TransModeler Training
7- Model Review and Calibration

presented to

Caltrans, District 1-Eureka

presented by

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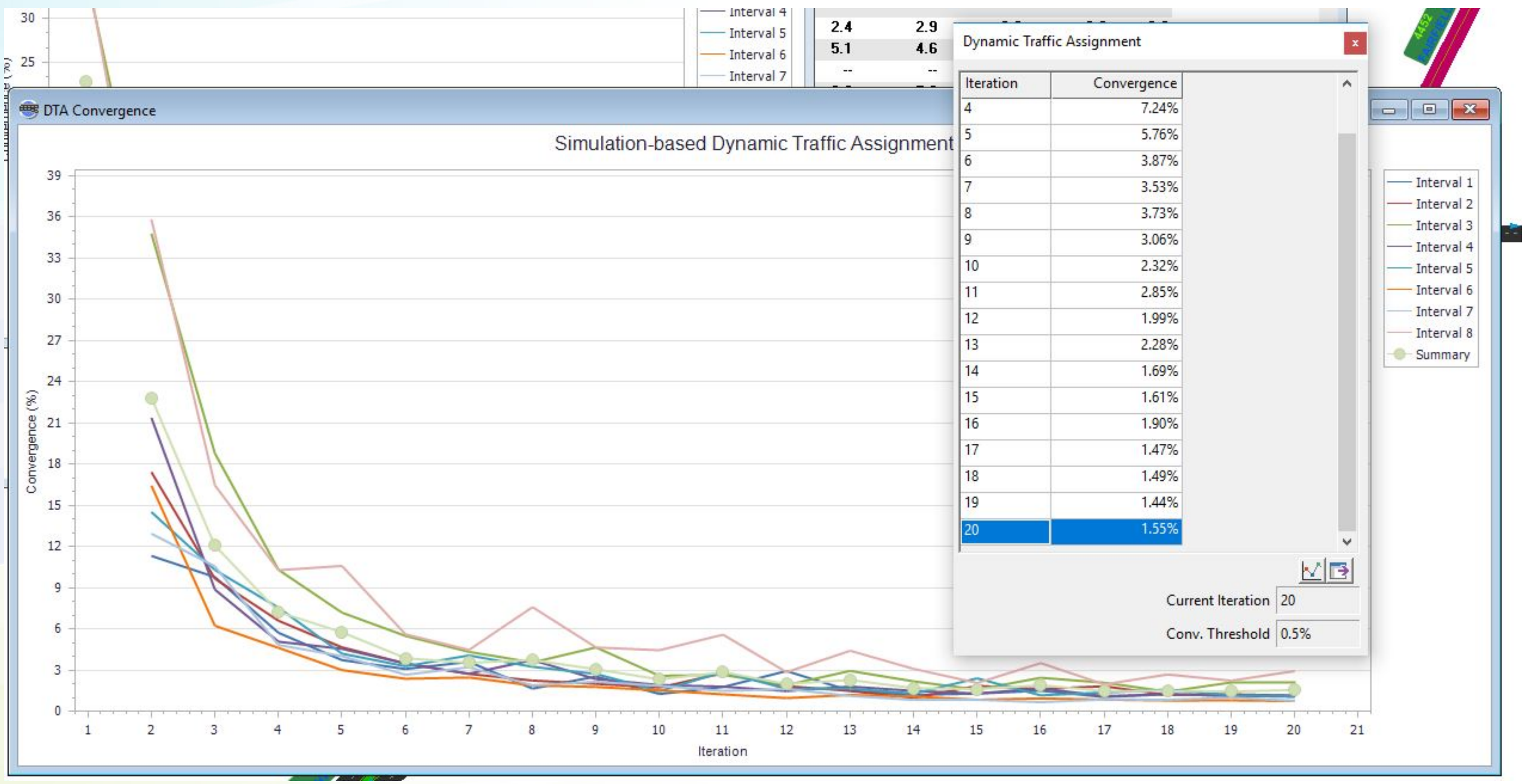
CAMBRIDGE SYSTEMATICS

Think Forward

November 2018

DTA Review

- Convergence:



CAMBRIDGE SYSTEMATICS

DTA Review

- Travel Time Fluctuation:

Dataview1 - Historical Travel Times

ID	AB_Time_0700	BA_Time_0700	AB_Time_0715	BA_Time_0715	AB_Time_0730	BA_Time_0730	AB_Time_0745	BA_Time_0745	AB_Time_0800	BA_Time_0800	AB_Time_0815	BA_Time_0815	AB_Time_0830	BA_Time_0830	AB_Time_0845	BA_Time_0845	AI
7716	68.8	60.8	68.9	61.3	69.3	60.7	70.6	60.6	69.8	60.3	70.3	61.1	69.2	61.1	67.7	61.1	
4598	59.9	--	60.4	--	59.9	--	59.3	--	60.5	--	60.2	--	60.4	--	59.1	--	
4640	52.8	63.5	57.2	64.0	55.6	60.8	55.4	68.4	56.1	65.4	55.4	63.4	55.8	60.8	55.9	65.8	
8065	51.3	--	51.3	--	51.3	--	51.3	--	51.3	--	51.3	--	51.3	--	51.3	--	
7684	50.8	10.8	50.8	10.8	50.8	10.8	50.8	10.8	50.8	10.8	50.8	10.8	50.8	10.8	50.8	10.8	
8066	41.5	--	42.1	--	42.5	--	42.3	--	42.7	--	42.5	--	42.4	--	42.5	--	
8094	42.0	43.5	42.0	43.3	41.7	43.6	42.0	44.4	42.9	43.8	42.4	44.0	41.9	43.4	41.4	43.5	
6651	39.2	--	39.4	--	39.5	--	39.5	--	39.5	--	39.7	--	39.7	--	39.8	--	
8023	40.6	10.4	37.7	10.3	41.8	10.2	38.4	10.3	38.4	10.5	46.9	10.5	45.8	10.3	41.2	10.2	
8040	17.7	2.9	18.3	2.9	32.7	2.9	36.2	2.8	39.1	2.8	31.0	2.9	39.0	2.8	33.6	2.8	
7991	32.6	7.7	32.6	7.8	32.6	7.8	32.6	8.0	29.9	7.7	34.8	7.9	28.7	7.7	30.1	7.7	
4174	31.8	13.5	31.8	15.8	31.8	15.0	31.8	15.7	31.8	14.9	31.8	16.8	31.8	14.2	31.8	14.5	
8093	30.0	--	30.7	--	30.0	--	30.0	--	29.3	--	30.2	--	29.8	--	30.2	--	
3850	29.5	12.5	29.5	13.5	29.5	13.8	29.5	15.0	29.5	14.7	29.5	13.3	29.4	15.4	29.4	14.1	
4691	22.3	--	21.8	--	26.3	--	29.0	--	27.2	--	26.4	--	21.9	--	22.9	--	
4052	28.9	11.2	28.9	11.2	28.9	11.2	28.9	11.2	28.9	11.2	28.9	11.2	28.9	11.2	28.9	11.2	
8077	27.7	27.8	27.5	27.9	27.6	28.3	28.2	28.1	28.4	28.2	28.3	27.9	28.4	28.4	28.5	28.2	
4534	26.4	--	25.9	--	25.9	--	26.1	--	26.1	--	25.7	--	25.9	--	25.9	--	
8082	14.0	--	17.8	--	18.2	--	24.5	--	24.0	--	26.5	--	24.3	--	21.9	--	
4612	23.5	10.5	23.5	10.5	23.5	10.7	23.4	10.4	26.1	10.5	27.3	10.5	26.7	10.4	21.1	10.4	
3822	23.0	14.0	23.0	15.0	23.0	15.8	23.0	17.3	23.0	17.8	23.0	15.4	23.0	16.2	23.0	14.9	
6934	22.2	--	22.3	--	22.3	--	22.3	--	22.3	--	22.4	--	22.3	--	22.4	--	
4101	20.6	28.3	21.8	25.8	23.8	28.2	22.0	28.7	20.5	26.7	21.0	26.4	21.0	28.1	21.6	26.7	
3765	16.4	25.2	23.9	26.6	26.4	26.6	21.6	38.5	24.6	38.5	18.3	38.5	16.8	38.5	21.8	38.5	
4641	21.5	27.5	20.4	30.4	23.2	22.7	21.0	21.0	22.7	24.4	24.6	22.3	27.3	27.5	25.0	24.2	

- Sorted the historical travel time table decreasing for 7:30 and 7:45, checked the higher travel times and their fluctuation over time. Looks reasonable.

Calibration

- Calibration is a process whereby the analyst selects the model parameters that cause the model to best reproduce field-measured local traffic operations conditions.
- A robust calibration leads to reliable future and alternative analysis
- Usually a modeler tries to calibrate:

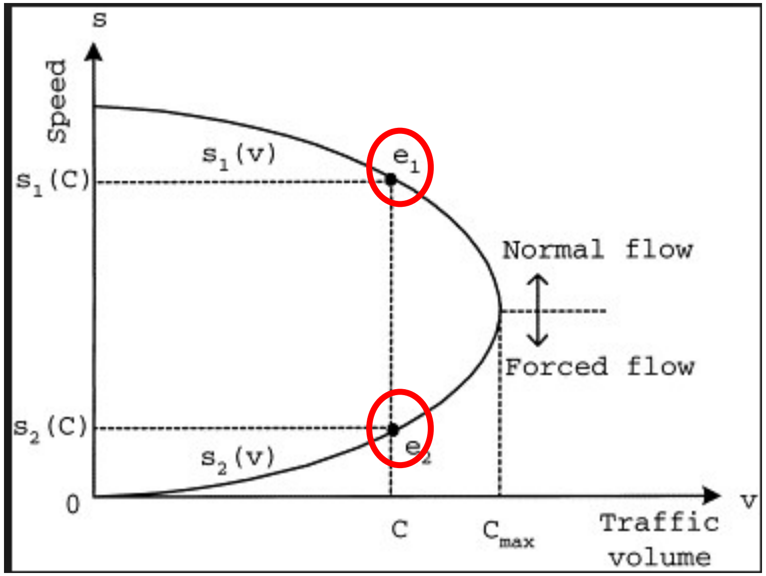
  link volume and intersection turning movements
  link speed and intersection delay
  link/intersection queue length
  temporal and spatial limits of bottlenecks
  route choice
  OD pattern

Interaction between Volume and Speed

- On fundamental speed-flow curve, there are always two traffic states with the same flow but different speeds. One is stable and has demand and flow lower than capacity, and the other one is unstable, has flow lower than and demand higher than the capacity.

- In presence of congestion, replicating volume without speed is useless. But simultaneous replication of volume and speed guarantees replication of the demand.

- Calibrating speed and volume is usually iterative, and adjusting one, will affect the other one.



Calibration approach

- Since calibration of demand, route choice, and network parameters is an iterative procedure, it is recommended to approach calibration through these steps to minimize the number of iterations between these components:

1. Error checking
2. Setting capacity parameters
3. Calibration of demand and route choice
4. Fine tuning for delay and speeds

Following these steps is particularly useful in congested and complex networks.

Error Checking

- Network connectivity (track a single vehicle along a route, assure there is no superimposed link, node, run the model with low demand and make sure all vehicles are assigned)
- Facility type, number of lanes (color coded maps)
- Intersection geometry, conflicts & priorities
- Speed limits, reduced speed areas
- Signal timings
- Demand (total generated and attracted, OD Desire Lines, aggregated vehicle composition, vehicle performance specification)
- Run model with 40%-50% demand, any congestion?
- trace single vehicle through network and see if there is any location it unexpectedly slows down.
- Run and watch animation with 20% and then 50% demand

Set Capacity Parameters*

- Uninterrupted flow: Capacity-metered volume (locations where queues persist for at least 15 min)
- Signalized Intersections: Identify the approach legs that frequently have queues of at least 10 vehicles per lane and measure the saturation flow rate per hour per lane

$$c = s\frac{g}{C} \quad \text{(Equation 2)}$$

where:

c = capacity (vehicles per hour (veh/h))

s = saturation flow (veh/h per green phase)

g = effective green time

C = cycle length

- Several measurements of maximum flow rates should be made in the field and averaged.

Set Capacity Parameters

- ***Freeway Facilities:***

Mean following headway.

Driver reaction time.

Critical gap for lane changing.

Minimum separation under stop-and-go conditions.

- ***Signalized Intersections:***

Startup lost time.

Queue discharge headway.

Gap acceptance for unprotected left turns.

Driver behavior

- Aggressiveness
- Reaction time
- Desired speed
- Acceptable critical gap
- Cooperation
- Awareness (familiarity with the road and traffic condition
- Compliance

Calibrating Demand and Route Choice

- This is an iterative effort
- First, check if for screenlines, if total model volume matches total observed counts. If they match, the mismatch of volume/count on individual route can be fixed by improving the route travel time and route choice parameter, if not, it means the demand needs to be adjusted*.
- The analyst must adjust the input demand as necessary to create a queue upstream of the target section to be calibrated so that the model will report the maximum possible flow rate through the bottleneck.
- If the model initially shows congested bottlenecks at locations that DO NOT exist in the field, it will be necessary to temporarily increase the capacity at those false bottlenecks (using temporary link-specific headway adjustments). These temporary adjustments are then removed during the fine-tuning phase.

Calibrating Demand and Route Choice-cont

- Once the analyst is satisfied that the model reproduces as closely as possible the field-measured capacities, the next step is to then calibrate the route choice parameters in the model to better match the observed flows. The temporary demand adjustments used in the previous capacity calibration step are reversed. The model-predicted volumes are then compared to the field counts and the analyst adjusts the route choice algorithm parameters until the best volume fit is achieved.

- usually involve weightings placed on the actual cost and travel time for each route.

Parameter selection

- Global vs local, for having a robust model, it is better to first, and as much as possible to change global parameters tat affect the whole model, and adjust the local parameters if defendable.
- Keep it manageable: The analyst should attempt to keep the set of adjustable parameters as small as possible to minimize the effort required to calibrate them. Whenever practical, the analyst should use observed field data to reflect local conditions. This observed data will serve as the nonadjustable values for certain calibration parameters, thus leaving the set of adjustable parameters to a minimum. However, the tradeoff is that more parameters allow the analyst more degrees of freedom to better fit the calibrated model to the specific location.
- Avoid overfitting: a model may perfectly match the current situation, but could poorly predict the future conditions, response unreasonably to small change in network or demand and will not be reliable for alternative analysis.

Caltrans Calibration Recommendation

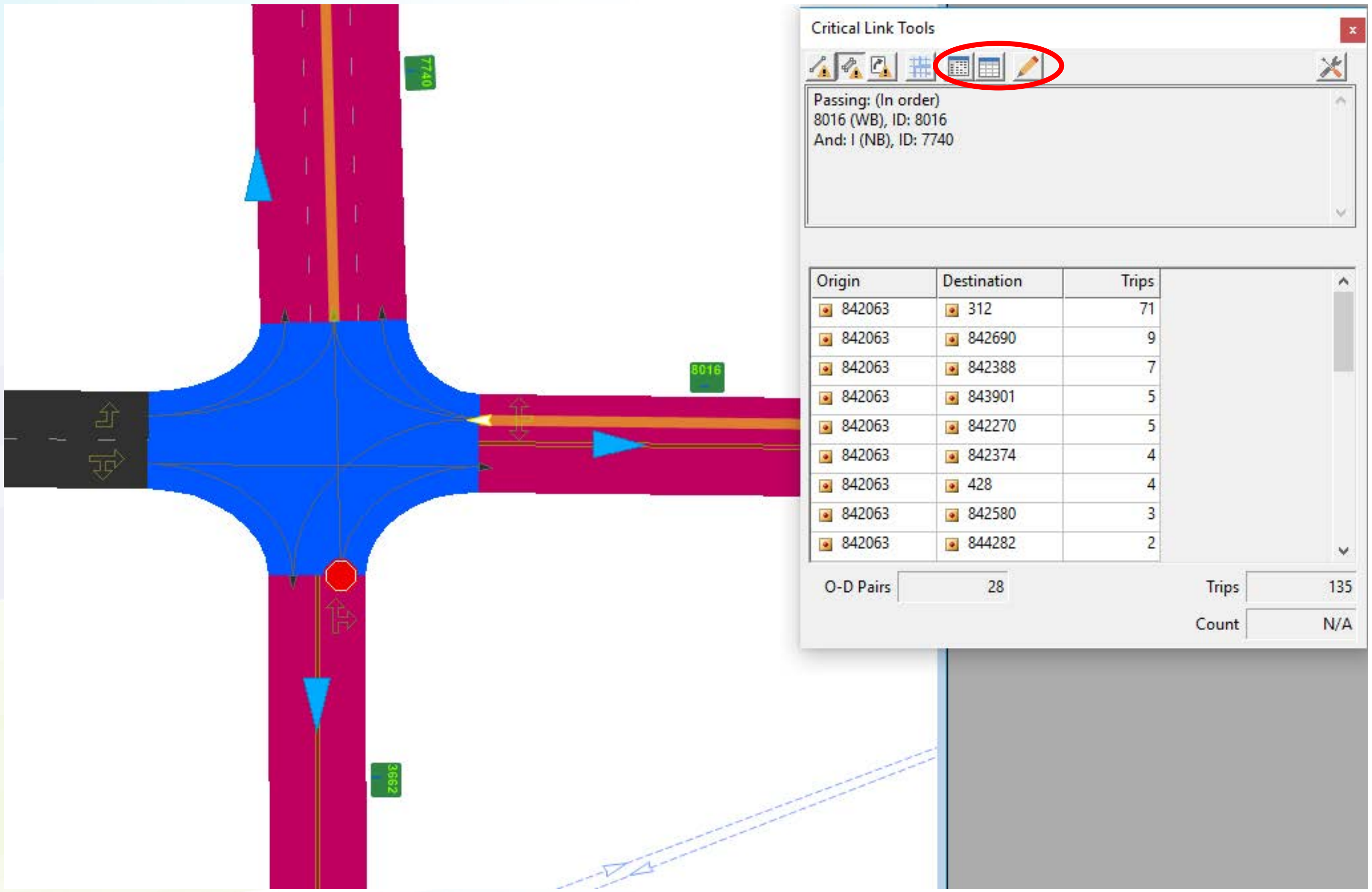
Criteria & Measures	Acceptability Targets
Hourly Flows, Model vs. Observed	
Individual Link Flows	
Within 15%, for 700 vph < Flow <2700 vph	> 85% of cases
Within 100 vph, for Flow < 700 vph	> 85% of cases
Within 400 vph, for Flow > 2700 vph	> 85% of cases
Total Link Flows	
Within 5%	All Accepting Links
GEH Statistic – Individual Link Flows	
GEH < 5	> 85% of cases
GEH Statistic – Total Link Flows	
GEH < 4	All Accepting Links
Travel Times, Model vs. Observed	
Journey Times Network	
Within 15% (or one minute, if higher)	> 85% of cases
Visual Audits	
Individual Link Speeds	
Visually acceptable Speed-Flow relationship	To analyst's satisfaction
Bottlenecks	
Visually acceptable Queuing	To analyst's satisfaction

Source: FREEWAY SYSTEM OPERATIONAL ASSESSMENT, Technical Report I-33, Paramics Calibration & Validation Guidelines, DRAFT , Wisconsin Department Of Transportation, District 2, June 2002

Improve Goodness of Fit

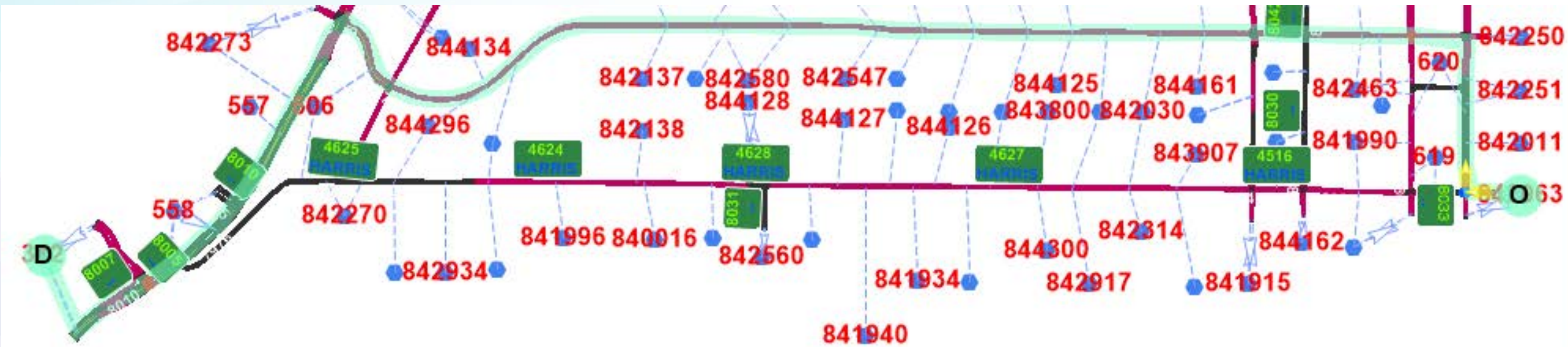
- Volume: Manually and slightly adjusting trip tables (already a result of ODME), only for OD pairs that contribute significantly on link volumes that are significantly different from observed count. This adjustment should be accompanied by local knowledge and judgment.
- TransModeler provides a tool that determine OD pairs that would potentially pass thorough a certain link, or turning movement
- Make sure in the project setting, the output folder has the address of your desirable run
- Go to Demand→ Critical Link Tools*
  turning movement 8016-842046-7740 under-estimated for 8 to 9 a.m. and we like to increase the trips that contribute to this turning movement:

Improve Goodness of Fit



Improve Goodness of Fit

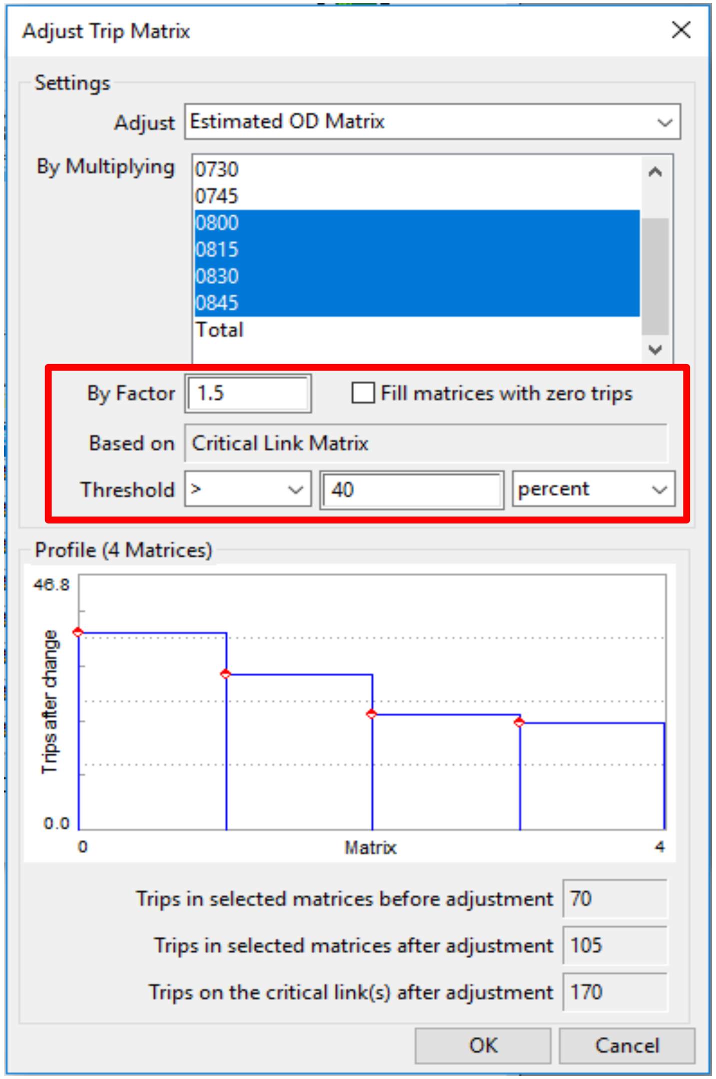
- Review major contributors to this turning movement by clicking on those with highest number of trips:



- Make a copy of the estimated OD and call it Adjusted OD
- Open the adjusted OD file and click on to edit the matrix

Improve Goodness of Fit

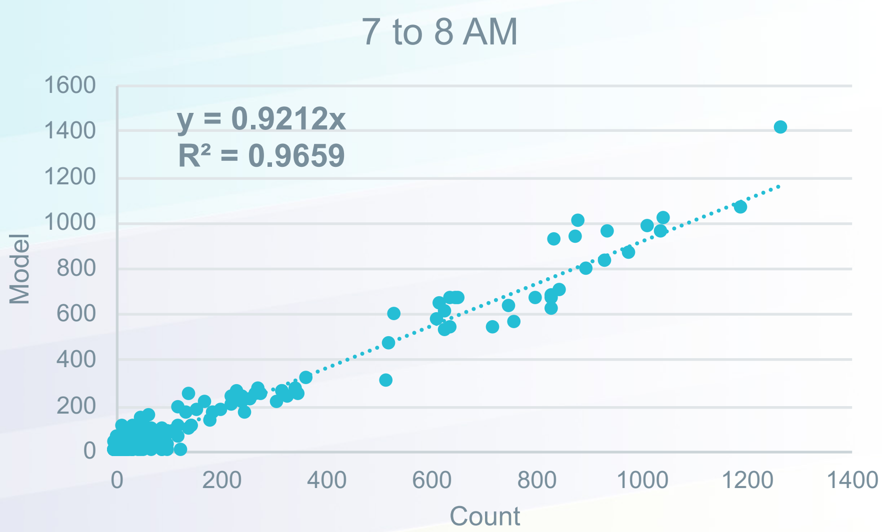
- You can apply a decreasing or increasing factor to all matrices or individual time periods that contribute on this turning:

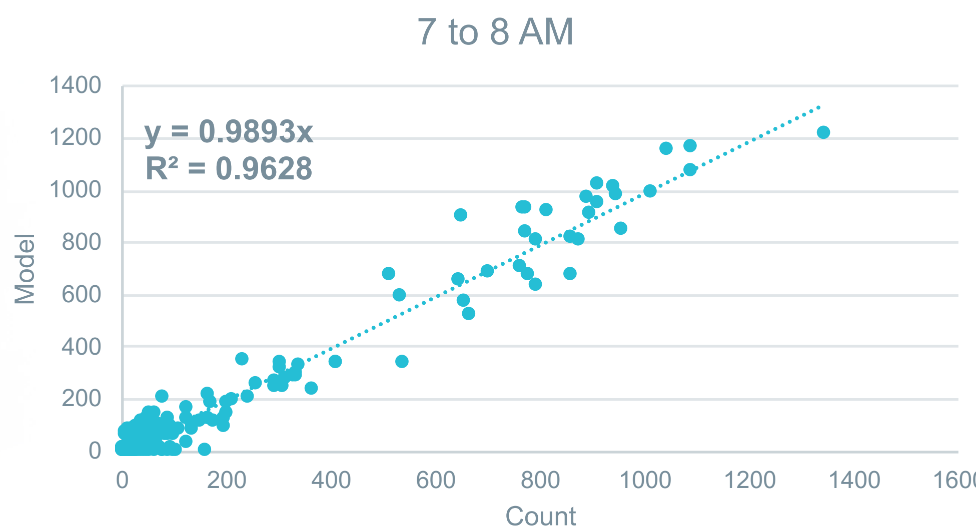


Improve Goodness of Fit

- The model has generally smaller travel time compared to the observed travel time. The free flow speed can be adjusted to improve the route travel time replication.

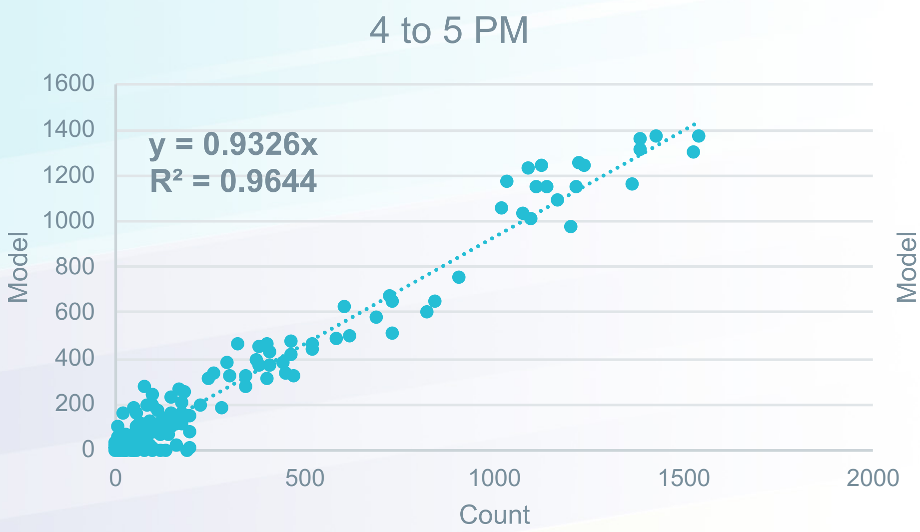
Turning Movement Replication - AM

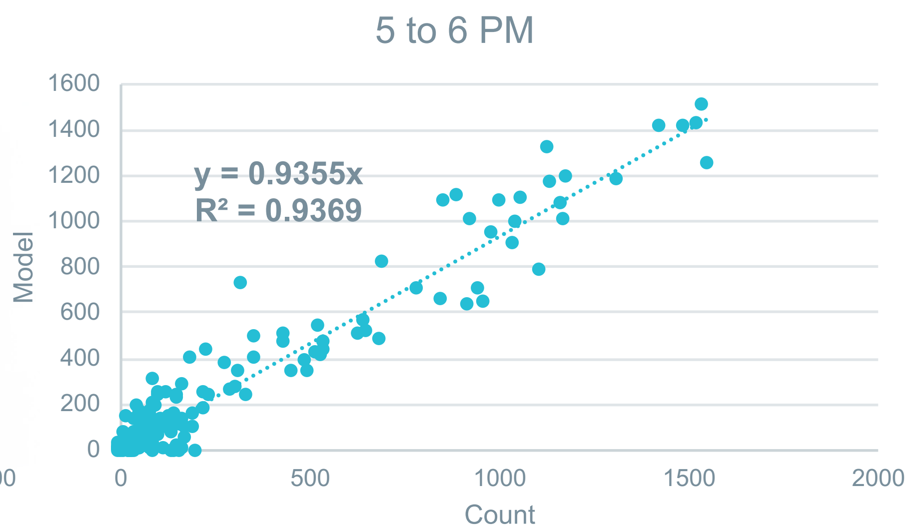




- GEH<5: 7 to 8: 71%, 8 to 9: 71%
- GEH<10: 7 to 8: 96%, 8 to 9: 94%

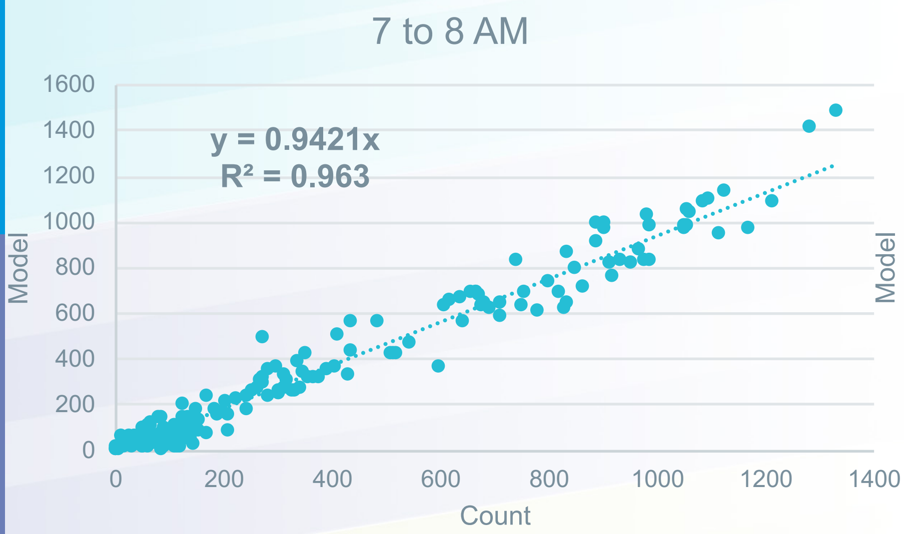
Turning Movement Replication - PM

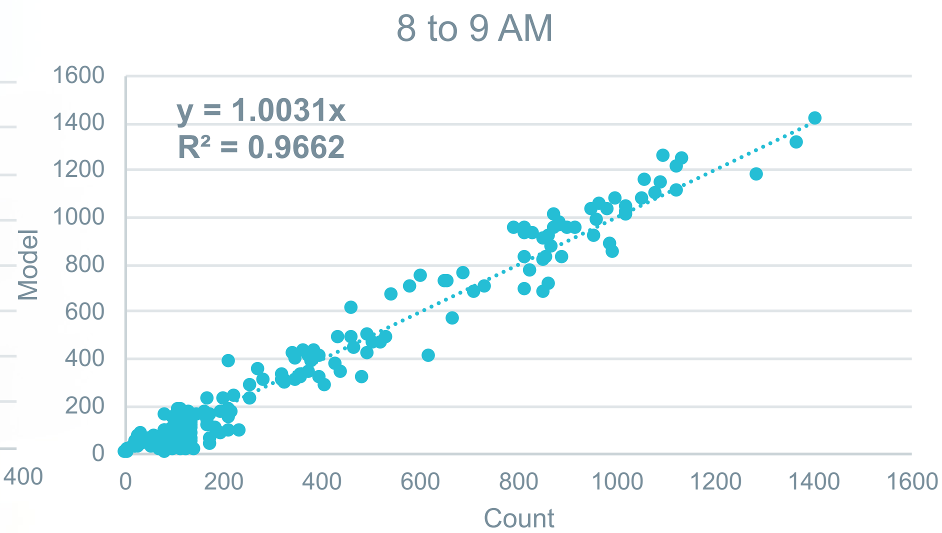




- GEH<5: 4 to 5: 66%, 5 to 6: 59%
- GEH<10: 4 to 5: 89%, 5 to 6: 89%

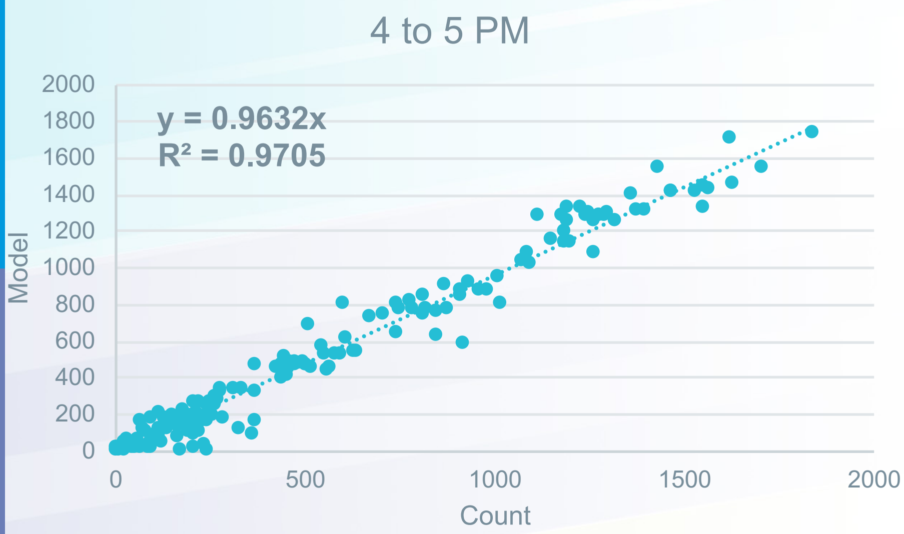
Segment Volume Replication- AM

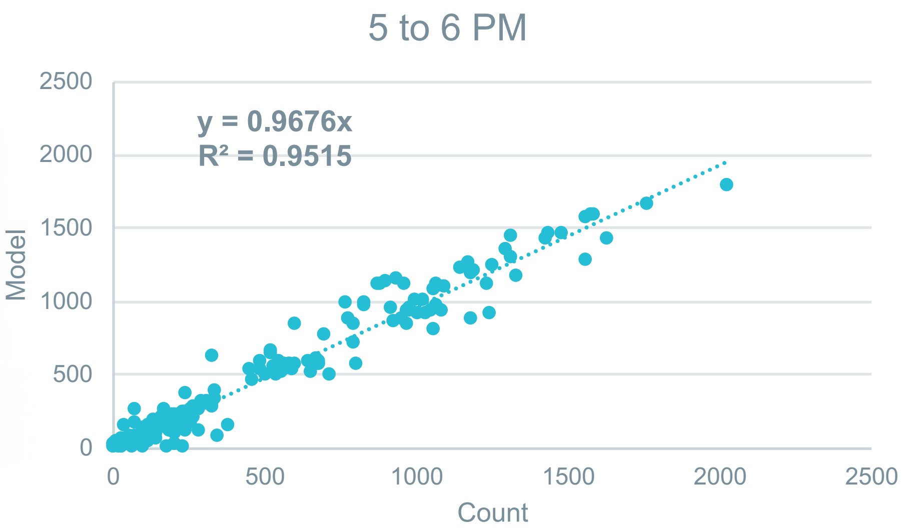




- GEH<5: 7 to 8: 76%, 8 to 9: 75%
- GEH<5: 7 to 8: 94%, 8 to 9: 94%

Segment Volume Replication- PM





- GEH<5: 4 to 5: 80%, 5 to 6: 72%
- GEH<5: 4 to 5: 95%, 5 to 6: 92%

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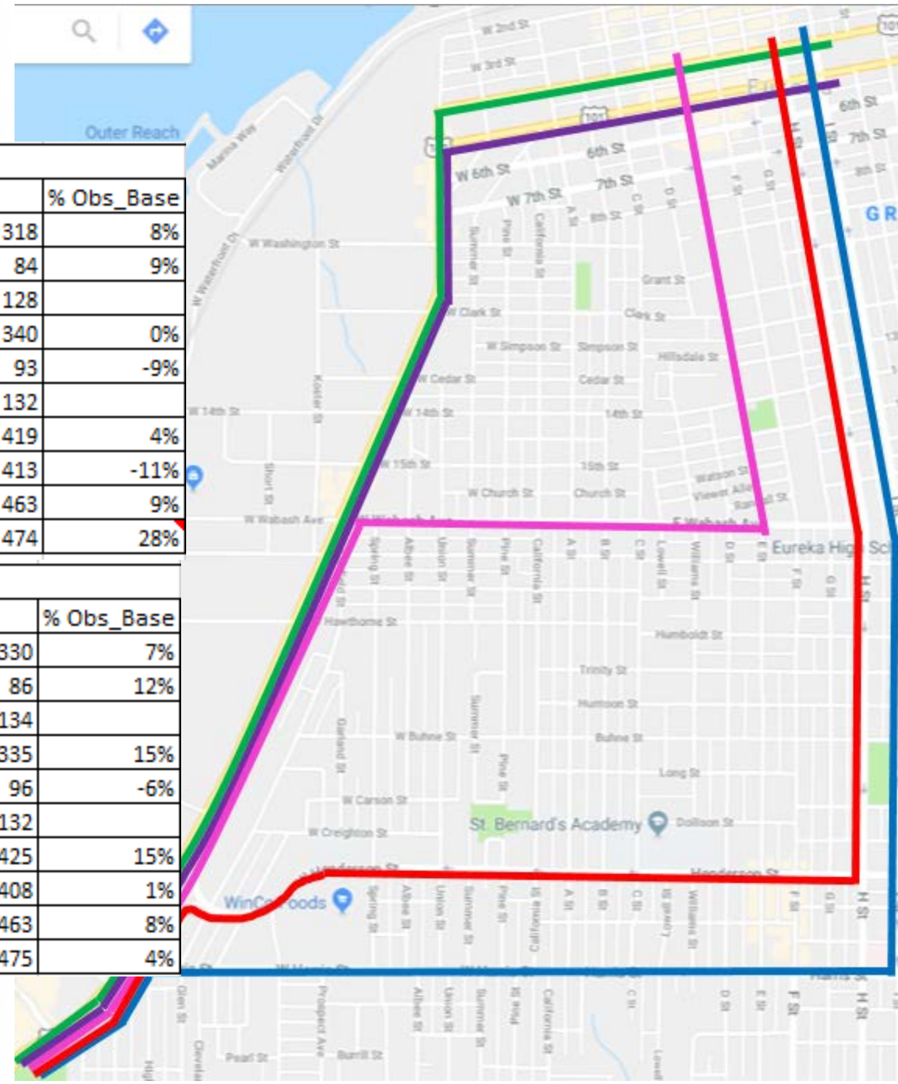
Route Travel Time Replication- AM

	7 TO 8 AM					
	Route	min Obs	Observed	Max Obs	Base	% Obs_Base
Total		266	294	349	318	8%
on 4 st		75	77	85	84	9%
On Koster Wabsh to 4 st		na	na	na	128	
		280	340	400	340	0%
on 5th st		81	102	111	93	-9%
On Broadway Wabash to 5 st		na	na	na	132	
SB		357	401	401	419	4%
NB		399	465	465	413	-11%
		382	425	478	463	9%
		371	371	461	474	28%

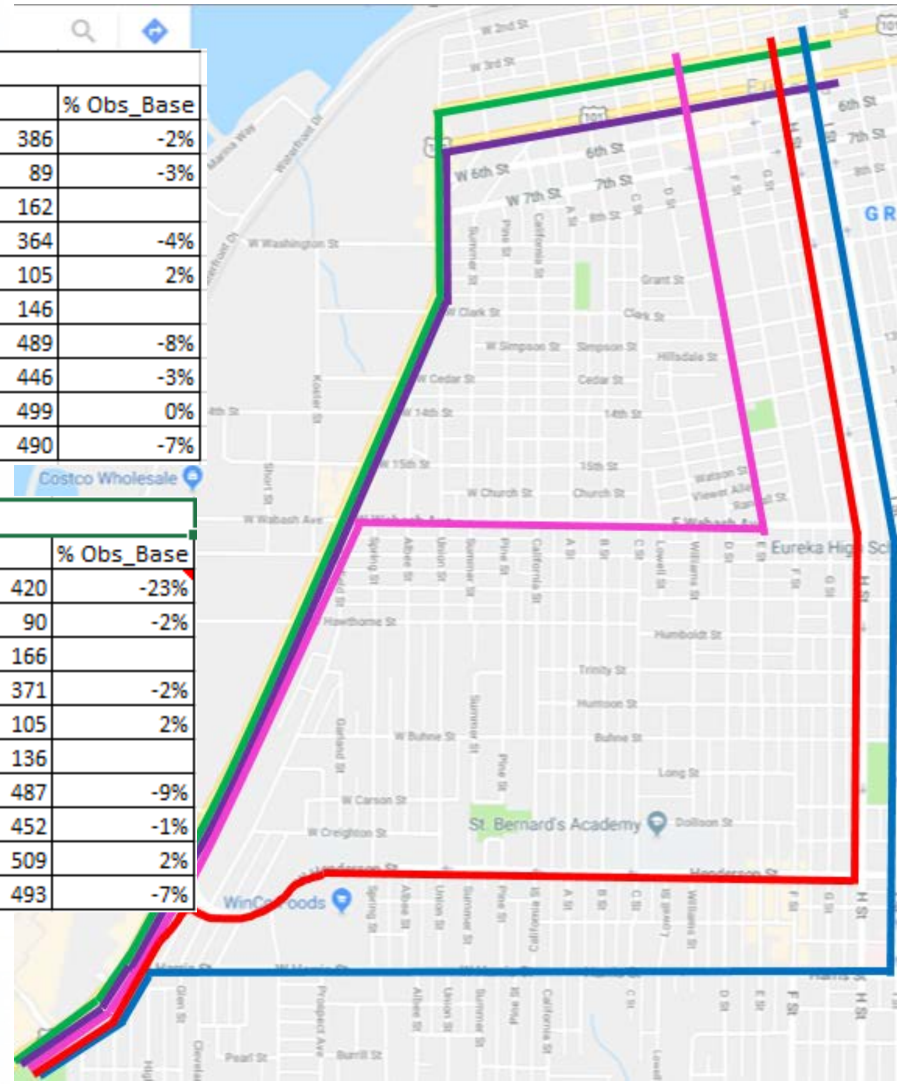
	8 to 9 AM					
	Route	min Obs	Observed	Max Obs	Base	% Obs_Base
Total		266	307	349	330	7%
on 4 st		75	77	85	86	12%
On Koster Wabsh to 4 st		na	na	na	134	
		280	292	400	335	15%
on 5th st		81	102	111	96	-6%
On Broadway Wabash to 5 st		na	na	na	132	
SB		357	371	401	425	15%
NB		399	402	465	408	1%
		382	430	478	463	8%
		371	456	461	475	4%



Route Travel Time Replication- PM

	4 TO 5 PM					
	Route	min Obs	Observed	Max Obs	Base	% Obs_Base
Total		339	395	545	386	-2%
on 4 st		82	92	108	89	-3%
On Koster Wabsh to 4 st		na	na	na	162	
		319	379	446	364	-4%
on 5th st		79	103	123	105	2%
On Broadway Wabash to 5 st		na	na	na	146	
SB		421	533	592	489	-8%
NB		424	459	524	446	-3%
		446	498	533	499	0%
		497	529	563	490	-7%

	5 TO 6 PM					
	Route	min Obs	Observed	Max Obs	Base	% Obs_Base
Total		339	544	545	420	-23%
on 4 st		82	92	108	90	-2%
On Koster Wabsh to 4 st		na	na	na	166	
		319	379	446	371	-2%
on 5th st		79	103	123	105	2%
On Broadway Wabash to 5 st		na	na	na	136	
SB		421	533	592	487	-9%
NB		424	459	524	452	-1%
		446	498	533	509	2%
		497	529	563	493	-7%



Alternative Model Development

- Once a model is reasonably calibrated, alternative networks can be built.
- Each alternative will have a separate folder, .smp, underlying .dbd, and other inputs.
- While modifying the network for alternative analysis please check:

I. When deleting a link, did that link include count? Do you need to adjust the turning movement bin file?

II. When adding a link, fill the free flow speed at segment layer, and function classification at link layer

III. How the change will affect the signal timing? For some locations new signal timing is needed. You can fine tune it by watching the simulation.

IV. Be mindful of how to change centroid connectors as a result of the network modification.