243-22

Ruthanne Fuller
Mayor

City of Newton, Massachusetts

Office of the Mayor

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March 28, 2022

Honorable City Council
Newton City Hall
1000 Commonwealth Avenue
Newton, MA 02459

Honorable City Councilors:

I respectfully submit this docket item to this Honorable Council requesting a discussion of MassDOT's proposed modification to the roundabout design located at the Grove Street intersection with the I-95 SB off-ramp and Quinobequin Road consistent with the requirements of Riverside Special Permit #27-20 (2), Condition 14c.

The relevant language from the Riverside Special Permit states:

Any material modifications to the final design of the Interchange Improvements by either MassDOT or FHWA will be considered consistent with the conceptually approved plan if, in the opinion of the Commissioner of Public Works, after consultation with the appropriate committee(s) of the City Council, the modified design achieves the same performance objectives as the conceptually approved design.

Please see the attached memo from Commissioner of Public Works James McGonagle and the detailed report from VHB on behalf of the project proponents.

Thank you for your consideration of this matter.

Sincerely,

Ruthanne Fuller

Mayor Ruthanne Fuller

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CITY CLERK
NEWTON, MA. 02459

City of Newton
Ruthanne
Fuller

DEPARTMENT OF PUBLIC WORKS

OFFICE OF THE COMMISSIONER
1000 Commonwealth Avenue
Newton Centre, MA 02459-1449

March 25, 2022

To: Jonathan Yeo, Chief Operating Officer

From: James McGonagle, Commissioner

Subject: Request for Docket Item for Discussion of Riverside Station Off-site Transportation Improvements

Consistent the requirements of Special Permit #27-20(2), Condition 14.c., DPW would like to discuss MassDOT's proposed modification to the roundabout design located at the Grove Street intersection with the I-95 SB off-ramp and Quinobequin Road.

The relevant language from the Riverside Special Permit states:

Any material modifications to the final design of the Interchange Improvements by either MassDOT or FHWA will be considered consistent with the conceptually approved plan if, in the opinion of the Commissioner of Public Works, after consultation with the appropriate committee(s) of the City Council, the modified design achieves the same performance objectives as the conceptually approved design.

Sincerely,

James McGonagle
Commissioner of Public Works

cc: Shawna Sullivan, DPW Deputy Commissioner
Louis M. Taverna, P.E., City Engineer
Jason Sobel, P.E., PTOE, Director of Transportation Operations
Isaac Prizant, Transportation Engineer

Memorandum

To: City of Newton

Date: 02/04/2022

Project #: 10865.03

From: Randy Hart, Principal
Matthew Duranleau, PE

Re: Grove Street at I-95 Southbound Ramps
Potential Intersection Treatments

VHB, on behalf of Mark Development (the Proponent) has prepared this memorandum to discuss the evaluation of the various different treatments that were done for the intersection of Grove Street at the I-95 Southbound Ramps in Newton, Massachusetts. This intersection will be reconstructed as part of the approved Riverside redevelopment, which will include the construction of approximately 1,025,000 of new development on the existing site of the MBTA Riverside station parking lot and the Hotel Indigo. As part of the development, significant roadway improvements will be implemented, including the reconstruction of the I-95 Northbound Exit 38 off-ramp to Grove Street, an extension of Recreation Road to Grove Street, the installation of three adaptive traffic signals, and improvements at the intersection of Grove Street at the I-95 Southbound Ramps.

In the local and state filings, the intersection of Grove Street at the I-95 Southbound Ramps was proposed to be replaced with a single-lane roundabout with four approaches: Grove Street from the east and west, the I-95 Southbound Ramps from the south, and Asheville Road from the north. As development of the 25-percent design plans began, the Proponent has been in close coordination with MassDOT regarding all aspects of the offsite design. During these detailed consultations, MassDOT has stressed the need to create more deflection on the various approaches to the proposed intersection reconstruction, specifically the Grove Street westbound and I-95 Southbound Off-Ramp approaches to the intersection. Increasing deflection will slow the traffic entering the roundabout thereby enhancing the pedestrian environment.

Revised Roundabout Concept

To meet the requests of MassDOT, the roundabout has been shifted a short distance to the northeast and by doing so, the geometry and right-of-way doesn't allow for Asheville Road to be included in the roundabout. Under this scenario, Ashville Road becomes a right-in/right-out at Grove Street south of the roundabout and drivers exiting Asheville Road would only be able to take a right turn onto Grove Street. To access Grove Street eastbound, drivers would need to use Pine Grove Avenue or Pierrepont Road to turn left onto Grove Street instead. Alternatively, drivers could use Pierrepont Road to turn right onto Grove Street and reverse direction at the roundabout. The proposed roundabout would consist of three approaches: Grove Street from the east and west and the I-95 Southbound Ramps from the south.

The shifting of the roundabout is a minor change from what was previously contemplated for the design of this intersection, and the only significant change is the shifting of the Roundabout easterly and the treatment of Asheville Road. There are benefits and disadvantages associated with this change, which include the following:

Benefits

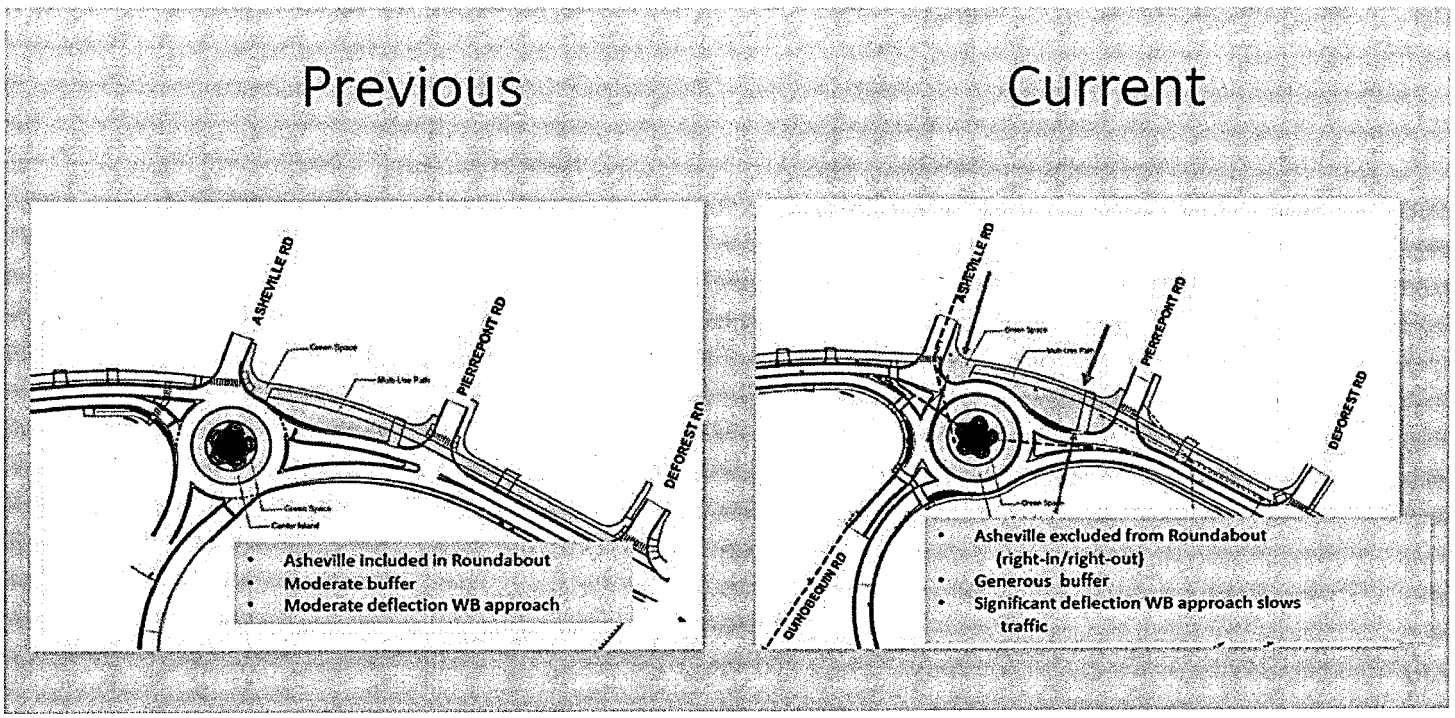
- Increased deflection of the approaches will slow traffic even more than former concepts
- Increased (substantially) green buffer between Grove Street and residents in northwest quadrant of intersection
- Deemphasizes traffic movements onto Asheville Road (northern neighborhood traffic will likely not use Asheville to gain access to the roundabout)
- Lower speed and more green space results in enhanced pedestrian environment

Detriments

- Residents on Asheville Road will not be able to turn left at Grove Street from Ashville's intersection with Grove.

To demonstrate the two roundabout options that have been considered, Figure 1 provides a side-by-side comparison of the previous four-legged roundabout concept and the currently proposed three-legged roundabout concept.

Figure 1 Comparison of Previous and Current Roundabout Concepts



Additional Intersection Concepts

At the initial Riverside Redevelopment Liaison Committee meeting on Tuesday January 25, 2022, the revised concept for the roundabout was presented. The initial feedback from members of the community was concern for the changes that would be introduced to Asheville Road. As a result of the comments and concerns, additional review of potential options has been considered and further discussion is being planned with MassDOT and the City of Newton.

To aid in those conversations, this memorandum has been prepared to evaluate various options that have been considered. These include:

- Original Four-Legged Roundabout Concept (with Asheville Road included)
- Revised Three-Legged Roundabout Concept (with Asheville Road excluded)
- Signalized intersection with slight shift of northbound approach (the I-95 Southbound Ramps approach is shifted slightly west from its current location to directly align with Asheville Road)
- Signalized intersection in current location (each approach has the same geometry as existing conditions with the I-95 Southbound Ramps and Asheville Road slightly offset from each other)

Concept plans for the two signalized scenarios are provided in the Attachments to this memorandum.

The following section summarizes the intersection capacity results of the proposed roundabout and signalized intersection concepts.

Intersection Operations

To demonstrate future traffic operations at the intersection under different concept alternatives, intersection capacity analyses have been conducted based on the 2031 Build Conditions with mitigation traffic volumes as presented in the most recent MEPA filings for the Riverside redevelopment project[1]. The traffic volumes present a future condition that includes a growth in traffic over existing conditions due to the Riverside redevelopment as well as due to other background projects. The intersection capacity analyses have been conducted for the weekday morning, weekday evening, and Saturday midday peak hours using Synchro 10 software for the signalized concepts and using Sidra 8 software for the roundabout concepts.

Roundabout Concepts

Table 1 presents a summary of the capacity analyses for intersection under the four-legged and three-legged roundabout alternatives. The intersection capacity worksheets are included in the Attachments to this memorandum.

[1] Supplemental Draft Environmental Impact Report, EEA No. 16024, Riverside Station Redevelopment; Prepared by VHB; May 17, 2021.

Table 1 Roundabout Intersection Capacity Analysis Summary

Location	2031 Build Conditions w/ Mitigation Original Four-Legged Concept					2031 Build Conditions w/ Mitigation Revised Three-Legged Concept				
	D [a]	v/c [b]	Delay [c]	LOS [d]	95th Q [e]	D	v/c	Delay	LOS	95th Q
Grove Street at I-95 Southbound Ramps / Asheville Road										
Weekday Morning										
Grove Street EB LTR	575	0.75	20	C	321	590	0.76	20	C	339
Grove Street WB LTR	380	0.38	7	A	50	380	0.38	7	A	50
I-95 SB Off-Ramp NB LTR	375	0.67	20	C	143	375	0.66	20	C	142
Asheville Road SB LTR	15	0.03	6	A	2	n/a	n/a	n/a	n/a	n/a
Overall			**16**	**C**				**16**	**C**	
Weekday Evening										
Grove Street EB LTR	260	0.43	12	B	56	265	0.43	12	B	57
Grove Street WB LTR	730	0.76	17	C	212	730	0.75	17	C	212
I-95 SB Off-Ramp NB LTR	190	0.25	7	A	25	190	0.25	7	A	25
Asheville Road SB LTR	10	0.02	8	A	1	n/a	n/a	n/a	n/a	n/a
Overall			**14**	**B**				**14**	**B**	
Saturday Midday										
Grove Street EB LTR	220	0.28	7	A	29	235	0.29	7	A	31
Grove Street WB LTR	350	0.36	7	A	45	350	0.36	7	A	45
I-95 SB Off-Ramp NB LTR	280	0.33	7	A	37	280	0.32	7	A	37
Asheville Road SB LTR	15	0.02	5	A	2	n/a	n/a	n/a	n/a	n/a
Overall			**7**	**A**				7	**A**	

Source: analyzed with Sidra 8 software.
a Demand (input)
b volume-to-capacity ratio
c average total delay, in seconds per vehicle
d level of service
e 95th percentile queue length, measured in feet

As shown in Table 1, the intersection with either roundabout concept is proposed to operate at overall LOS C or better during each peak hour. Each approach is also expected to operate at LOS C or better and the queues on each approach are expected to be less than 350 feet during each peak hour. Operations are expected to be comparable between the four-legged and the three-legged roundabout concepts.

Signalized Intersection Concepts

Table 2 presents a summary of the capacity analyses for intersection under the two different signalized alternatives (Concept 1 assumes the I-95 Southbound Ramps approach is shifted slightly west to directly align with Asheville Road and Concept 2 assumes each approach has the same geometry as under existing conditions). The intersection capacity worksheets are included in the Attachments to this memorandum.

Table 2 Four-Legged Signalized Intersection Capacity Analysis

Location	2031 Build Conditions w/ Mitigation Concept 1					2031 Build Conditions w/ Mitigation Concept 2				
	v/c [a]	Delay [b]	LOS [c]	50th Q [d]	95th Q [e]	v/c	Delay	LOS	50th Q	95th Q
Grove Street at I-95 Southbound Ramps / Asheville Road										
Weekday Morning										
Grove Street EB LTR	0.80	27	C	192	#526	0.73	24	C	158	#587
Grove Street WB L	0.45	7	A	22	103	0.50	11	B	22	148
Grove Street WB TR	0.12	5	A	12	61	0.12	6	A	12	81
I-95 SB Off-Ramp NB LT	0.03	33	C	2	15	0.03	31	C	2	15
I-95 SB Off-Ramp NB R	0.64	25	C	115	#374	0.74	32	C	120	#426
Asheville Road SB LTR	0.10	35	C	6	28	0.10	34	C	5	29
Overall		**21**	**C**				**22**	**C**		
Weekday Evening										
Grove Street EB LTR	0.58	27	C	81	220	0.64	32	C	86	#302
Grove Street WB L	0.56	8	A	46	212	0.61	13	B	47	#344
Grove Street WB TR	0.23	5	A	26	122	0.25	7	A	26	162
I-95 SB Off-Ramp NB LT	0.25	33	C	14	62	0.28	34	C	15	62
I-95 SB Off-Ramp NB R	0.20	10	B	19	102	0.19	11	B	22	104
Asheville Road SB LTR	0.04	31	C	2	18	0.04	33	C	3	18
Overall		**13**	**B**				**16**	**B**		
Saturday Midday										
Grove Street EB LTR	0.51	23	C	51	173	0.50	23	C	49	188
Grove Street WB L	0.36	7	A	22	104	0.36	9	A	20	131
Grove Street WB TR	0.12	6	A	11	56	0.12	7	A	10	71
I-95 SB Off-Ramp NB LT	0.16	25	C	9	52	0.18	28	C	9	56
I-95 SB Off-Ramp NB R	0.32	11	B	28	157	0.33	14	B	28	194
Asheville Road SB LTR	0.08	26	C	4	27	0.07	30	C	4	30
Overall		**13**	**B**				**15**	**B**		

Source: analyzed with Synchro 10 software.
Note: analyzed with right turns on red prohibited on all approaches to provide a conservative analysis.

a volume-to-capacity ratio
b average delay in seconds per vehicle
c level of service
d 50th percentile queue length, measured in feet
e 95th percentile queue length, measured in feet
95th percentile volume exceeds capacity, queue may be longer

As shown in Table 2, the intersection with the four-legged signalized concept is proposed to operate at overall LOS C or better during each peak hour under both concepts. Each approach is also expected to operate at LOS C or better during each peak hour under both concepts.

Overall, operations are slightly better under signalized Concept 1 compared to signalized Concept 2. Under Concept 1, the I-95 Southbound Ramps is shifted slightly west to directly align with Asheville Road. This means that the Asheville Road and the I-95 Southbound Ramps approaches can run concurrently and have green lights at the same time. Under Concept 2, the two approaches cannot run concurrently and have green lights at different times due to the

approaches being offset from each other. By not allowing the two approaches to run at the same time, there is additional lost time at the intersection with the needed yellow and all-red time for the additional signal phase, which causes slightly higher delays and queues for all the approaches.

It should be noted that under both signalized concepts the queues are expected to be longer then compared to the roundabout concepts. For example, during the weekday morning peak hour, the 95th-percentile queue on the Grove Street eastbound approach is expected to be approximately 526 feet or 587 feet under the two signalized concepts but only 339 feet under the three-legged roundabout concept. In addition, the 95th-percentile queue on the I-95 Southbound Off-Ramp is expected to be approximately 374 feet or 426 feet during the weekday morning peak hour under the two signalized concepts but only 142 feet under the three-legged roundabout option.

Comparison of Options

The operational analyses presented above show the difference in operations between a roundabout and traffic signal options. As highlighted, there is significant difference in vehicle queuing along Grove Street northbound and on the Southbound Ramp. To demonstrate, visually, the differences in options the following two graphics have been created to demonstrate the difference between the two critical periods. Figure 2 and Figure 3 provide illustrative comparisons of the 95th-percentile queues during the weekday morning peak hour on the Grove Street eastbound and I-95 SB Off-Ramp northbound approaches, respectively.

Figure 2 Grove Street Eastbound Approach Weekday Morning Peak Hour 95th Percentile Queues

Figure 3 I-95 SB Off-Ramp Northbound Approach Weekday Morning Peak Hour 95th Percentile Queues

As shown in Figures 1 and 2, queues on critical approaches to the intersection are substantially shorter with the roundabout proposed. This is particularly true along the I-95 Southbound Off-Ramp, where the queue under the proposed roundabout concept is less than one-third the length of the queue under the potential signalized options.

As part of the proposed Project, the Proponent is being required to do clearing in the interior of the I-95 Southbound Grove Street Off-Ramp to increase sight lines to ensure visibility to back of queue is available. This is a very important safety consideration for MassDOT and therefore treatments that minimize ramp queues should be considered preferable.

In addition, a major difference between the proposed roundabout concept and the signalized options is the elimination of the right-turn slip lane from the I-95 Southbound Off-Ramp to Grove Street eastbound. Under existing conditions, the slip lane does not provide adequate deflection to significantly reduce the speed of drivers exiting the interstate. Although the signalized options would include a signal on the slip lane, drivers will still be able to travel at high speeds onto Grove Street without significantly slowing down when the signal is green. Under the roundabout concept, the slip lane is eliminated, and all right-turning traffic must travel through the roundabout. The deflection provided in the three-legged roundabout will force drivers to slow down as they turn onto Grove Street.

Conclusion

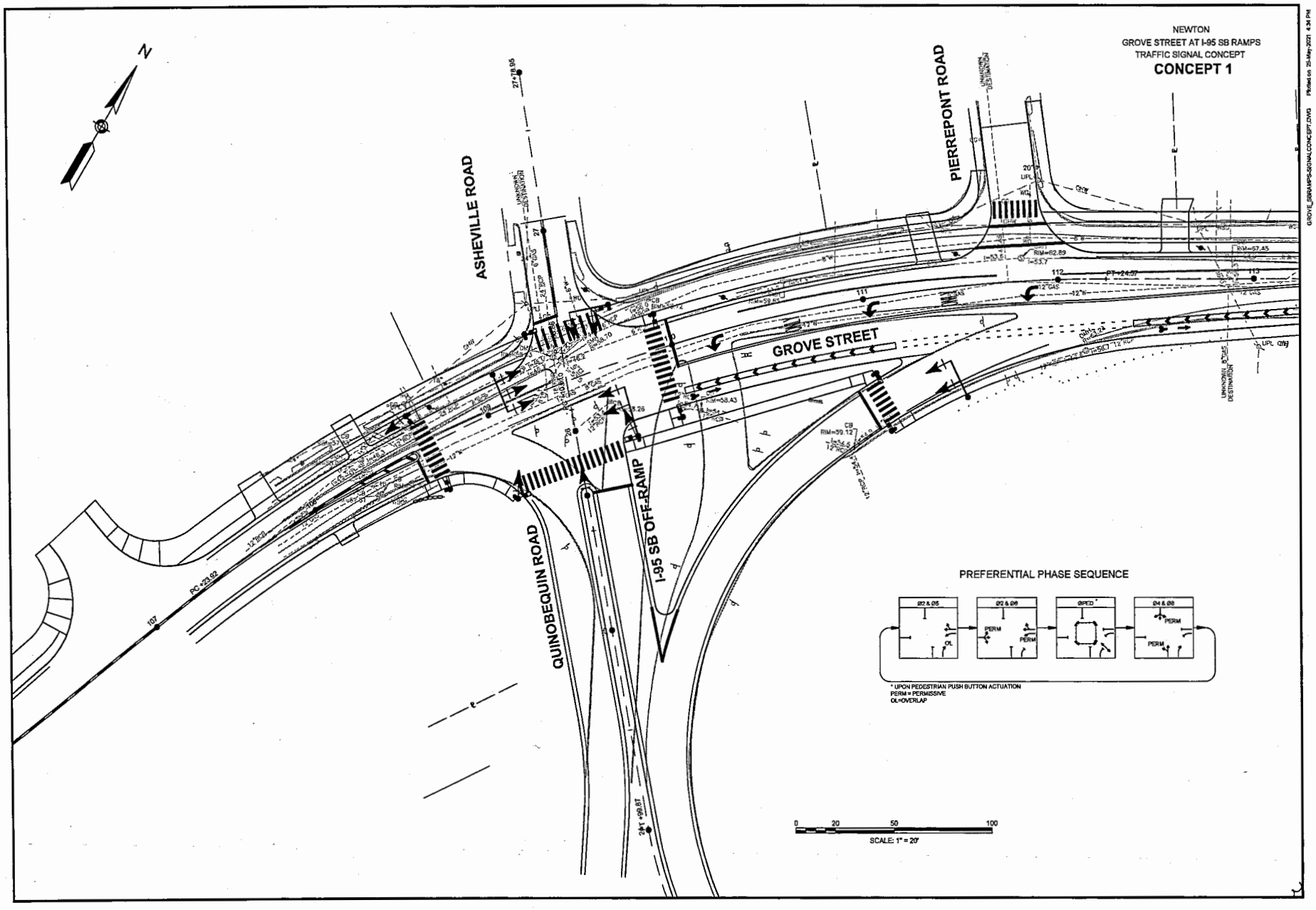
As outlined in this memorandum, future traffic conditions at the intersection of Grove Street at the I-95 Southbound Ramps are expected to operate at acceptable levels-of-service under both the roundabout concepts and the four-legged signalized concepts. However, the queues on each approach are expected to be much shorter under the roundabout concepts than under the signalized concepts. In addition, the three-legged roundabout concept is expected to provide improved safety for all users over the signalized concepts with lower vehicle speeds through the intersection and the elimination of the right-turn slip lane from the I-95 Southbound Off-Ramp to Grove Street eastbound.

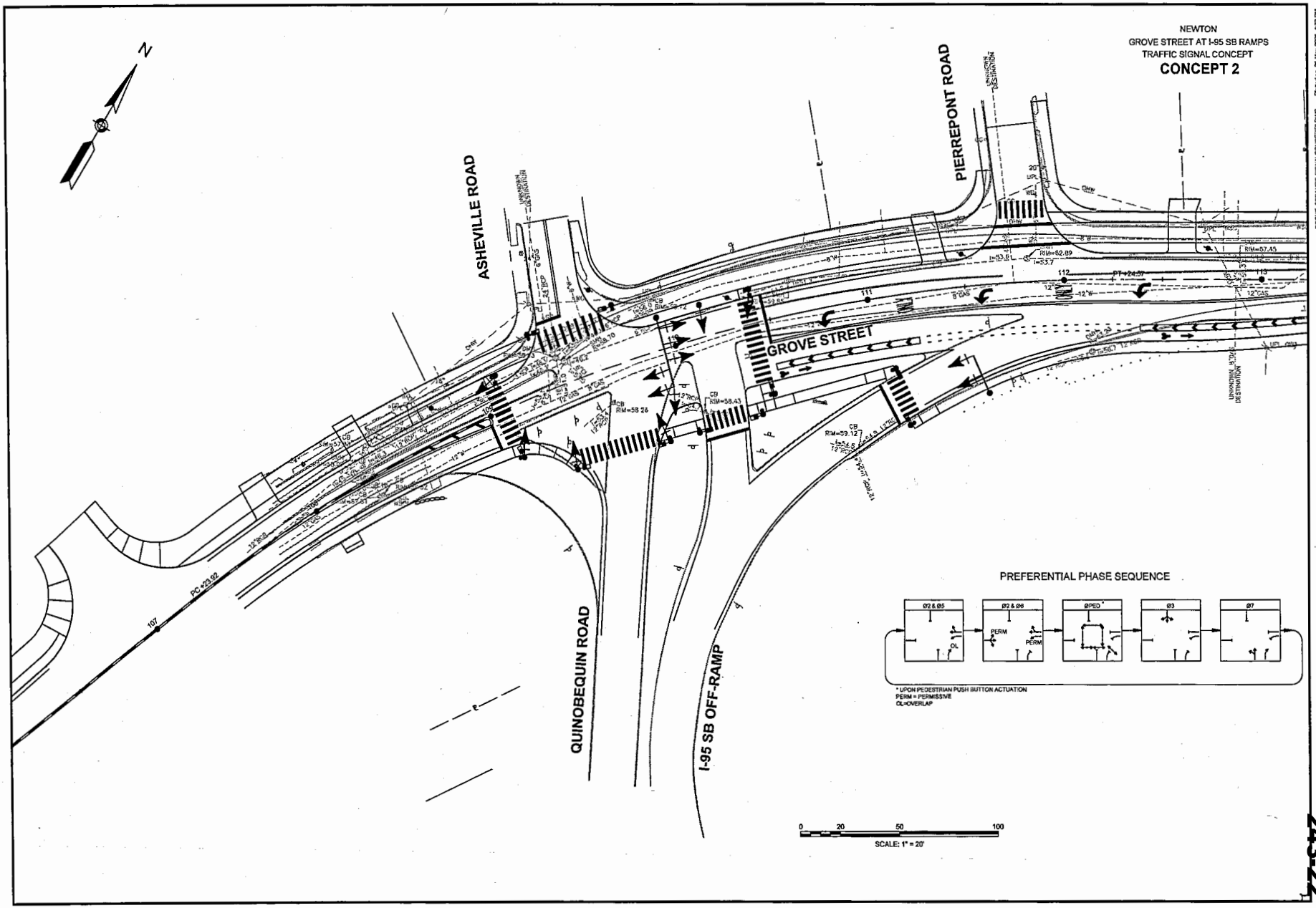
City of Newton
Ref: 10865.03
02/04/2022
Attachments

vhb
Memorandum

Attachments

- Concept Plans – Signalized
- Intersection Capacity Analyses – Roundabout
- Intersection Capacity Analyses – Signalized


NEWTON
GROVE STREET AT I-95 SB RAMPS
TRAFFIC SIGNAL CONCEPT
CONCEPT 1
N
ASHEVILLE ROAD
PIERREPONT ROAD
GROVE STREET
QUINOBEQUIN ROAD
I-95 SB OFF-RAMP
PREFERENTIAL PHASE SEQUENCE
PERM
PERM
PERM
PERM
* UPON PEDESTRIAN PUSH BUTTON ACTUATION
PERM = PERMISSIVE
OL=OVERLAP
0
20
50
100
SCALE: 1" = 20'
GROVE_SBRAMPS-SIGNAL CONCEPT.DWG
Plotted on 25-May-2021 4:34 PM


NEWTON
GROVE STREET AT I-95 SB RAMPS
TRAFFIC SIGNAL CONCEPT
CONCEPT 2
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ASHEVILLE ROAD
PIERREPONT ROAD
GROVE STREET
QUINOBEQUIN ROAD
I-95 SB OFF-RAMP
PREFERENTIAL PHASE SEQUENCE
Ø2 & Ø5
Ø2 & Ø6
ØPED *
Ø3
Ø7
PERM
PERM
OL
* UPON PEDESTRIAN PUSH BUTTON ACTUATION
PERM = PERMISSIVE
OL=OVERLAP
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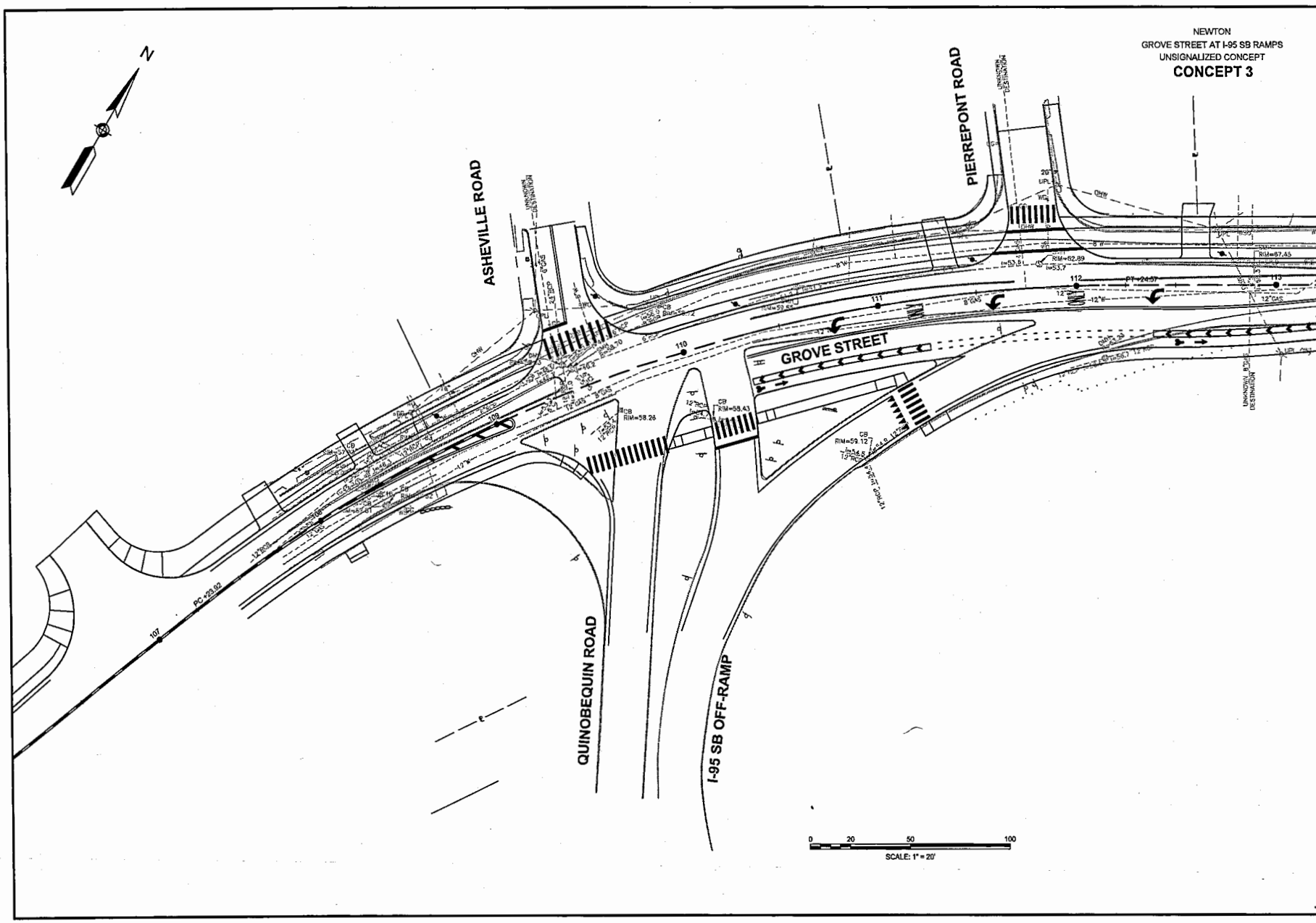
SCALE: 1" = 20'
243-22



GROVE_SBRAMPS-SIGNALCONCEPT3.DWG Plotted on 4-Jun-2021 8:28 AM

243-22

LANE SUMMARY

Site: 101 [Weekday Morning_2031 Build with Mitigation]

Grove Street at Asheville Road / I-95 SB Ramps
Site Category: (None)
Roundabout

Lane Use and Performance													
	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: I-95 SB Ramps													
Lane 1[d]	409	2.0	615	0.665	100	20.0	LOS C	5.6	143.1	Full	1600	0.0	0.0
Approach	409	2.0		0.665		20.0	LOS C	5.6	143.1				
East: Grove Street													
Lane 1[d]	413	3.0	1089	0.379	100	7.2	LOS A	2.0	50.1	Full	1600	0.0	0.0
Approach	413	3.0		0.379		7.2	LOS A	2.0	50.1				
North: Asheville Road													
Lane 1[d]	17	7.0	690	0.025	100	5.5	LOS A	0.1	2.1	Full	1600	0.0	0.0
Approach	17	7.0		0.025		5.5	LOS A	0.1	2.1				
West: Grove Street													
Lane 1[d]	626	2.0	832	0.752	100	20.0	LOS C	12.6	321.1	Full	1600	0.0	0.0
Approach	626	2.0		0.752		20.0	LOS C	12.6	321.1				
Intersection	1465	2.3		0.752		16.2	LOS C	12.6	321.1				

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

LANE SUMMARY

Site: 101 [Weekday Evening_2031 Build with Mitigation]

Grove Street at Asheville Road / I-95 SB Ramps
Site Category: (None)
Roundabout

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: I-95 SB Ramps													
Lane 1[d]	207	5.0	840	0.246	100	6.9	LOS A	0.9	24.7	Full	1600	0.0	0.0
Approach	207	5.0		0.246		6.9	LOS A	0.9	24.7				
East: Grove Street													
Lane 1[d]	793	2.0	1051	0.755	100	16.9	LOS C	8.3	212.0	Full	1600	0.0	0.0
Approach	793	2.0		0.755		16.9	LOS C	8.3	212.0				
North: Asheville Road													
Lane 1[d]	9	0.0	486	0.018	100	7.6	LOS A	0.1	1.4	Full	1600	0.0	0.0
Approach	9	0.0		0.018		7.6	LOS A	0.1	1.4				
West: Grove Street													
Lane 1[d]	284	3.0	665	0.427	100	11.5	LOS B	2.2	56.0	Full	1600	0.0	0.0
Approach	284	3.0		0.427		11.5	LOS B	2.2	56.0				
Intersection	1292	2.7		0.755		14.1	LOS B	8.3	212.0				

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

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LANE SUMMARY

Site: 101 [Saturday Midday_2031 Build with Mitigation]

Grove Street at Asheville Road / I-95 SB Ramps
Site Category: (None)
Roundabout

Lane Use and Performance													
	Demand Flows Total veh/h	HV %	Cap veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: I-95 SB Ramps													
Lane 1[d]	304	1.0	934	0.326	100	7.3	LOS A	1.5	37.1	Full	1600	0.0	0.0
Approach	304	1.0		0.326		7.3	LOS A	1.5	37.1				
East: Grove Street													
Lane 1[d]	380	1.0	1065	0.357	100	7.0	LOS A	1.8	45.2	Full	1600	0.0	0.0
Approach	380	1.0		0.357		7.0	LOS A	1.8	45.2				
North: Asheville Road													
Lane 1[d]	17	0.0	745	0.023	100	5.1	LOS A	0.1	1.9	Full	1600	0.0	0.0
Approach	17	0.0		0.023		5.1	LOS A	0.1	1.9				
West: Grove Street													
Lane 1[d]	239	1.0	855	0.280	100	7.2	LOS A	1.2	29.3	Full	1600	0.0	0.0
Approach	239	1.0		0.280		7.2	LOS A	1.2	29.3				
Intersection	941	1.0		0.357		7.1	LOS A	1.8	45.2				

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

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LANE SUMMARY

Site: 101 [Weekday Morning_2031 Build with Mitigation]

Grove Street at Asheville Road / I-95 SB Ramps
Site Category: (None)
Roundabout

Lane Use and Performance													
	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: I-95 SB Ramps													
Lane 1[d]	408	2.0	616	0.662	100	19.9	LOS C	5.6	141.8	Full	1600	0.0	0.0
Approach	408	2.0		0.662		19.9	LOS C	5.6	141.8				
East: Grove Street													
Lane 1[d]	413	3.0	1091	0.379	100	7.2	LOS A	2.0	50.0	Full	1600	0.0	0.0
Approach	413	3.0		0.379		7.2	LOS A	2.0	50.0				
West: Grove Street													
Lane 1[d]	641	2.0	847	0.757	100	20.0	LOS C	13.4	339.3	Full	1600	0.0	0.0
Approach	641	2.0		0.757		20.0	LOS C	13.4	339.3				
Intersection	1462	2.3		0.757		16.3	LOS C	13.4	339.3				

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

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LANE SUMMARY

Site: 101 [Weekday Evening_2031 Build with Mitigation]

Grove Street at Asheville Road / I-95 SB Ramps
Site Category: (None)
Roundabout

Lane Use and Performance	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: I-95 SB Ramps													
Lane 1[d]	207	5.0	841	0.245	100	6.9	LOS A	0.9	24.6	Full	1600	0.0	0.0
Approach	207	5.0		0.245		6.9	LOS A	0.9	24.6				
East: Grove Street													
Lane 1[d]	793	2.0	1052	0.754	100	16.8	LOS C	8.3	211.8	Full	1600	0.0	0.0
Approach	793	2.0		0.754		16.8	LOS C	8.3	211.8				
West: Grove Street													
Lane 1[d]	288	3.0	670	0.430	100	11.5	LOS B	2.2	57.0	Full	1600	0.0	0.0
Approach	288	3.0		0.430		11.5	LOS B	2.2	57.0				
Intersection	1288	2.7		0.754		14.1	LOS B	8.3	211.8				

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

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LANE SUMMARY

Site: 101 [Saturday Midday_2031 Build with Mitigation]

Grove Street at Asheville Road / I-95 SB Ramps
Site Category: (None)
Roundabout

Lane Use and Performance	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: I-95 SB Ramps													
Lane 1[d]	304	1.0	939	0.324	100	7.3	LOS A	1.5	36.9	Full	1600	0.0	0.0
Approach	304	1.0		0.324		7.3	LOS A	1.5	36.9				
East: Grove Street													
Lane 1[d]	380	1.0	1071	0.355	100	7.0	LOS A	1.8	44.9	Full	1600	0.0	0.0
Approach	380	1.0		0.355		7.0	LOS A	1.8	44.9				
West: Grove Street													
Lane 1[d]	250	1.0	869	0.288	100	7.2	LOS A	1.2	30.5	Full	1600	0.0	0.0
Approach	250	1.0		0.288		7.2	LOS A	1.2	30.5				
Intersection	935	1.0		0.355		7.2	LOS A	1.8	44.9				

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

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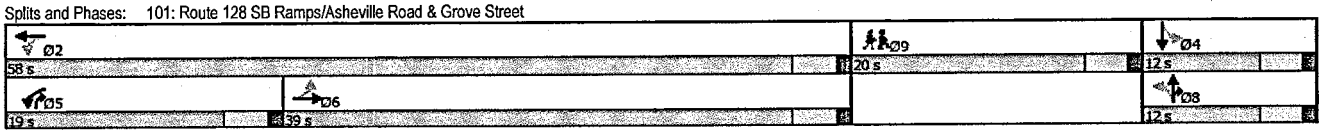
Riverside Station Development :: 10865.03 — 2031 Build Conditions with Mitigation - Signal at SB Ramps - Concept 1
101: Route 128 SB Ramps/Asheville Road & Grove Street — Timing Plan: Weekday Morning

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	1	520	55	240	135	5	5	1	370	10	5	0	
Future Volume (vph)	1	520	55	240	135	5	5	1	370	10	5	0	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	0		0	200		0	0		200	0		0	
Storage Lanes	0		0	1		0	0		1	0		0	
Taper Length (ft)	25			25			25			25			
Satd. Flow (prot)	0	1835	0	1752	1834	0	0	1788	1583	0	1717	0	
Flt Permitted				0.243				0.837			0.843		
Satd. Flow (perm)	0	1835	0	448	1834	0	0	1559	1583	0	1497	0	
Right Turn on Red			No			No			No			No	
Satd. Flow (RTOR)													
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		1604			920			838			182		
Travel Time (s)		36.5			20.9			19.0			4.1		
Confl. Peds. (#/hr)	7					7							
Confl. Bikes (#/hr)			1			1							
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	2%	2%	2%	7%	7%	7%	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	0	626	0	261	152	0	0	6	402	0	16	0	
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	pt+ov	Perm	NA		
Protected Phases		6		5	2			8	5 8		4		9
Permitted Phases	6			2			8			4			
Detector Phase	6	6		5	2		8	8	5 8	4	4		
Switch Phase													
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0		6.0	6.0		4.0
Minimum Split (s)	14.0	14.0		10.0	14.0		10.0	10.0		10.0	10.0		20.0
Total Split (s)	39.0	39.0		19.0	58.0		12.0	12.0		12.0	12.0		20.0
Total Split (%)	43.3%	43.3%		21.1%	64.4%		13.3%	13.3%		13.3%	13.3%		22%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0		3.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		1.0
Lost Time Adjust (s)		0.0		0.0	0.0			0.0			0.0		
Total Lost Time (s)		4.0		4.0	4.0			4.0			4.0		
Lead/Lag	Lag	Lag		Lead									
Lead-Lag Optimize?													
Recall Mode	Min	Min		None	Min		None	None		None	None		None
Act Effct Green (s)		28.0		45.8	45.8			8.4	26.1		6.8		
Actuated g/C Ratio		0.43		0.70	0.70			0.13	0.40		0.10		
v/c Ratio		0.80		0.45	0.12			0.03	0.64		0.10		
Control Delay		27.0		7.0	4.5			33.0	25.3		34.5		
Queue Delay		0.0		0.0	0.0			0.0	0.0		0.0		
Total Delay		27.0		7.0	4.5			33.0	25.3		34.5		
LOS		C		A	A			C	C		C		
Approach Delay		27.0			6.1			25.4			34.5		
Approach LOS		C			A			C			C		
Queue Length 50th (ft)		192		22	12			2	115		6		
Queue Length 95th (ft)		#526		103	61			15	#374		28		
Internal Link Dist (ft)		1524			840			758			102		
Turn Bay Length (ft)				200					200				
Base Capacity (vph)		1026		626	1531			199	683		191		
Starvation Cap Reductn		0		0	0			0	0		0		
Spillback Cap Reductn		0		0	0			0	0		0		
Storage Cap Reductn		0		0	0			0	0		0		
Reduced v/c Ratio		0.61		0.42	0.10			0.03	0.59		0.08		

Intersection Summary
Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 65.4
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.80
Intersection Signal Delay: 20.7 — Intersection LOS: C
Intersection Capacity Utilization 68.7% — ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 101: Route 128 SB Ramps/Asheville Road & Grove Street

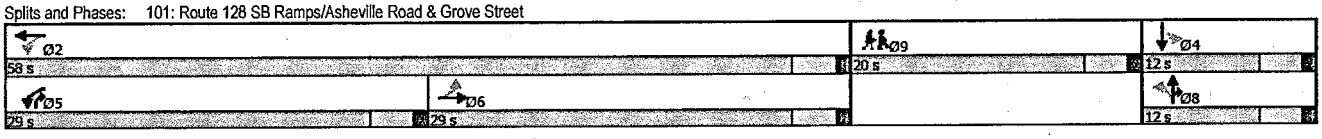


Riverside Station Development :: 10865.03 — 2031 Build Conditions w/ Mitigation - Signal at SB Ramps - Concept 1
101: Route 128 SB Ramps/Asheville Road & Grove Street — Timing Plan: Weekday Evening

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	1	215	45	445	275	10	40	5	145	5	2	1	
Future Volume (vph)	1	215	45	445	275	10	40	5	145	5	2	1	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	0		0	200		0	0		200	0		0	
Storage Lanes	0		0	1		0	0		1	0		0	
Taper Length (ft)	25			25			25			25			
Satd. Flow (prot)	0	1802	0	1770	1851	0	0	1732	1538	0	1812	0	
Flt Permitted		0.999		0.341				0.743			0.813		
Satd. Flow (perm)	0	1800	0	635	1851	0	0	1344	1538	0	1518	0	
Right Turn on Red			No			No			No			No	
Satd. Flow (RTOR)													
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		1604			883			838			182		
Travel Time (s)		36.5			20.1			19.0			4.1		
Confl. Peds. (#/hr)	16					16							
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	5%	5%	5%	0%	0%	0%	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	0	284	0	484	310	0	0	48	158	0	8	0	
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	pt+ov	Perm	NA		
Protected Phases		6		5	2			8	5 8		4		9
Permitted Phases	6			2			8			4			
Detector Phase	6	6		5	2		8	8	5 8	4	4		
Switch Phase													
Minimum Initial (s)	10.0	10.0		6.0	6.0		6.0	6.0		6.0	6.0		4.0
Minimum Split (s)	14.0	14.0		10.0	10.0		10.0	10.0		10.0	10.0		20.0
Total Split (s)	29.0	29.0		29.0	58.0		12.0	12.0		12.0	12.0		20.0
Total Split (%)	32.2%	32.2%		32.2%	64.4%		13.3%	13.3%		13.3%	13.3%		22%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0		3.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		1.0
Lost Time Adjust (s)		0.0		0.0	0.0			0.0			0.0		
Total Lost Time (s)		4.0		4.0	4.0			4.0			4.0		
Lead/Lag	Lag	Lag		Lead									
Lead-Lag Optimize?													
Recall Mode	Min	Min		None	None		None	None		None	None		None
Act Effct Green (s)		15.2		40.4	41.9			8.1	29.5		8.1		
Actuated g/C Ratio		0.27		0.72	0.74			0.14	0.52		0.14		
v/c Ratio		0.58		0.56	0.23			0.25	0.20		0.04		
Control Delay		26.7		8.1	5.0			33.0	10.4		31.0		
Queue Delay		0.0		0.0	0.0			0.0	0.0		0.0		
Total Delay		26.7		8.1	5.0			33.0	10.4		31.0		
LOS		C		A	A			C	B		C		
Approach Delay		26.7			6.9			15.6			31.0		
Approach LOS		C			A			B			C		
Queue Length 50th (ft)		81		46	26			14	19		2		
Queue Length 95th (ft)		220		212	122			62	102		18		
Internal Link Dist (ft)		1524			803			758			102		
Turn Bay Length (ft)				200					200				
Base Capacity (vph)		907		1027	1660			216	975		244		
Starvation Cap Reductn		0		0	0			0	0		0		
Spillback Cap Reductn		0		0	0			0	0		0		
Storage Cap Reductn		0		0	0			0	0		0		
Reduced v/c Ratio		0.31		0.47	0.19			0.22	0.16		0.03		

Intersection Summary
Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 56.3
Natural Cycle: 65
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.58
Intersection Signal Delay: 12.8 — Intersection LOS: B
Intersection Capacity Utilization 53.8% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 101: Route 128 SB Ramps/Asheville Road & Grove Street



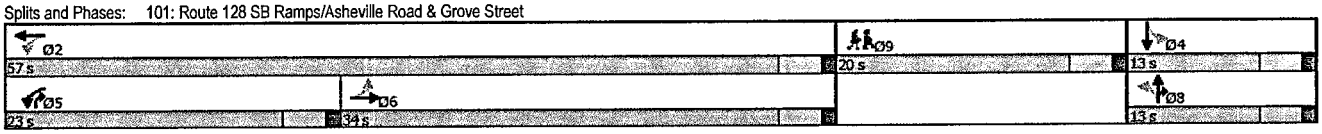
Riverside Station Development :: 10865.03
101: Route 128 SB Ramps/Asheville Road & Grove Street

2031 Build Conditions with Mitigation - Signal at SB Ramps - Concept 1
Timing Plan: Saturday Midday

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	5	150	65	230	115	5	35	5	240	10	5	1	
Future Volume (vph)	5	150	65	230	115	5	35	5	240	10	5	1	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	0		0	200		0	0		200	0		0	
Storage Lanes	0		0	1		0	0		1	0		0	
Taper Length (ft)	25			25			25			25			
Satd. Flow (prot)	0	1804	0	1787	1868	0	0	1802	1599	0	1826	0	
Flt Permitted		0.995		0.398				0.767			0.849		
Satd. Flow (perm)	0	1797	0	749	1868	0	0	1443	1599	0	1600	0	
Right Turn on Red			No			No			No			No	
Satd. Flow (RTOR)													
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		1604			883			759			182		
Travel Time (s)		36.5			20.1			17.3			4.1		
Confl. Peds. (#/hr)	4					4							
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	0	239	0	250	130	0	0	43	261	0	17	0	
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	pt+ov	Perm	NA		
Protected Phases		6		5	2			8	5 8		4		9
Permitted Phases	6			2			8			4			
Detector Phase	6	6		5	2		8	8	5 8	4	4		
Switch Phase													
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0		6.0	6.0		4.0
Minimum Split (s)	14.0	14.0		10.0	14.0		10.0	10.0		10.0	10.0		20.0
Total Split (s)	34.0	34.0		23.0	57.0		13.0	13.0		13.0	13.0		20.0
Total Split (%)	37.8%	37.8%		25.6%	63.3%		14.4%	14.4%		14.4%	14.4%		22%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0		3.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		1.0
Lost Time Adjust (s)		0.0		0.0	0.0			0.0			0.0		
Total Lost Time (s)		4.0		4.0	4.0			4.0			4.0		
Lead/Lag	Lag	Lag		Lead									
Lead-Lag Optimize?													
Recall Mode	Min	Min		None	Min		None	None		None	None		None
Act Effct Green (s)		12.9		29.4	29.4			9.0	25.5		6.9		
Actuated g/C Ratio		0.26		0.59	0.59			0.18	0.52		0.14		
v/c Ratio		0.51		0.36	0.12			0.16	0.32		0.08		
Control Delay		22.5		7.4	5.9			25.0	10.8		25.9		
Queue Delay		0.0		0.0	0.0			0.0	0.0		0.0		
Total Delay		22.5		7.4	5.9			25.0	10.8		25.9		
LOS		C		A	A			C	B		C		
Approach Delay		22.5			6.9			12.8			25.9		
Approach LOS		C			A			B			C		
Queue Length 50th (ft)		51		22	11			9	28		4		
Queue Length 95th (ft)		173		104	56			52	157		27		
Internal Link Dist (ft)		1524			803			679			102		
Turn Bay Length (ft)				200					200				
Base Capacity (vph)		1179		876	1738			283	1052		315		
Starvation Cap Reductn		0		0	0			0	0		0		
Spillback Cap Reductn		0		0	0			0	0		0		
Storage Cap Reductn		0		0	0			0	0		0		
Reduced v/c Ratio		0.20		0.29	0.07			0.15	0.25		0.05		

Intersection Summary
Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 49.5
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.51
Intersection Signal Delay: 13.1 Intersection LOS: B
Intersection Capacity Utilization 42.4% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 101: Route 128 SB Ramps/Asheville Road & Grove Street



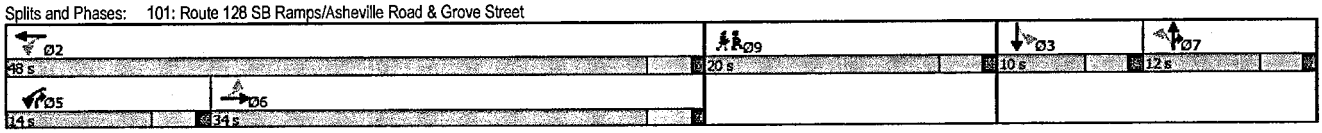
Riverside Station Development :: 10865.03
101: Route 128 SB Ramps/Asheville Road & Grove Street

2031 Build Conditions with Mitigation - Signal at SB Ramps - Concept 2
Timing Plan: Weekday Morning

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	1	520	55	240	135	5	5	1	370	10	5	0	
Future Volume (vph)	1	520	55	240	135	5	5	1	370	10	5	0	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	0		0	200		0	0		200	0		0	
Storage Lanes	0		0	1		0	0		1	0		0	
Taper Length (ft)	25			25			25			25			
Satd. Flow (prot)	0	1835	0	1752	1834	0	0	1788	1583	0	1717	0	
Flt Permitted				0.253				0.832					
Satd. Flow (perm)	0	1835	0	467	1834	0	0	1550	1583	0	1776	0	
Right Turn on Red			No			No			No			No	
Satd. Flow (RTOR)													
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		1604			920			838			182		
Travel Time (s)		36.5			20.9			19.0			4.1		
Confl. Peds. (#/hr)	7					7							
Confl. Bikes (#/hr)			1			1							
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	2%	2%	2%	7%	7%	7%	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	0	626	0	261	152	0	0	6	402	0	16	0	
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	pt+ov	Perm	NA		
Protected Phases		6		5	2			7	5 7		3		9
Permitted Phases	6			2			7			3			
Detector Phase	6	6		5	2		7	7	5 7	3	3		
Switch Phase													
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0		6.0	6.0		4.0
Minimum Split (s)	14.0	14.0		10.0	14.0		10.0	10.0		10.0	10.0		20.0
Total Split (s)	34.0	34.0		14.0	48.0		12.0	12.0		10.0	10.0		20.0
Total Split (%)	37.8%	37.8%		15.6%	53.3%		13.3%	13.3%		11.1%	11.1%		22%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0		3.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		1.0
Lost Time Adjust (s)		0.0		0.0	0.0			0.0			0.0		
Total Lost Time (s)		4.0		4.0	4.0			4.0			4.0		
Lead/Lag	Lag	Lag		Lead			Lag	Lag		Lead	Lead		
Lead-Lag Optimize?													
Recall Mode	Min	Min		None	Min		None	None		None	None		None
Act Effct Green (s)		30.8		45.2	45.2			8.2	22.6		6.2		
Actuated g/C Ratio		0.47		0.68	0.68			0.12	0.34		0.09		
v/c Ratio		0.73		0.50	0.12			0.03	0.74		0.10		
Control Delay		23.8		11.0	6.4			31.3	32.4		33.6		
Queue Delay		0.0		0.0	0.0			0.0	0.0		0.0		
Total Delay		23.8		11.0	6.4			31.3	32.4		33.6		
LOS		C		B	A			C	C		C		
Approach Delay		23.8			9.3			32.4			33.6		
Approach LOS		C			A			C			C		
Queue Length 50th (ft)		158		22	12			2	120		5		
Queue Length 95th (ft)		#587		#148	81			15	#426		29		
Internal Link Dist (ft)		1524			840			758			102		
Turn Bay Length (ft)				200					200				
Base Capacity (vph)		856		519	1254			192	541		165		
Starvation Cap Reductn		0		0	0			0	0		0		
Spillback Cap Reductn		0		0	0			0	0		0		
Storage Cap Reductn		0		0	0			0	0		0		
Reduced v/c Ratio		0.73		0.50	0.12			0.03	0.74		0.10		

Intersection Summary
Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 66
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.74
Intersection Signal Delay: 22.2 Intersection LOS: C
Intersection Capacity Utilization 68.7% ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 101: Route 128 SB Ramps/Asheville Road & Grove Street



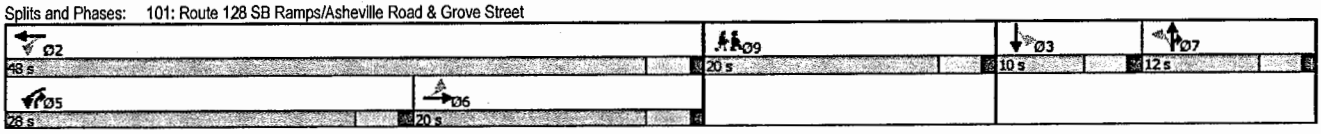
Riverside Station Development :: 10865.03
101: Route 128 SB Ramps/Asheville Road & Grove Street

2031 Build Conditions w/ Mitigation - Signal at SB Ramps - Concept 2
Timing Plan: Weekday Evening

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	1	215	45	445	275	10	40	5	145	5	2	1	
Future Volume (vph)	1	215	45	445	275	10	40	5	145	5	2	1	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	0		0	200		0	0		200	0		0	
Storage Lanes	0		0	1		0	0		1	0		0	
Taper Length (ft)	25			25			25			25			
Satd. Flow (prot)	0	1802	0	1770	1851	0	0	1732	1538	0	1812	0	
Flt Permitted		0.999		0.283				0.743					
Satd. Flow (perm)	0	1800	0	527	1851	0	0	1344	1538	0	1868	0	
Right Turn on Red			No			No			No			No	
Satd. Flow (RTOR)													
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		1604			883			838			182		
Travel Time (s)		36.5			20.1			19.0			4.1		
Confl. Peds. (#/hr)	16					16							
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	5%	5%	5%	0%	0%	0%	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	0	284	0	484	310	0	0	48	158	0	8	0	
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	pt+ov	Perm	NA		
Protected Phases		6		5	2			7	5 7		3		9
Permitted Phases	6			2			7			3			
Detector Phase	6	6		5	2		7	7	5 7	3	3		
Switch Phase													
Minimum Initial (s)	10.0	10.0		6.0	6.0		6.0	6.0		6.0	6.0		4.0
Minimum Split (s)	14.0	14.0		10.0	10.0		10.0	10.0		10.0	10.0		20.0
Total Split (s)	20.0	20.0		28.0	48.0		12.0	12.0		10.0	10.0		20.0
Total Split (%)	22.2%	22.2%		31.1%	53.3%		13.3%	13.3%		11.1%	11.1%		22%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0		3.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		1.0
Lost Time Adjust (s)		0.0		0.0	0.0			0.0			0.0		
Total Lost Time (s)		4.0		4.0	4.0			4.0			4.0		
Lead/Lag	Lag	Lag		Lead			Lag	Lag		Lead	Lead		
Lead-Lag Optimize?													
Recall Mode	Min	Min		None	None		None	None		None	None		None
Act Effct Green (s)		15.2		40.9	40.9			7.8	33.5		6.3		
Actuated g/C Ratio		0.25		0.67	0.67			0.13	0.55		0.10		
v/c Ratio		0.64		0.61	0.25			0.28	0.19		0.04		
Control Delay		32.4		12.7	7.0			34.4	10.8		32.9		
Queue Delay		0.0		0.0	0.0			0.0	0.0		0.0		
Total Delay		32.4		12.7	7.0			34.4	10.8		32.9		
LOS		C		B	A			C	B		C		
Approach Delay		32.4			10.5			16.3			32.9		
Approach LOS		C			B			B			C		
Queue Length 50th (ft)		86		47	26			15	22		3		
Queue Length 95th (ft)		#302		#344	162			62	104		18		
Internal Link Dist (ft)		1524			803			758			102		
Turn Bay Length (ft)				200					200				
Base Capacity (vph)		497		866	1405			185	904		193		
Starvation Cap Reductn		0		0	0			0	0		0		
Spillback Cap Reductn		0		0	0			0	0		0		
Storage Cap Reductn		0		0	0			0	0		0		
Reduced v/c Ratio		0.57		0.56	0.22			0.26	0.17		0.04		

Intersection Summary
Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 61.2
Natural Cycle: 80
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.64
Intersection Signal Delay: 16.4 Intersection LOS: B
Intersection Capacity Utilization 53.8% ICU Level of Service A
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

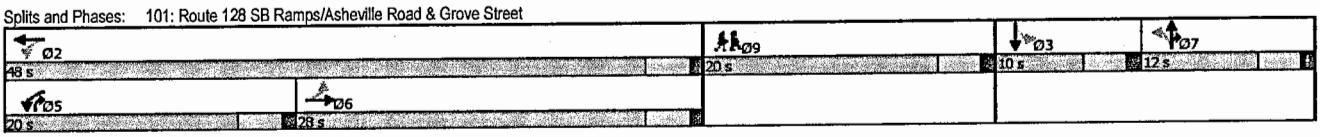
Splits and Phases: 101: Route 128 SB Ramps/Asheville Road & Grove Street



Riverside Station Development :: 10865.03
101: Route 128 SB Ramps/Asheville Road & Grove Street

2031 Build Conditions with Mitigation - Signal at SB Ramps - Concept 2
Timing Plan: Saturday Midday

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	5	150	65	230	115	5	35	5	240	10	5	1	
Future Volume (vph)	5	150	65	230	115	5	35	5	240	10	5	1	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	0		0	200		0	0		200	0		0	
Storage Lanes	0		0	1		0	0		1	0		0	
Taper Length (ft)	25			25			25			25			
Satd. Flow (prot)	0	1804	0	1787	1868	0	0	1802	1599	0	1826	0	
Flt Permitted		0.995		0.380				0.756					
Satd. Flow (perm)	0	1797	0	715	1868	0	0	1422	1599	0	1885	0	
Right Turn on Red			No			No			No			No	
Satd. Flow (RTOR)													
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		1604			883			759			182		
Travel Time (s)		36.5			20.1			17.3			4.1		
Confl. Peds. (#/hr)	4					4							
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	0	239	0	250	130	0	0	43	261	0	17	0	
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	pt+ov	Perm	NA		
Protected Phases		6		5	2			7	5 7		3		9
Permitted Phases	6			2			7			3			
Detector Phase	6	6		5	2		7	7	5 7	3	3		
Switch Phase													
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0		6.0	6.0		4.0
Minimum Split (s)	14.0	14.0		10.0	14.0		10.0	10.0		10.0	10.0		20.0
Total Split (s)	28.0	28.0		20.0	48.0		12.0	12.0		10.0	10.0		20.0
Total Split (%)	31.1%	31.1%		22.2%	53.3%		13.3%	13.3%		11.1%	11.1%		22%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0		3.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		1.0
Lost Time Adjust (s)		0.0		0.0	0.0			0.0			0.0		
Total Lost Time (s)		4.0		4.0	4.0			4.0			4.0		
Lead/Lag	Lag	Lag		Lead			Lag	Lag		Lead	Lead		
Lead-Lag Optimize?													
Recall Mode	Min	Min		None	Min		None	None		None	None		None
Act Effct Green (s)		13.7		30.7	30.7			8.6	25.6		6.6		
Actuated g/C Ratio		0.27		0.59	0.59			0.17	0.50		0.13		
v/c Ratio		0.50		0.36	0.12			0.18	0.33		0.07		
Control Delay		23.0		8.6	7.1			28.4	13.6		29.6		
Queue Delay		0.0		0.0	0.0			0.0	0.0		0.0		
Total Delay		23.0		8.6	7.1			28.4	13.6		29.6		
LOS		C		A	A			C	B		C		
Approach Delay		23.0			8.1			15.7			29.6		
Approach LOS		C			A			B			C		
Queue Length 50th (ft)		49		20	10			9	28		4		
Queue Length 95th (ft)		188		131	71			56	194		30		
Internal Link Dist (ft)		1524			803			679			102		
Turn Bay Length (ft)				200					200				
Base Capacity (vph)		924		793	1633			244	924		242		
Starvation Cap Reductn		0		0	0			0	0		0		
Spillback Cap Reductn		0		0	0			0	0		0		
Storage Cap Reductn		0		0	0			0	0		0		
Reduced v/c Ratio		0.26		0.32	0.08			0.18	0.28		0.07		

Intersection Summary
Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 51.6
Natural Cycle: 65
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.50
Intersection Signal Delay: 14.7 Intersection LOS: B
Intersection Capacity Utilization 42.4% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 101: Route 128 SB Ramps/Asheville Road & Grove Street