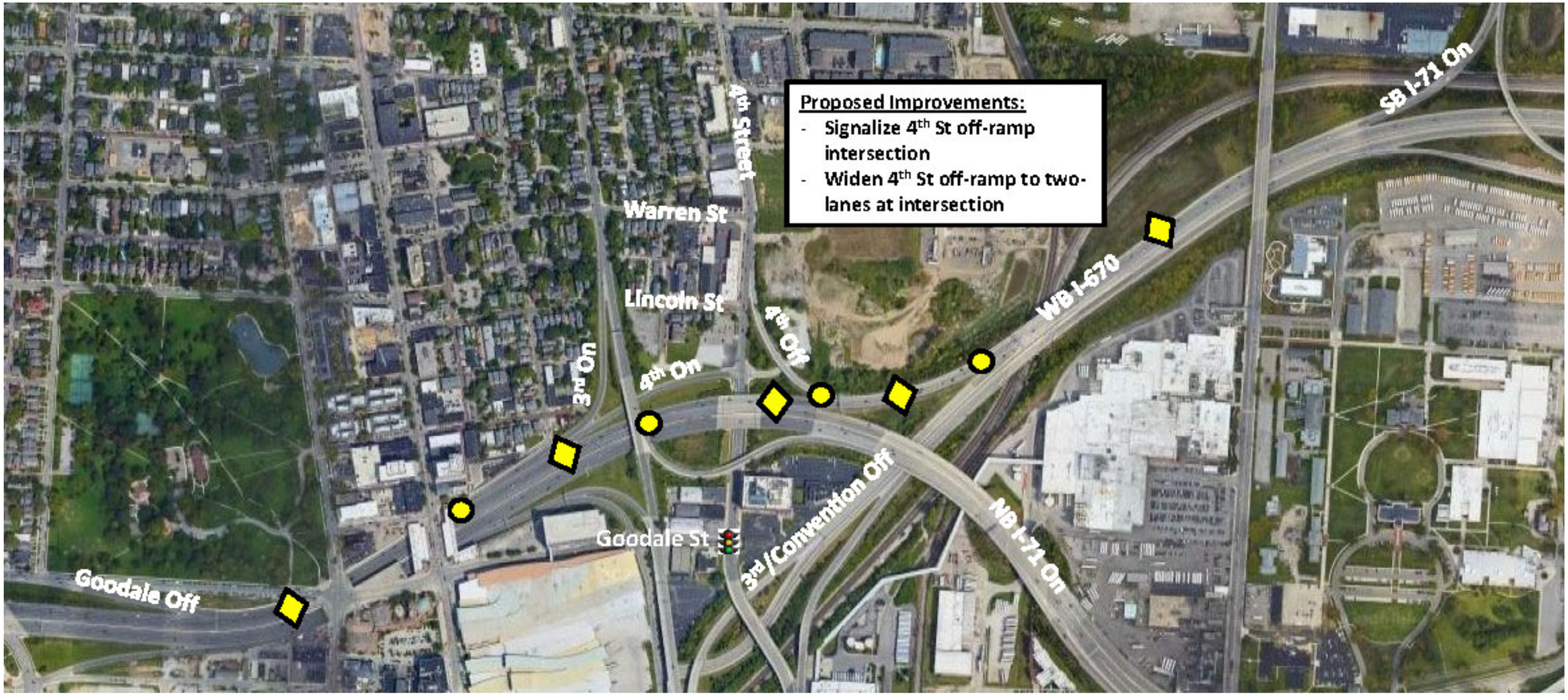
FRA-670 & 4TH STREET INTERCHANGE OPERATIONS STUDY

Project Summary

Location	Westbound I-670 & 4th Street Interchange
	Columbus, Ohio
	Franklin County
PID	No PID
Study Sponsor	City of Columbus
Proposed Work	Convert the westbound I-670 off-ramp to northbound 4th Street ramp intersection from free-flow to a signalized intersection. Widen ramp to two-lanes at the intersection.

Project Intersection

Study Area


Proposed Improvements:
- Signalize 4th St off-ramp intersection
- Widen 4th St off-ramp to two-lanes at intersection
4th Street
Warren St
Lincoln St
4th Off
SB I-71 On
WB I-670
3rd On
4th On
Goodale St
3rd/Convention Off
NB I-71 On
Goodale Off

Capacity Analysis Points:

Freeway Analysis

- Westbound I-670, east of the Third St/Convention Center Dr diverge (complex weave)
- Westbound I-670, east of the 4th Street diverge
- Westbound I-670, east of the NB I-71 merge
- Westbound I-670, east of the 3rd St/4th St merge
- Westbound I-670, east of the Goodale St diverge (complex weave)

Ramp Analysis

- Westbound I-670 diverge to 3rd St/Convention Center (drop lane)
- Westbound I-670 diverge to 4th St (drop lane)
- Westbound I-670 merge from NB I-71 (add lane)
- Westbound I-670 merge from 3rd St/4th St (add lane)

Intersection Analysis

- 4th Street & Goodale Street
- 4th Street & WB I-670 on-ramp
- 4th Street & WB I-670 off-ramp
- 4th Street & Warren Street

Problem Description

The existing westbound I-670 and 4th Street off-ramp intersection is located just north of downtown Columbus, Ohio. 4th Street is a one-way northbound facility with two through lanes and I-670 ramp is a single lane that is a free-flow right turn movement onto 4th Street that merges into the two through lanes approximately 300 feet north of the intersection. Because of the free-flow movement, the speeds of vehicles coming from I-670 are well above the 35-mph posted speed on 4th Street.

The 4th Street corridor north of I-670 is developing into a major residential area with the construction of the Jeffrey Park community. Jeffrey Park will add approximately 1500 residential units and some office space to the corridor. Additional restaurants and shops along 4th Street will increase the numbers of pedestrians and bicyclist along 4th Street. This additional pedestrian and bicyclist activity creates a safety concern with the high speeds along the corridor.

In 2019, the City of Columbus conducted a study at the ramp intersection to evaluate the feasibility of signalizing the westbound I-670 and 4th Street off-ramp intersection to eliminate the high-speed traffic merge condition. The preferred alternative from this study adds a traffic signal at the intersection and widens the ramp from one lane to two lanes north of the existing

bridge along the ramp. The stop bar is located about 375 feet north of the northern edge of the existing bridge, allowing for approximately 325 feet of two-lane ramp. The traffic signal will promote slower speeds along the corridor and improve the safety for pedestrians and bicyclist.

This Interchange Operations Study documents the impacts the proposed changes will have on the westbound I-670 mainline and at the westbound I-670 off-ramp & 4th Street intersection. No-Build and Build condition exhibits for the intersection are included at the end of this memo. A high-resolution Build condition exhibit for the 4th Street intersection is included in the ***Appendix***.

Capacity Analysis

Posted Speed Limits of roadways within the Study Area:

- Mainline, I-670 – 55 mph
- 4th Street – 35 mph
- Goodale Street – 35 mph
- Warren Street – 25 mph

Capacity analysis for the No-Build and Build conditions was conducted for the 2045 design year. There are two complex weaving segments along the westbound I-670 mainline that cannot be analyzed in *HCS*. Because of this, *TransModeler* was selected to be the primary analysis tool. This analysis showed that several mainline segments are over capacity which prevents the full demand traffic from accessing the 4th Street off-ramp. In order to evaluate the 4th Street intersections using the full demand traffic, the intersections were evaluated using *HCS*.

The Levels of Service (LOS) for basic freeway segments, weaves, ramp roadways and intersections for the Design Year (2045) is presented in ***Table 1*** for the westbound I-670 mainline, ***Table 2*** for AM peak intersections and ***Table 3*** for the PM peak intersections. Mainline and intersection capacity results are discussed below and detailed outputs of the *TransModeler* and *HCS* analysis are contained in the ***Appendix***.

Table 1: Westbound I-670 Freeway Operations Level of Service from *TransModeler*

Location (I-670 WB)	2045AM No-Build			2045 AM Build			2045 PM No-Build			2045 PM Build		
	LOS	Density	Model Throughput	LOS	Density	Model Throughput	LOS	Density	Model Throughput	LOS	Density	Model Throughput
East of 3rd St/Convention Center Off-Ramp	F	113.9	5408	F	113.4	5499	F	116.7	4522	F	116.6	4507
3rd St/Convention Center Off-Ramp	D	28.2	2028	C	27.9	2063	A	8.9	698	A	8.7	686
East of 4th St Off-Ramp	C	25.6	3374	C	25.5	3429	F	67.7	3786	F	67.7	3782
4th Street Off-Ramp	A	5.9	251	A	6.6	259	A	8.9	367	B	10.0	368
East of NB I-71 On-Ramp	D	32.5	3122	D	33.6	3169	F	86.7	3381	F	86.6	3377
NB I-71 On-Ramp	D	29.3	2372	D	29.5	2373	F	80.4	2972	F	81.3	2954
East of 3rd St/4th St On-Ramp	F	50.4	5485	F	53.0	5529	F	78.2	6275	F	77.8	6253
3rd St/4th St On-Ramp	F	115.7	1237	F	117.5	1248	F	120.1	1242	F	116.6	1196
East of Goodale St Off-Ramp	F	39.7	6740	F	40.4	6799	F	46.0	7506	F	45.5	7437

Table 2: AM Peak Intersection Level of Service from *HCS*

INTERSECTION	APPROACH	2045 No-Build AM Peak					2045 Build AM Peak				
		LOS	V/C	DELAY	QSR	QUEUE	LOS	V/C	DELAY	QSR	QUEUE
4th Street & Goodale Street (Signalized)	EB Left	D	0.90	47.7	1.82	418'	D	0.90	47.7	1.82	418'
	EB Left/Through	D	0.83	45.4	1.18	382'	D	0.83	45.4	1.18	382'
	Eastbound	**D**	--	**46.6**	--	--	**D**	--	**46.6**	--	--
	WB Through/Right	E	0.38	58.3	0.23	30'	E	0.38	58.3	0.23	30'
	Westbound	**E**	--	**58.3**	--	--	**E**	--	**58.3**	--	--
	NB Left/Through	B	0.42	15.0	0.38	260'	B	0.42	15.0	0.38	260'
	NB Right	B	0.01	10.5	0.03	6'	B	0.01	10.5	0.03	6'
	Northbound	**B**	--	**14.6**	--	--	**B**	--	**14.6**	--	--
	Intersection Total	**C**	--	**26.9**	--	--	**C**	--	**26.9**	--	--
4th Street & WB I-670 On-Ramp (Unsignalized)	NB Left	A	0.34	9.8		38'	A	0.34	9.8		38'
4th Street & WB I-670 Off-Ramp (Signalized)	WB Right						D	0.57	46.4	0.31	166'
	Westbound						**D**	--	**46.4**	--	--
	NB Through						A	0.54	7.9	0.83	291'
	Northbound						**A**	--	**7.9**	--	--
	Intersection Total						**B**	--	**14.0**	--	--
4th Street & Warren Street (Unsignalized)	EB Left/Through	C	0.17	15.9		15'	C	0.17	15.9		15'
	Eastbound	**C**	--	**15.9**		--	**C**	--	**15.9**		--
	WB Right	C	0.11	15.3		10'	C	0.11	15.3		10'
	Westbound	**C**	--	**15.3**		--	**C**	--	**15.3**		--

Table 3: PM Peak Intersection Level of Service from *HCS*

INTERSECTION	APPROACH	2045 No-Build AM Peak					2045 Build AM Peak				
		LOS	V/C	DELAY	QSR	QUEUE	LOS	V/C	DELAY	QSR	QUEUE
4th Street & Goodale Street (Signalized)	EB Left	D	0.92	51.5	2.26	519'	D	0.92	51.5	2.26	519'
	EB Left/Through	D	0.77	41.0	1.23	401'	D	0.77	41.0	1.23	401'
	Eastbound	**D**	--	**46.7**	--	--	**D**	--	**46.7**	--	--
	WB Through/Right	E	0.44	57.4	0.34	44'	E	0.44	57.4	0.34	44'
	Westbound	**E**	--	**57.4**	--	--	**E**	--	**57.4**	--	--
	NB Left/Through	D	0.95	48.8	1.39	903'	D	0.95	48.8	1.39	903'
	NB Right	B	0.01	13.6	0.04	7'	B	0.01	13.6	0.04	7'
	Northbound	**D**	--	**43.6**	--	--	**D**	--	**43.6**	--	--
	Intersection Total	**D**	--	**44.6**	--	--	**D**	--	**44.6**	--	--
4th Street & WB I-670 On-Ramp (Unsignalized)	NB Left	A	0.27	9.3		28'	A	0.27	9.3		28'
4th Street & WB I-670 Off-Ramp (Signalized)	WB Right						D	0.90	44.4	0.69	372'
	Westbound						**D**	--	**44.4**	--	--
	NB Through						C	0.96	31.6	2.71	948'
	Northbound						**C**	--	**31.6**	--	--
	Intersection Total						**C**	--	**34.6**	--	--
4th Street & Warren Street (Unsignalized)	EB Left/Through	F	0.77	127.9		98'	F	0.77	127.9		98'
	Eastbound	**F**	--	**127.9**		--	**F**	--	**127.9**		--
	WB Right	F	0.81	58.5		155'	F	0.81	58.5		155'
	Westbound	**F**	--	**58.5**		--	**F**	--	**58.5**		--

As shown in ***Table 1,*** there are several westbound I-670 mainline segments that operate at LOS F in both the AM and PM peak hours. These LOS F conditions are caused by the two weaving segments on I-670. The weave between the NB I-71 on-ramp and the Goodale Street off-ramp is well over capacity and creates congestion that spills back through the upstream mainline and ramp segments. The weave between the SB I-71 on-ramp and the 4th Street off-ramp is also over capacity. Because the certified traffic volumes are the same between the No-Build and Build conditions and no capacity improvements were made to the mainline, the operation for both the No-Build and Build conditions are the same. There are some slight variations in the densities, but this can be attributed to slight differences between the multiple *TransModeler* runs. The LOS between the No-Build and Build conditions is the same and the operation on the I-670 mainline will not decline in the Build condition.

For the intersections along 4th Street, the turning movement volumes are the same in both the No-Build and Build conditions. As show in ***Tables 2 and 3***, the intersections at Goodale Street,

WB I-670 on-ramp, and Warren Street are expected to operate the same in both the No-Build and Build conditions. At the WB I-670 off-ramp intersection, the No-Build condition is unsignalized with free-flow movements for both approaches and operates with very little delay. The Build condition will signalize the intersection, causing additional delay and queuing. As show in ***Tables 2 and 3***, the overall intersection is expected to operate at LOS B in the AM peak and LOS C in the PM peak with individual movements operating at an acceptable LOS D or better. The northbound 95% queue length in the PM peak is 948 feet which is past the WB I-670 on-ramp intersection and within 200 feet of the Goodale Street intersection. *HCS* assumes a random arrival rate, however, 4th Street is a one-way street where very good signal progression is achievable. It is expected that the signals can be coordinated so that a large percentage of the northbound vehicles arrive on green, and the actual northbound queue length will be much lower than 948 feet. For the westbound approach, the 95% queue length is expected to be 372 feet which will just reach the northern edge of the existing bridge on the ramp roadway. This is approximately 350 feet from the mainline ramp gore. Queueing on the westbound approach at the WB I-670 off-ramp intersection will not impact the I-670 mainline.

Turn Lane Storage

Queue storage lengths were calculated for the westbound I-670 off-ramp terminal intersection at 4th Street. Turn storage lengths were only determined for the westbound right turn movement since that is the only one that would affect the I-670 mainline. Storage calculations are based on the procedures described in Section 401-7 to 401-12 and Figures 401-9 and 401-10 of the ODOT *Location and Design Manual* (L&D). The storage lengths are based on the highest of the AM and PM Peak hour storage requirements. These calculations are summarized in ***Table 4***.

Based on the L&D Manual, the required storage length for the westbound right turn movement is 750 feet. The preferred alternative has 325 feet of two-lane storage plus an additional 425 feet of single lane storage for a total of 1075 feet. This length exceeds the calculated storage length of 750 feet. As described in the capacity analysis section, this queue will not impact the westbound I-670 mainline.

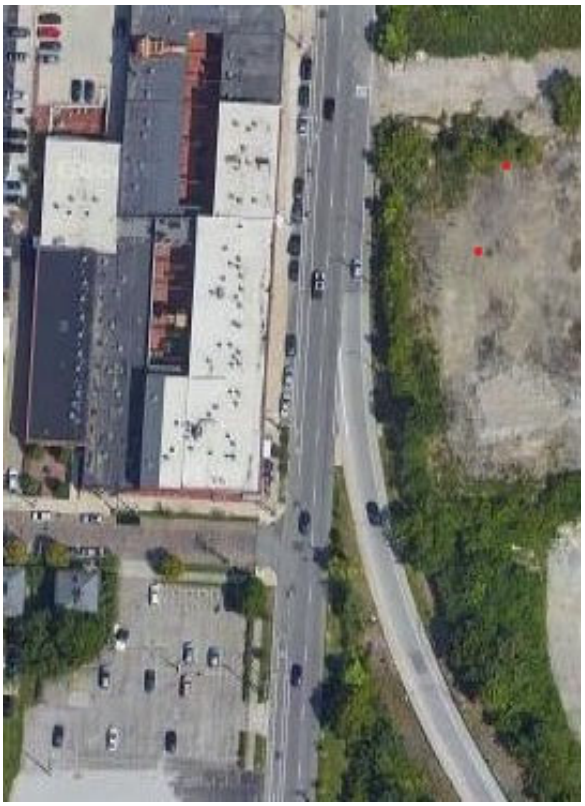
Table 4: Turn Lane Storage Length Calculations

Intersection/ Turn Lane	2045 Design Volume				Required Storage Length	Potential Through Backup	Recomm. Storage Length #	Proposed Turn Lane Length
	AM veh/hr		PM veh/hr					
	Turn	Through	Turn	Through				
WB I-670 & 4th Street Off	120 sec cycle		120 sec cycle					
WB RT	250	0	640	0	750’	N/A	750’	1075’

Conclusion

The IOS verifies that the proposed changes to the westbound I-670 off-ramp & 4th Street ramp intersection will not degrade the level of service between the 2045 No-Build and Build conditions for the I-670 mainline. While the delay and queue lengths at the ramp intersection are expected to increase in the Build condition, the intersection will operate with acceptable LOS and the queues will not impact the I-670 mainline. The additional delay at the intersection is a good tradeoff to achieve reduced vehicle speeds and increased pedestrian safety along the 4th Street corridor. This study meets the requirements of the Ohio Department of Transportation.

No-Build WB I-670 & 4th Street Exit Ramp



Build WB I-670 & 4th Street Exit Ramp