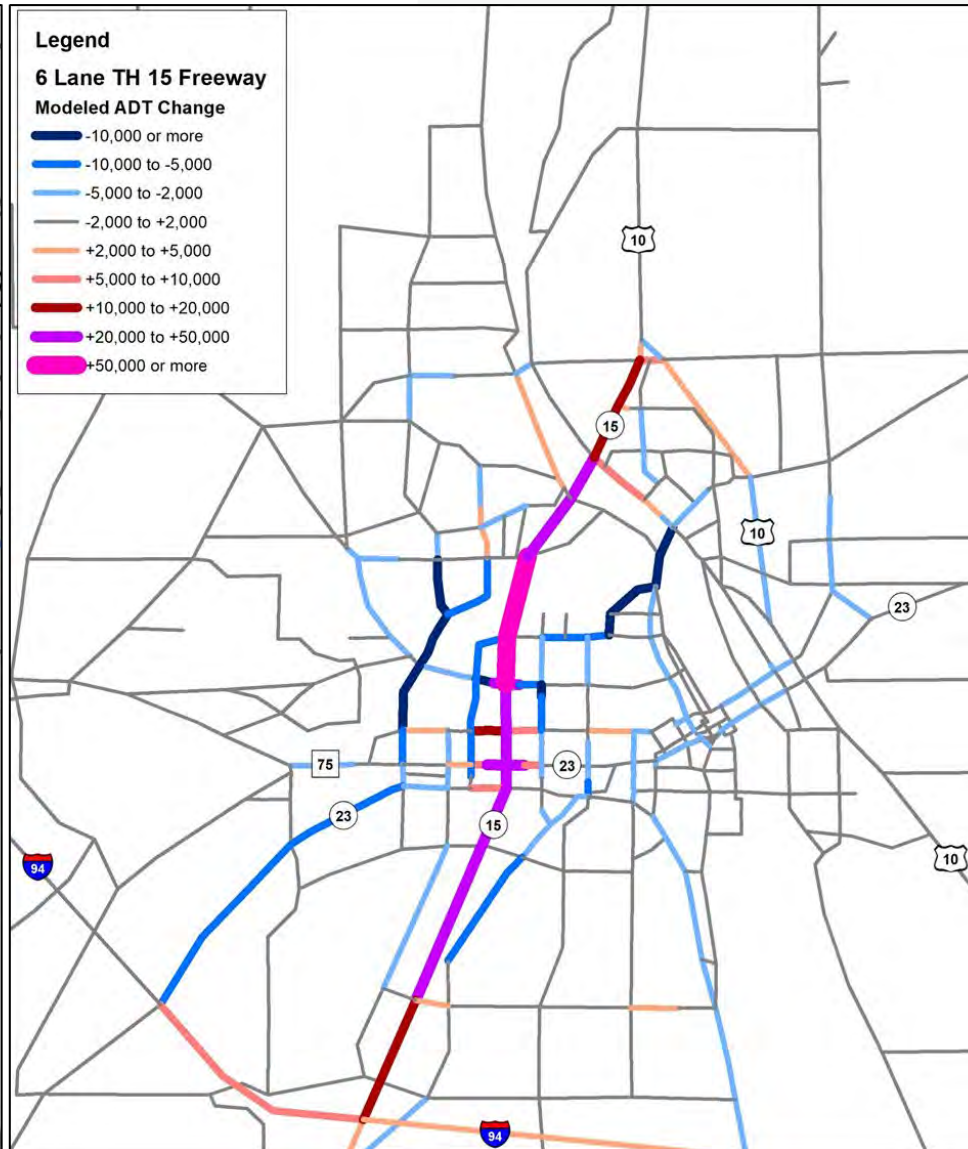
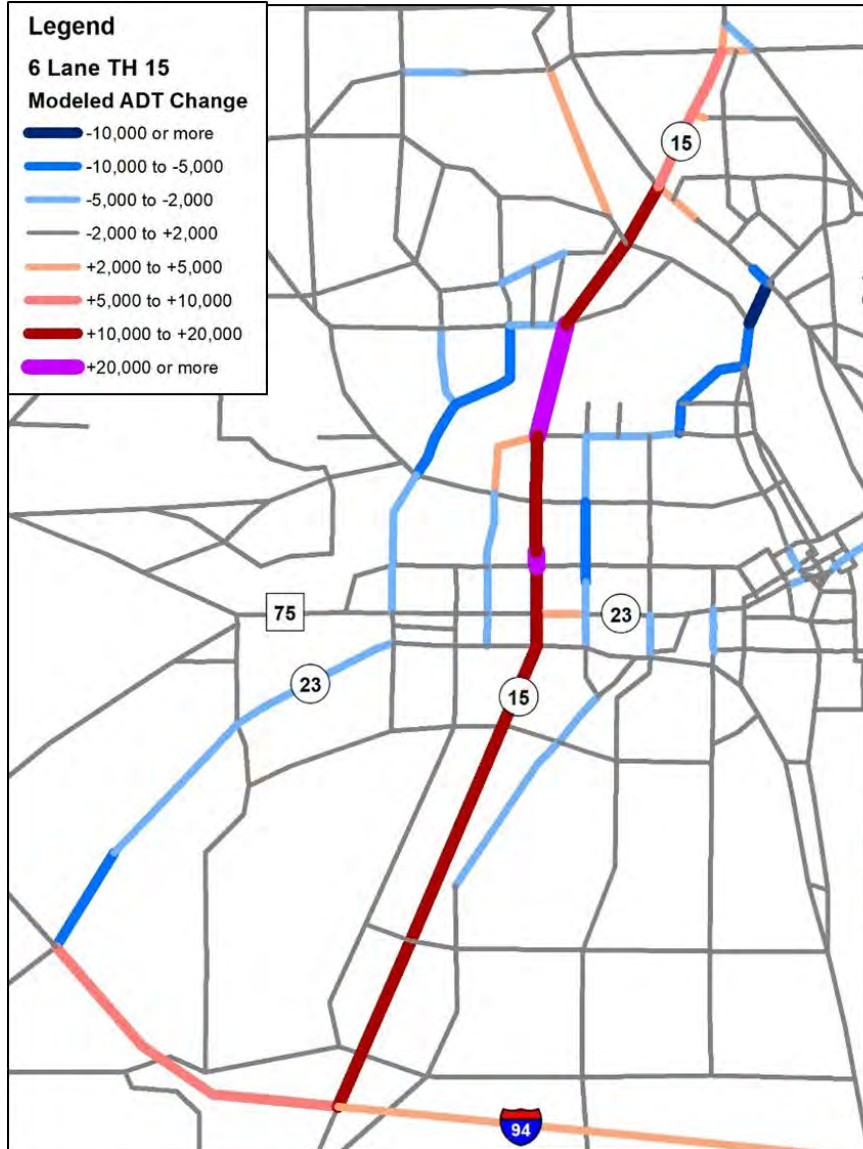


Case Study #3: MN Hwy 15

- State Highway 15 At-Grade vs Interchange
- Urban 4-lane (5 Signals)
- 3 of Top 5 highest crash intersections in Minnesota
- Evaluation included Node, Network, Travel Times, and SSAM
- Needed short-, mid-, and long-term implementation plan



Latent Demand is the MN Hwy 15 Corridor

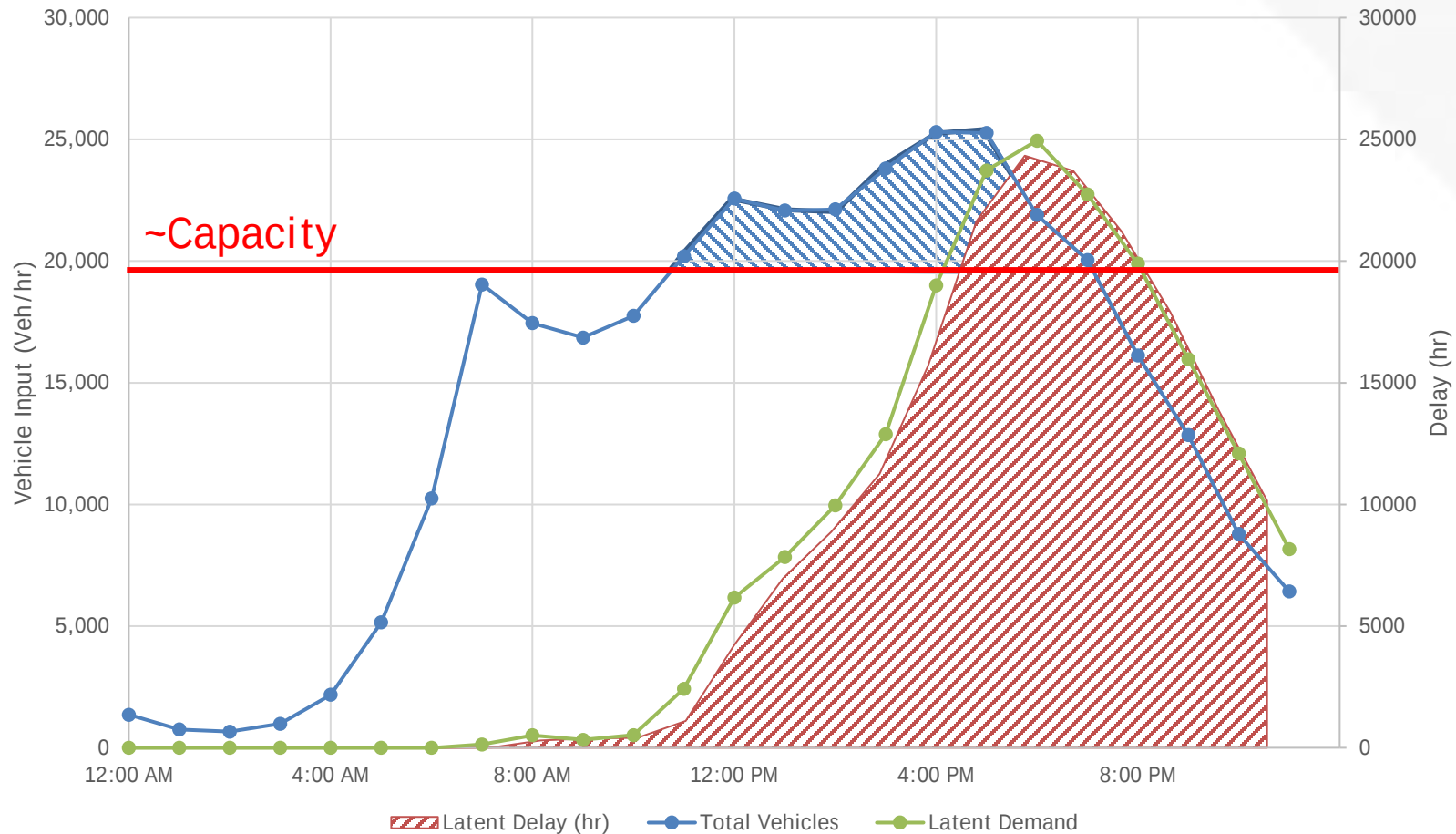


- > 15,000-20,000 with 6-lane
- > 25,000-30,000 with 4-lane freeway
- > 40,000-50,000 with 6-lane freeway



ENGINEERING, REIMAGINED

TH 15 No Build Latent Demand (Network Results)



- Over Capacity between 11:00am – 7:00pm
- Max of Latent Demand = Vehicles over Capacity
- Total Latent Demand 25,000 matched Cube Estimates for at-grade



“Can’t build out of Latent Demand”

➤ Interchange Options:

- Saw LOS E/F locations with added volume
- Saw increased conflict locations which decreased safety benefit
- Fixed Regional Movements but not Local Access Movements

[illegible]