BURGESS & NIPLE

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Mr. Greg Channel, PE
TSMO Coordinator/Area Engineer
ODOT District 6
400 East William Street
Delaware, OH 43015

Re: FRA-670-2.50 (WB Only) TSMO Study
D6 GES (PID 112260); Task 6-G (23)

May 8, 2023

Dear Greg,

B&N has completed a preliminary study to evaluate potential TSMO strategies on I-670 Westbound between I-71 and SR 315 to address recurring congestion during the AM peak hour. The purpose of the study was to identify potential strategies or geometric modifications that could reduce recurring congestion experienced in the corridor. Solutions that reconfigure entire interchanges are outside of the scope of this study.

EXISTING CONDITIONS

I-670 Westbound between I-71 and SR 315 experiences recurring congestion, particularly during the AM peak hour. This corridor has two high volume weaving segments that are contributing to the congestion. The weaving segments are:

- I-71 Southbound on-ramp to 3rd Street/Convention Center Drive and 4th Street off-ramps
- I-71 Northbound and 3rd/4th Street on-ramps to Neil Avenue and SR 315 Northbound off-ramps

Both weaving segments contain ramps on both the left and right side of the mainline. This requires ramp-to-ramp traffic to make up to three lane changes in order to reach its destination. These lane changes combined with mainline lanes that are already near capacity result in congestion that spills back upstream of the I-71 interchange. **Figure 1** shows the 2022 INRIX congestion scan for I-670 Westbound. It shows that the mainline speeds are the lowest between the I-71 Southbound on-ramp and the 4th Street off-ramp. After 4th Street, they begin to pick up. While this study is focused on the AM Peak Hour, the INRIX data shows similar congestion patterns in the PM Peak as well. Knowing that traffic patterns have changed after the Covid pandemic, INRIX data was also obtained for 2019. **Figure 2** shows the 2019 congestion scan. The 2019 data shows similar congestion to the 2022 data except that speeds through the SR 315 interchange were a little lower in the 2019 PM compared to 2022.

2022 traffic volumes for the corridor were obtained from the ODOT TMMS site for the AM Peak. Knowing that the corridor currently experiences congestion, it was assumed that the counts represent the capacity of the corridor and not the true demand. The counts were increased by 20% to represent an assumed demand for the corridor and allow a more meaningful comparison of the analysis results. Weaving percentages in the corridor were determined using StreetLight data. **Figure 3** and **Figure 4** shows the 2022 AM Peak volumes with a 20% increase.

Capacity analysis was conducted for the existing configuration using the 2022 AM Peak volumes. Because segments of the corridor are over capacity and there are complex weaves that cannot be evaluated in the HCS software, the analysis was conducted using TransModeler software. **Table 1** shows the TransModeler results for the 2022 existing condition. To allow for a comparison with the concepts, the table shows the traffic demand for the AM Peak as well as the volume that was actually able to travel through the link in TransModeler.

Table 1: 2022 Existing Condition Capacity Analysis

Westbound I-670 Segment	Demand Volume	Volume	LOS	Density
East of I-71 Off	6910	6376	F	67.3
I-71 Off	2180	2069	C	24.1
Between I-71 Off & SB I-71 On	4730	4127	F	95.1
SB I-71 On	1780	1767	D	32.8
Between SB I-71 On & 3rd St/Convention Center Off	6510	5891	F	75.9
3rd St/Convention Center Off	1890	1718	C	21.6
Between 3rd St/Convention Center Off & 4th St Off	4620	4177	E	35.0
4th St Off	240	216	A	5.4
Between 4th St Off & NB I-71 On	4380	3956	F	45.3
NB I-71 On	1630	1620	C	18.6
Between NB I-71 On & 3rd/4th St On	6010	5574	D	32.0
3rd/4th St On	1040	1037	C	24.8
Between 3rd/4th St On & Neil Ave Off	7050	6609	D	32.6
Neil Ave Off	1020	971	B	11.7
Between Neil Ave Off & NB SR 315 Off	6030	5621	D	29.5
NB SR 315 Off	1970	1834	F	47.2
Between NB SR 315 Off & Goodale St On	4060	3772	C	24.5
Goodale St On	340	345	A	7.7
Between Goodale St On & SB SR 315 Off	4400	4120	C	20.1
SB SR 315 Off	1250	1178	D	27.5
Between SB SR 315 Off & SB SR 315 On	3150	2930	C	18.6
SB SR 315 On	860	863	B	17.4
West of SB SR 315 On	4010	3797	C	20.2

As shown in Table 1, the weave between I-71 Southbound on-ramp and 3rd Street/Convention Center Drive is well over capacity and the LOS F conditions spillback upstream. Through this weaving area the demand volume is 6510 vehicles per hour. However, only 5891 vehicles are able to get through the segment in the peak hour. Downstream of the 4th Street diverge the demand volume is 4380 vehicles in the two-lane section. This is over the capacity of a two-lane segment and will be an additional bottleneck location for I-670. Finally, the single lane ramp to SR 315 Northbound is at capacity.

TSMO STRATEGIES

As shown in the existing conditions, weaving movements and high traffic volumes are the primary capacity issues in the corridor. Strategies that may reduce traffic volumes in the corridor or provide additional capacity could potentially be beneficial. Possible strategies are:

Ramp Metering – Ramp metering is a potential strategy that could reduce the volume of traffic through the weaving segments provided there is room to store vehicles on the ramps without spilling back onto the arterials. For this corridor, most on-ramps have a fairly short length and even with a two-lane ramp meter could only store 30-40 vehicles per ramp. Between I-270 and I-71 there are three on-ramps at service interchanges. Metering these ramps keep some traffic off of I-670, but it would not be close to the approximately 500 vehicles needed for the weaving segment between I-71 and 3rd Street/Convention Center Drive. The 3rd/4th Street on-ramp is another location that could be metered. This ramp is longer than typical ramps and would be able to store 60 or more vehicles. This would eliminate some of the vehicles from this weaving segment and provide a little relief. Ramp metering will not provide a significant capacity improvement, but it could potentially provide some relief.

Part-Time Shoulder Use (SmartLane) – Adding a SmartLane through this corridor will not likely provide a significant impact. While the corridor and weaves could benefit from the additional lane through the weaving segments to spread traffic volumes out, the overall length of need is fairly short and finding a logical way to begin/end the SmartLane will be difficult. For this corridor it would make more sense to provide targeted permanent capacity improvements as opposed to part time improvements.

GEOMETRIC CONCEPTS

In addition to the TSMO strategies discussed previously, four separate geometric concepts were developed to address the weaving maneuvers and lane volumes along I-670 Westbound. These concepts differ in how the 3rd Street/Convention Center Drive and 4th Street off-ramps are configured as well as the mainline number of lanes west of the 4th Street off-ramp. There are also modifications to the I-71 Northbound to I-670 Westbound ramp to accommodate these changes.

Concepts 1A and 1B: Eliminate I-71 Southbound to 3rd Street/Convention Center Drive Movement

Concept 1A

This concept reduces the weaving volume between the I-71 Southbound entrance ramp and the 3rd Street/Convention Center Drive and 4th Street diverges by prohibiting the movement from the Southbound I-71 ramp to 3rd Street/Convention Center Drive. Vehicles wanting to make this movement will be required to remain on I-71 Southbound and access Downtown Columbus at Spring Street or Main Street. This prohibition will be nearly impossible to enforce with just signing or pavement marking changes. In order to prevent the movement, the 3rd Street/Convention Center Drive ramp will exit from Westbound I-670 as a single drop lane prior to the Southbound I-71 entrance and be barrier separated. The two remaining westbound mainline lanes will join with the Southbound I-71 entrance ramp creating three lanes with a drop lane to 4th Street and two lanes continuing past 4th Street. The I-670 Westbound cross section will remain at the existing 4-lanes; however, the barrier and additional shoulders will require the mainline to be widened approximately 8-feet to 10-feet.

The widening needed to implement this concept was minimized by narrowing the inside shoulder, now the left side shoulder of the 3rd Street/Convention Center Drive ramp, to 6-feet. Horizontal stopping sight distance (HSSD) will need to be confirmed; however, it appears that it will be adequate based on the typical design speed of a single lane ramp. In addition to the widening, full depth pavement reconstruction and cross slope correction will be required to

add the barrier and shift lanes. Widening of the I-670 WB bridge over the railroad tracks can potentially be avoided by shifting the lanes towards the median and reconstructing a portion of the existing median barrier. This would require narrowing of the left shoulder on the I-670 EB entrance ramp from 4th Street/Convention Center Drive that currently has excess width. Further analysis will need to be done to confirm the required bridge work. Vertical geometry will also need to be confirmed where ramp gores are proposed to be reconstructed.

Concept 1B

This concept builds upon Concept 1A by changing the off-ramp to 4th Street from a drop-lane to a standard diverge. This allows three mainline lanes to be carried past the 4th Street gore instead of the existing two. In order to accommodate the additional lane, the ramp from I-71 NB to I-670 WB will be reduced from two lanes to one by tapering in one of the lanes along the ramp roadway. The three mainline lanes will join with the single lane from I-71 NB, matching the existing 4-lane section east of the 3rd/4th Street on-ramp. Concept 1B will have the same widening needs as Concept 1A. To accommodate 3-lanes continuing westbound past the 4th Street exit ramp without increasing the already sharp horizontal curve of that ramp, the mainline lanes were shifted to the inside. This allows the 4th Street exit ramp to tie into existing before the sharp horizontal curve, however there may still be vertical challenges due to the need to reconstruct other ramp gores and the fixed profiles of the nearby existing bridges. This also requires the reconstruction of the I-71 NB to I-670 WB ramp gore, which will need to be analyzed vertically if this concept were to move forward.

Concept 2: Create Three Mainline Lanes Past 4th Street Diverge

This concept keeps all the lanes and access between the I-71 Southbound on-ramp and the 3rd Street/Convention Center Drive off-ramp the same as the existing condition. The change occurs at the 4th Street off-ramp where it will be converted to a standard diverge, allowing three mainline lanes to continue past the 4th Street gore instead of the existing two. In order to accommodate the additional lane, the ramp from I-71 NB to I-670 WB will be reduced from two lanes to one by tapering in one of the lanes along the ramp roadway. The three mainline lanes will join with the single lane from I-71 Northbound, matching the existing 4-lane section east of the 3rd/4th Street on-ramp. This concept is similar to Concept 1B except that the barrier separated ramp to 3rd Street/Convention Center Drive has been removed, allowing for all weaving movements. The development of the standard diverge to 4th Street will require minor widening just west of the I-670 bridge over the railroad tracks where the ramp diverge is implemented. Similar to Concept 2B, the westbound lanes are shifted to the inside to allow the 4th Street exit ramp to tie into existing before the sharp horizontal curve. This concept may have vertical challenges due to the need to reconstruct existing ramp gores, and the proximity of the existing bridges that have fixed vertical profiles.

Concept 3: Relocate 4th Street Ramp

As discussed in Concept 1B and Concept 2, converting the 4th Street off-ramp to a standard diverge will be difficult due to the widening required work over the existing railroad bridge, and potential vertical profile challenges. While these concepts do not sharpen the horizontal curve of the existing 4th Street exit ramp, the curve and other geometry as it exists today are sub-standard. Concept 3 relocates the 4th Street off-ramp by combining it with the 3rd Street/Convention Center Drive left hand exit ramp. It will then diverge from the right side of the combined ramp near the point where the Convention Center Drive ramp diverges from the left side. The 4th Street ramp will tie into 4th Street south of the Smith Brothers Hardware building, across from East Goodale Street where there is an existing traffic signal. This Concept can be combined with Concept 1B or Concept 2 and would have impacts to the parking lot on the east side of the 4th Street and Goodale Street intersection.

Conceptual schematic drawings of all three alternatives are included in **Appendix A**.

SUMMARY OF THE TRAFFIC ANALYSIS

Capacity analysis for the geometric concepts was conducted in TransModeler for the AM Peak. **Table 2** shows the LOS, density, and model throughput volumes for the existing condition and the four geometric concepts. As discussed previously, the existing condition weave between I-71 Southbound on-ramp and 3rd Street/Convention Center Drive is well over capacity and the actual volume able to get through the segment is approximately 600 vehicles less than the demand traffic. Downstream of the 4th Street diverge the demand volume is 4380 vehicles in the two-lane section. This is over the capacity of a two-lane segment and will serve as an additional bottleneck location for I-670.

For Concept 1A, the movement from the I-71 Southbound on-ramp to the 3rd Street/Convention Center Drive ramp has been prohibited. This removes 540 vehicles from the weaving segment which allows more traffic from the I-670 WB mainline to pass through the corridor and weaving segment. Approximately 200 additional vehicles are able to get past the 4th Street off-ramp compared to the existing condition. However, the two-lane segment between the 4th Street off-ramp and the I-71 NB on-ramp has now replaced the weaving segment as the primary bottleneck for the corridor. Additional capacity is required for this segment.

Concept 1B addresses the capacity issues on the two-lane segment between the 4th Street off-ramp and the I-71 Northbound on-ramp by adding a third lane to this segment. With the third lane and the prohibition of the I-71 to 3rd Street movement, the I-670 corridor has improved. Nearly all of the demand traffic is able to pass through the corridor and the LOS F conditions have been improved.

Concept 2 maintains the movement from I-71 SB to 3rd Street and adds the third lane between the 4th Street off-ramp and the I-71 NB on-ramp. Similar to Concept 1B, the addition of the third mainline lane has smoothed out the LOS along the corridor and allows nearly all the demand traffic to pass through the corridor. The third mainline lane has improved the operation of the upstream weaving segment by allowing the mainline through traffic to spread out over three lanes rather than two. This reduces the number of vehicles per lane which in turn creates more gaps in each lane allowing more weaving lane changes to be made. The weave segment is expected to operate at LOS F but nearly 500 additional vehicles will be able to pass through the segment compared to the existing condition.

Concept 3 relocates the 4th Street off-ramp to the combined 3rd Street/Convention Center ramp and adds a third mainline lane similar to Concept 1B and Concept 2. With the 4th Street ramp now going off the left side there are more lane changes required for I-71 Southbound traffic to get to 4th Street. This additional weaving slightly increases the density and throughput for the weave compared to Concept 2.

CONCLUSIONS AND NEXT STEPS

In summary, this study has shown that there are some improvements that could be made to the I-670 Westbound corridor that would provide a positive benefit. These improvements will likely not be a long-term capacity solution; however, they were evaluated on an existing traffic volume plus 20% scenario so they should provide a good benefit for a few years. The solutions that have the most promise are:

- Geometric Improvement Concept 2 – The analysis identified that the biggest capacity constraint is the two-lane mainline segment located between the 4th Street off-ramp and the I-71 NB on-ramp. This two-lane segment is at capacity which forces traffic to position themselves into these two lanes for a significant distance upstream. This makes the weave for I-71 SB traffic destined for 3rd Street/Convention Center Drive very difficult as they must pass through these two lanes. Spreading the volume over three lanes creates more

gaps for the weaving traffic. The LOS will still be at E or F, but approximately 10% more traffic will be able to pass through the segment compared to the Existing condition.

- Ramp Metering – Ramp metering will not be a significant increase to capacity; however, it does have the potential to remove a couple hundred vehicles from the I-670 corridor. Used in combination with Concept 2 would provide the biggest benefit.

Recommended next steps would be:

1. Develop 10- or 20-year forecasts for the corridor including the PM Peak to get a better under understanding of the potential benefit and lifespan of these improvements.
2. Perform a more in depth horizontal and vertical geometric evaluation of Concept 2 and potential ramp metering to identify any geometric constraints and develop a cost estimate.

If you have any questions or need additional information related to our analysis, please to not hesitate to contact us.

Sincerely,

Randy Kill

Randy Kill, PE, PTOE
Study Manager

Table 2: 2022 Capacity Analysis Results

Westbound I-670 Segment		Existing Condition			Concept 1A			Concept 1B			Concept 2			Concept 3		
	Demand Volume	Volume	LOS	Density	Volume	LOS	Density	Volume	LOS	Density	Volume	LOS	Density	Volume	LOS	Density
East of I-71 Off	6910	6376	F	67.3	6771	F	48.9	6825	D	32.3	6823	D	34.5	6820	D	33.5
I-71 Off	2180	2069	C	24.1	2160	C	25.2	2168	C	25.0	2167	C	25.1	2166	C	25.1
Between I-71 Off & SB I-71 On	4730	4127	F	95.1							4655	E	43.5	4607	F	61.2
Between I-71 Off & 3rd/Convention Center Off	4730				4478	F	72.7	4661	D	34.8						
3rd St/Convention Center Off	1350				1275	D	34.8	1326	E	36.6						
Between 3rd St/Convention Center Off & SB I-71 On	3380				3224	F	83.9	3363	E	37.1						
SB I-71 On	1780/**1240**	1767	D	32.8	1217	B	14.5	1225	B	12.5	1771	C	22.2	1769	C	23.6
Between SB I-71 On & 3rd St/**4th St**/Conv Cent Off	6510	5891	F	75.9							6450	F	56.4	6376	F	63.6
3rd St/**4th St**/Convention Center Off	1890/**2130**	1718	C	21.6							1879	C	23.8	2088	D	26.5
Between 3rd St/Convention Center Off & 4th St Off	4620	4177	E	35.0							4578	C	22.8			
Between SB I-71 On & 4th St Off	4620				4369	F	59.8	4577	C	21.9						
4th St Off	240	216	A	5.4	218	A	5.2	233	A	5.4	234	A	5.5			
Between 4th St Off & NB I-71 On	4380	3956	F	45.3	4161	F	52.2	4343	D	29.5	4339	D	29.8			
Between 3rd St/4th St/Conv Cent Dr & NB I-71 On	4380													4278	D	29.6
NB I-71 On	1630	1620	C	18.6	1621	C	18.6	1619	E	38.5	1619	E	38.2	1620	E	38.4
Between NB I-71 On & 3rd/4th St On	6010	5574	D	32.0	5779	D	34.6	5961	E	36.0	5955	E	35.5	5904	D	34.7
3rd/4th St On	1040	1037	C	24.8	1035	D	25.8	1037	D	25.5	1037	D	26.6	1037	D	26.0
Between 3rd/4th St On & Neil Ave Off	7050	6609	D	32.6	6811	D	34.9	6995	E	36.8	6992	E	36.3	6940	E	35.4
Neil Ave Off	1020	971	B	11.7	999	B	11.7	1022	B	12.3	1022	B	12.3	1015	B	12.2
Between Neil Ave Off & NB SR 315 Off	6030	5621	D	29.5	5793	D	31.0	5954	D	32.5	5950	D	32.2	5900	D	31.9
NB SR 315 Off	1970	1834	F	47.2	1885	F	48.6	1932	F	50.2	1931	F	49.8	1916	F	49.7
Between NB SR 315 Off & Goodale St On	4060	3772	C	24.5	3890	C	25.2	4005	C	26.0	4003	D	26.1	3966	C	25.7
Goodale St On	340	345	A	7.7	345	A	7.6	345	A	7.4	344	A	7.8	344	A	7.6
Between Goodale St On & SB SR 315 Off	4400	4120	C	20.1	4239	C	20.7	4354	C	21.2	4351	C	21.2	4313	C	21.3
SB SR 315 Off	1250	1178	D	27.5	1214	D	29.0	1243	D	29.8	1242	D	29.0	1232	D	28.8
Between SB SR 315 Off & SB SR 315 On	3150	2930	C	18.6	3012	C	19.1	3095	C	19.7	3093	C	19.7	3065	C	19.5
SB SR 315 On	860	863	B	17.4	862	B	17.1	863	B	17.4	863	B	17.6	862	B	17.6
West of SB SR 315 On	4010	3797	C	20.2	3881	C	20.5	3966	C	21.3	3961	C	20.8	3933	C	20.8

XXXX – Concepts 1A and 1B condition
XXXX – Concept 3 condition

Figure 1: 2022 INRIX Congestion Scan for I-670 Westbound

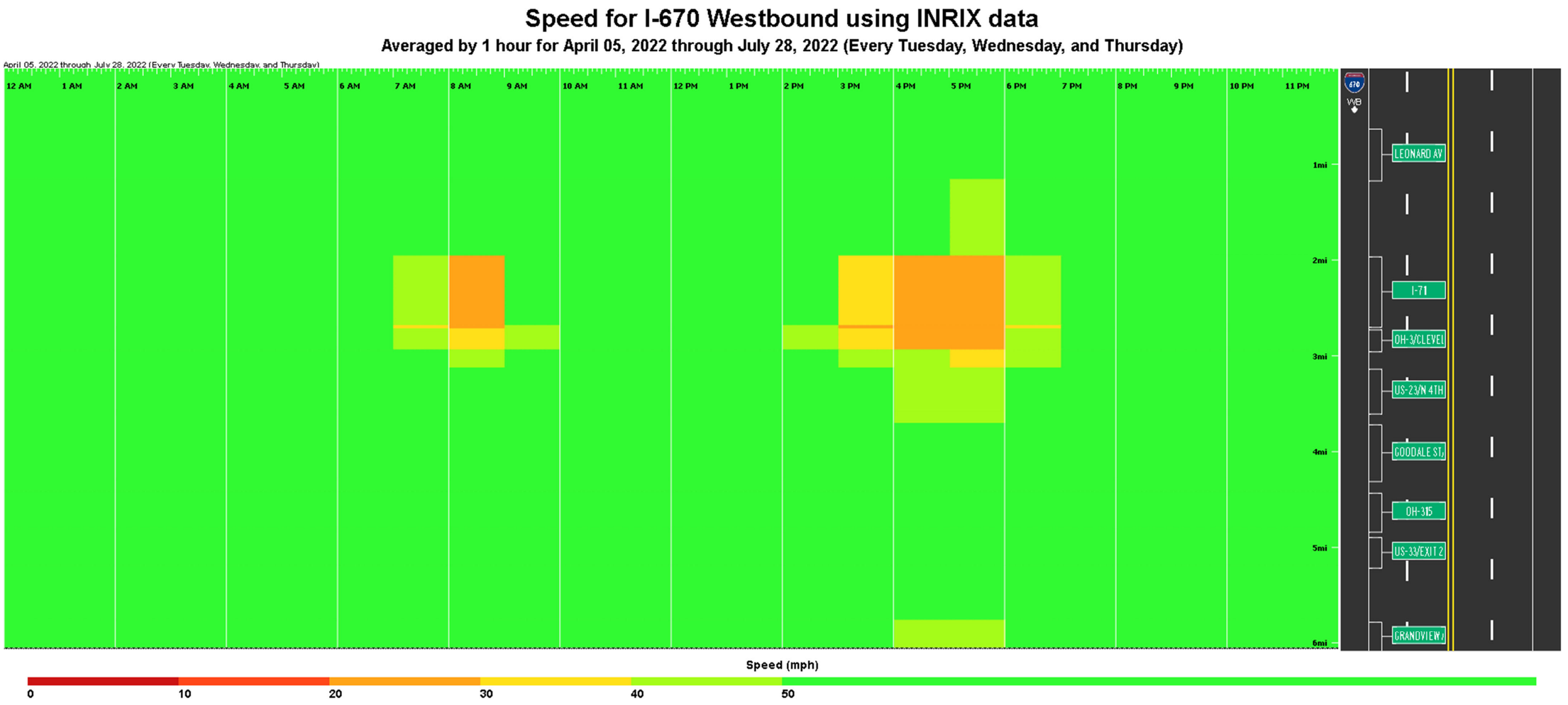
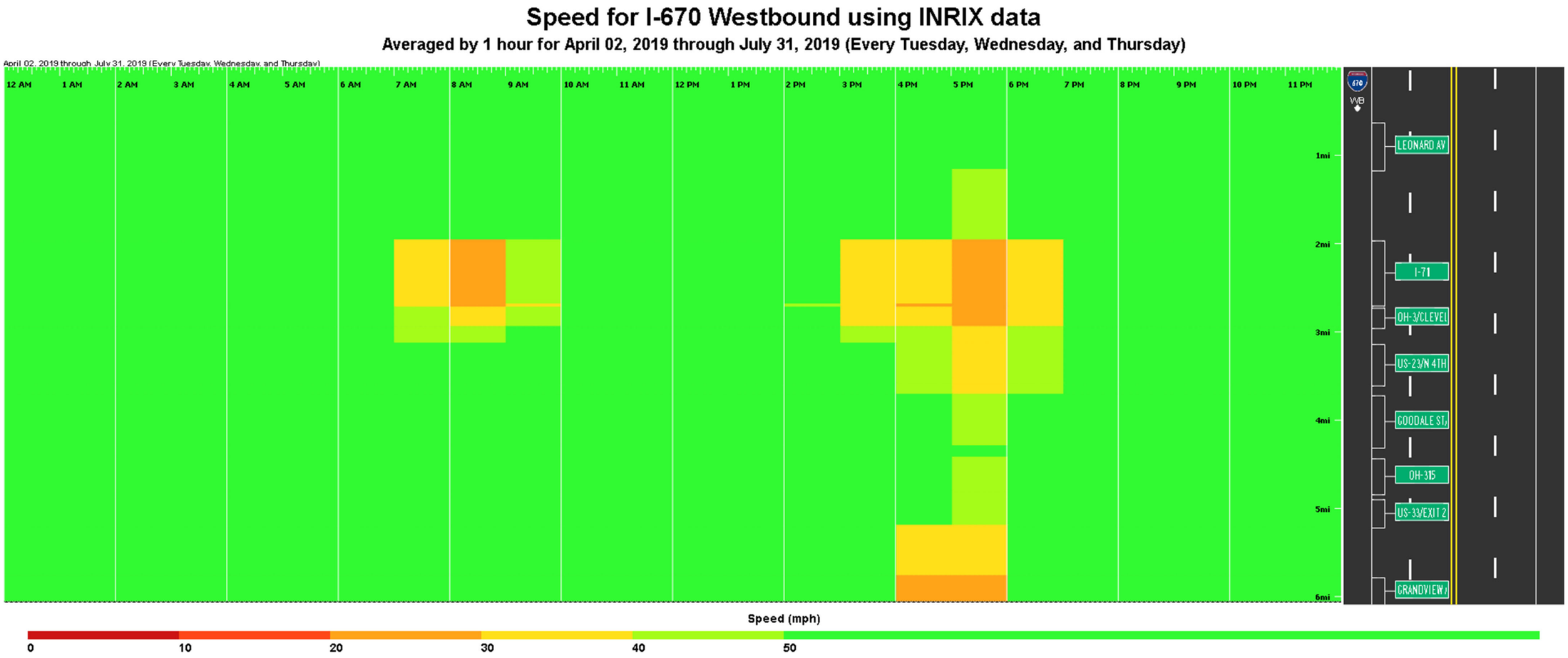
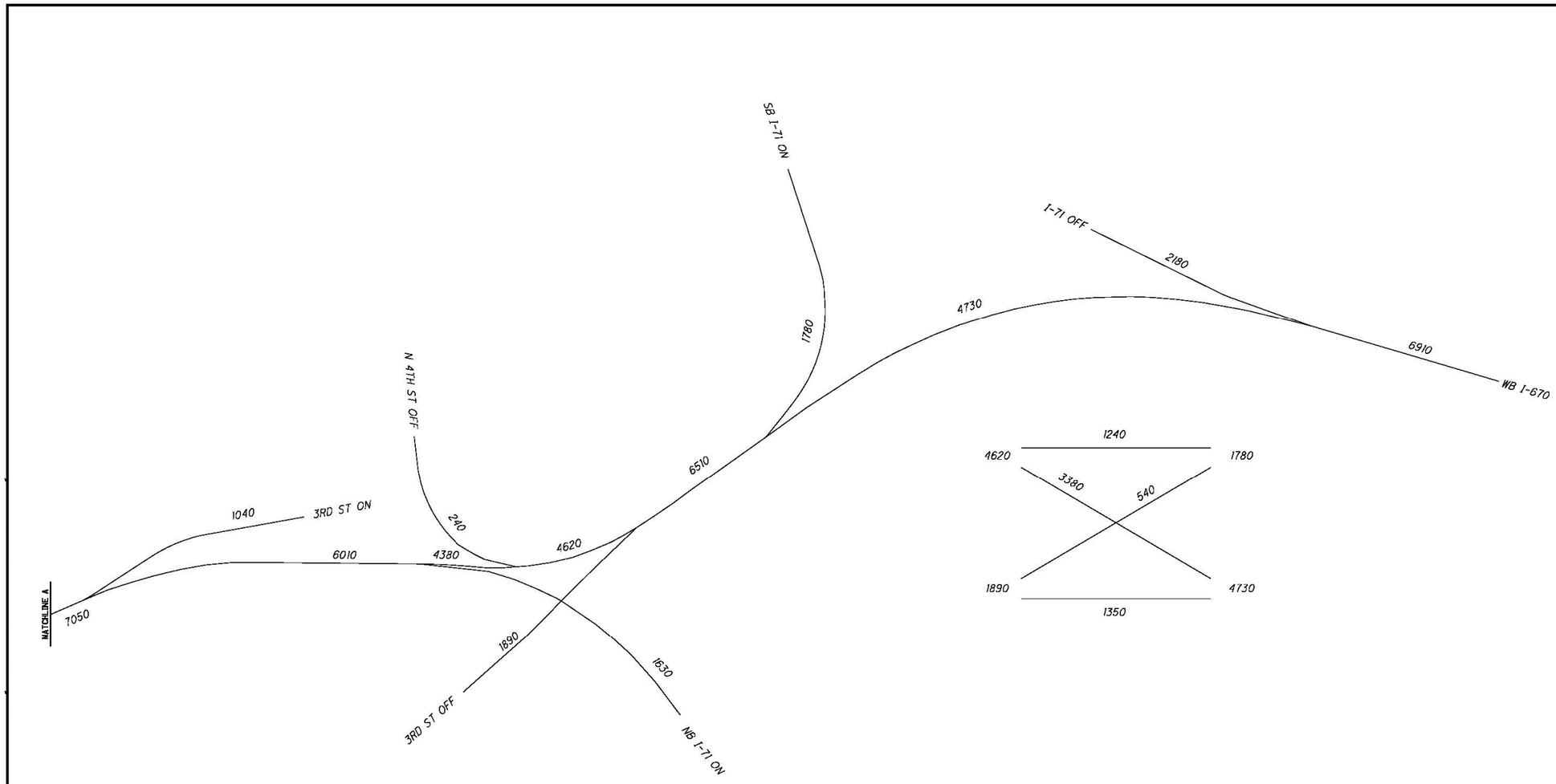


Figure 2: 2019 INRIX Congestion Scan for I-670 Westbound

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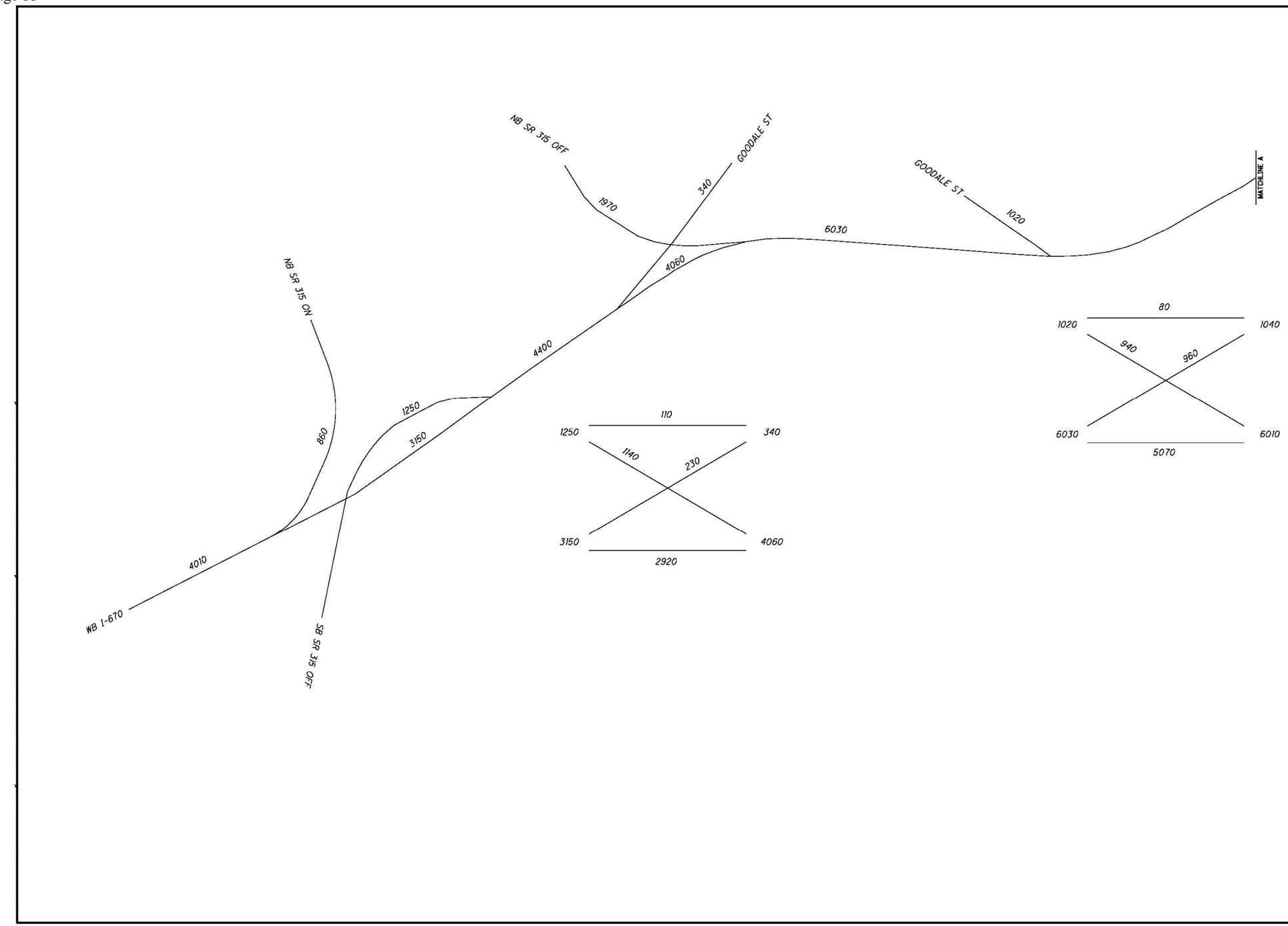
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