

MEMORANDUM

Ref: 1831A

To: Juliet T.H. Walker, AICP
City of Portsmouth

From: Stephen G. Pernaw, P.E., PTOE

Subject: West End Yards Traffic Study – ADDENDUM 1
Portsmouth, New Hampshire

Date: July 25, 2019

On April 24, 2019 our office published the report entitled “*Traffic Impact and Site Access Study-Updated / Proposed Mixed-Use Site*” for Torrington Properties, Inc. to assess the traffic impacts associated with the proposed West End Yards residential/commercial development located on the east side of US1 Bypass at the site of the Frank Jones Center in Portsmouth, New Hampshire.

We recently received the plan entitled “*Roadway Plan & Profile – Cate Street,*” Sheet CS-101, prepared by Fuss & O’Neill dated 06/20/2019 (revised 06/20/2019) that shows the widening of the Cate Street Extension approach to the Bypass from two to three westbound lanes (see Attachment 1). The proposed lane configuration includes one exclusive left-turn lane, one shared through-right lane, and one exclusive right-turn lane. As recommended by The Engineering Corporation (TEC), the City’s peer review engineer, the previously proposed northbound right-turn lane on US1 Bypass at the Cottage Street/Coakley Road intersection has been eliminated.

The purpose of this memorandum is to provide the City with the updated intersection capacity and Level of Service analyses for these two signalized intersections on the Bypass. Table 6 from the original traffic report has been updated with a new column labeled “Mitigation 2” and is found on the following page. The computations are attached (see Attachments 2-7).

We remain available to discuss these findings with TEC and the City staff, if necessary.

Attachments

cc: Jay Bisognano, Torrington Properties, Inc.
Gregg M. Mikolaities, P.E., August Consulting, PLLC
Richard Lundborn, P.E., Fuss & O’Neill

Table 6
(Addendum 1)

Signal-Controlled Intersection Capacity Analysis Summary - with Mitigation
2030 Weekday PM Peak Hour

	2030 No-Build				2030 Build				2030 Build w/Mitigation 2			
	V/C ¹⁾	Delay ²⁾	LOS ³⁾	Queue Avg/95 th ⁴⁾	V/C ¹⁾	Delay ²⁾	LOS ³⁾	Queue Avg/95 th ⁴⁾	V/C ¹⁾	Delay ²⁾	LOS ³⁾	Queue Avg/95 th ⁴⁾
US1 Bypass/Cottage St/Coakley Rd ⁵⁾												
Coakley Road - EB LT&TH& RT	0.34	39.4	D	2 (3)	0.49	45.7	D	2 (3)	0.49	45.7	D	2 (3)
Cottage Street - WB LT&TH	1.03	104.8	F	10 (13)	1.17	156.4	F	11 (14)	1.17	156.4	F	11 (14)
Cottage Street - WB RT	0.33	40.2	D	2 (4)	0.10	40.9	D	0 (2)	0.06	40.5	D	0 (0)
US1 Bypass - NB LT	0.28	58.1	E	0 (1)	0.28	51.7	D	1 (1)	0.21	54.4	D	0 (1)
US1 Bypass - NB 2TH&RT	1.03	46.5	D	40 (45)	1.12	70.3	E	48 (49)	1.12	69.8	E	49 (53)
US1 Bypass - NB 2TH	-	-	-	-	-	-	-	-	-	-	-	-
US1 Bypass - NB RT	-	-	-	-	-	-	-	-	-	-	-	-
US1 Bypass - SB LT	0.76	86.0	F	2 (5)	0.63	69.6	E	2 (4)	0.63	69.6	E	2 (4)
US1 Bypass - SB 2TH&RT	0.44	11.8	B	6 (10)	0.49	10.6	B	6 (11)	0.50	11.4	B	6 (15)
Overall	1.01	42.5	D		1.10	58.5	E		1.10	58.5	E	
Cycle Length	120.0				120.0				120.0			
US1 Bypass/Borthwick Ave/Cate St Extension ⁶⁾												
Borthwick Avenue - EB LT	0.77	52.2	D	9 (12)	0.96	88.0	F	10 (15)	0.87	46.3	E	9 (14)
Borthwick Avenue - EB LT&TH	0.77	52.2	D	9 (12)	0.97	90.4	F	10 (15)	0.88	46.4	E	10 (14)
Borthwick Avenue - EB RT	0.07	37.9	D	0 (1)	0.07	42.2	D	0 (0)	0.07	40.3	D	0 (0)
Cate Street Extension - WB LT	0.12	55.8	E	0 (1)	0.23	46.1	D	2 (3)	0.48	54.0	E	2 (4)
Cate Street Extension - WB TH&RT	0.01	55.0	D	0 (0)	1.03	117.6	F	7 (15)	0.22	53.0	D	0 (4)
Cate Street Extension - WB LT&TH&RT	-	-	-	-	-	-	-	-	-	-	-	-
Cate Street Extension - WB RT	-	-	-	-	-	-	-	-	0.11	54.4	E	0 (2)
US1 Bypass - NB LT	0.47	60.0	E	1 (3)	0.51	61.7	E	1 (3)	0.31	53.3	D	1 (3)
US1 Bypass - NB 2TH&RT	0.73	22.0	C	16 (24)	0.98	54.6	D	23 (30)	0.89	29.4	D	21 (25)
US1 Bypass - SB LT	0.22	71.6	E	0 (1)	0.95	91.5	F	6 (11)	0.88	51.0	E	5 (10)
US1 Bypass - SB 2TH&RT	0.65	19.0	B	15 (20)	0.69	22.9	C	13 (19)	0.65	20.3	B	17 (5)
Overall	0.72	27.4	C		1.00	56.9	E		0.89	39.1	D	
Cycle Length	120.0				120.0				120.0			
























1) Volume-to-capacity ratio, 2) Delay in vehicles per seconds, 3) Level of Service, 4) Queue length in vehicles

5) Mitigation 2 = Maintain existing lanes, optimize signal phasing and offset.

6) Mitigation 2 = Widen WB approach to three lanes: one exclusive left-turn lane, one shared through-right lane, and one exclusive right-turn lane

HCM Signalized Intersection Capacity Analysis

1: US1 Bypass & Coakly Road/Cottage Street

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	38	6	10	220	10	74	15	1901	217	56	1131	10
Future Volume (vph)	38	6	10	220	10	74	15	1901	217	56	1131	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	6.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	*0.88		1.00	0.95	
Fr _t		0.97			1.00	0.85	1.00	0.98		1.00	1.00	
Fl _t Protected		0.97			0.95	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1753			1763	1615	1805	3228		1805	3535	
Fl _t Permitted		0.34			0.70	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		625			1298	1615	1805	3228		1805	3535	
Peak-hour factor, PHF	0.79	0.79	0.79	0.76	0.76	0.76	0.90	0.90	0.90	0.99	0.99	0.99
Adj. Flow (vph)	48	8	13	289	13	97	17	2112	241	57	1142	10
RTOR Reduction (vph)	0	7	0	0	0	79	0	6	0	0	0	0
Lane Group Flow (vph)	0	62	0	0	302	18	17	2347	0	57	1152	0
Heavy Vehicles (%)	3%	0%	0%	3%	0%	0%	0%	2%	2%	0%	2%	0%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Actuated Green, G (s)		22.0			22.0	22.0	3.4	76.0		4.0	76.6	
Effective Green, g (s)		24.0			24.0	22.0	5.4	78.0		6.0	78.6	
Actuated g/C Ratio		0.20			0.20	0.18	0.05	0.65		0.05	0.65	
Clearance Time (s)		6.0			6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		125			259	296	81	2098		90	2315	
v/s Ratio Prot							0.01	c0.73		c0.03	0.33	
v/s Ratio Perm		0.10			c0.23	0.01						
v/c Ratio		0.49			1.17	0.06	0.21	1.12		0.63	0.50	
Uniform Delay, d1		42.6			48.0	40.5	55.2	21.0		55.9	10.6	
Progression Factor		1.00			1.00	1.00	0.97	0.59		1.00	1.00	
Incremental Delay, d2		3.1			108.4	0.1	0.7	57.3		13.7	0.8	
Delay (s)		45.7			156.4	40.5	54.4	69.8		69.6	11.4	
Level of Service		D			F	D	D	E		E	B	
Approach Delay (s)		45.7			128.2			69.7			14.1	
Approach LOS		D			F			E			B	
Intersection Summary												
HCM 2000 Control Delay		58.5										
HCM 2000 Volume to Capacity ratio		1.10										
Actuated Cycle Length (s)		120.0							12.0			
Intersection Capacity Utilization		82.3%										
Analysis Period (min)		15										
c Critical Lane Group												

Timings

1: US1 Bypass & Coakly Road/Cottage Street

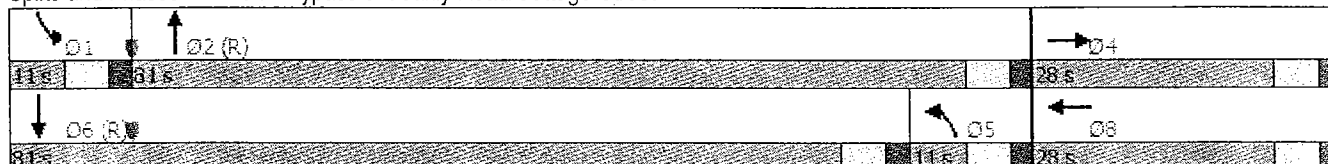
Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations									
Traffic Volume (vph)	38	6	220	10	74	15	1901	56	1131
Future Volume (vph)	38	6	220	10	74	15	1901	56	1131
Turn Type	Perm	NA	Perm	NA	Perm	Prot	NA	Prot	NA
Protected Phases		4		8		5	2	1	6
Permitted Phases	4		8		8				
Detector Phase	4	4	8	8	8	5	2	1	6
Switch Phase									
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	16.0	16.0	16.0	16.0	16.0	11.0	16.0	11.0	16.0
Total Split (s)	28.0	28.0	28.0	28.0	28.0	11.0	81.0	11.0	81.0
Total Split (%)	23.3%	23.3%	23.3%	23.3%	23.3%	9.2%	67.5%	9.2%	67.5%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)		-2.0		-2.0	0.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)		4.0		4.0	6.0	4.0	4.0	4.0	4.0
Lead/Lag						Lag	Lag	Lead	Lead
Lead-Lag Optimize?						Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	C-Min	None	C-Min
Act Effct Green (s)		24.0		24.0	22.0	10.3	79.2	7.0	83.4
Actuated g/C Ratio		0.20		0.20	0.18	0.09	0.66	0.06	0.70
v/c Ratio		0.52		1.17	0.24	0.11	1.10	0.54	0.47
Control Delay		52.9		151.2	3.9	47.7	65.8	74.3	10.3
Queue Delay		0.0		0.0	0.0	0.0	0.0	0.0	0.1
Total Delay		52.9		151.2	3.9	47.7	65.8	74.3	10.4
LOS		D		F	A	D	E	E	B
Approach Delay		52.9		115.4			65.7		13.4
Approach LOS		D		F			E		B

Intersection Summary

Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green, Master Intersection
 Natural Cycle: 150
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.17
 Intersection Signal Delay: 54.8
 Intersection Capacity Utilization 82.3%
 Analysis Period (min) 15

Intersection LOS: D
 ICU Level of Service E

Splits and Phases: 1: US1 Bypass & Coakly Road/Cottage Street



Queues

1: US1 Bypass & Coakly Road/Cottage Street

	→	←	↖	↗	↑	↘	↓
Lane Group	EBT	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	69	302	97	17	2353	57	1152
v/c Ratio	0.52	1.17	0.24	0.11	1.10	0.54	0.47
Control Delay	52.9	151.2	3.9	47.7	65.8	74.3	10.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total Delay	52.9	151.2	3.9	47.7	65.8	74.3	10.4
Queue Length 50th (ft)	42	~278	0	12	~1216	44	162
Queue Length 95th (ft)	80	#353	3	m13	#1336	#97	372
Internal Link Dist (ft)	998	606			304		719
Turn Bay Length (ft)			50	100		150	
Base Capacity (vph)	132	259	407	154	2137	105	2528
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	284
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.52	1.17	0.24	0.11	1.10	0.54	0.51

Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
- m Volume for 95th percentile queue is metered by upstream signal.

HCM Signalized Intersection Capacity Analysis

2: US1 Bypass & Borthwick Avenue/Cate Street Extension

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	485	14	87	52	11	288	36	1380	11	200	1034	140
Future Volume (vph)	485	14	87	52	11	288	36	1380	11	200	1034	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	6.0	4.0	4.0	6.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.95	0.95	1.00	1.00	0.95	0.95	1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.86	0.85	1.00	1.00		1.00	0.98	
Flt Protected	0.95	0.95	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1698	1708	1615	1805	1554	1534	1752	3497		1752	3502	
Flt Permitted	0.95	0.95	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1698	1708	1615	1805	1554	1534	1752	3497		1752	3502	
Peak-hour factor, PHF	0.83	0.83	0.83	0.90	0.90	0.90	0.97	0.97	0.97	0.96	0.96	0.96
Adj. Flow (vph)	584	17	105	58	12	320	37	1423	11	208	1077	146
RTOR Reduction (vph)	0	0	85	0	144	158	0	1	0	0	9	0
Lane Group Flow (vph)	298	303	20	58	22	8	37	1433	0	208	1214	0
Heavy Vehicles (%)	1%	0%	0%	0%	0%	0%	3%	3%	17%	3%	1%	3%
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	NA		Prot	NA	
Protected Phases	7	7	7	8	8	8	5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	22.3	22.3	22.3	6.0	6.0	6.0	6.1	53.5		14.2	61.6	
Effective Green, g (s)	24.3	24.3	22.3	8.0	8.0	6.0	8.1	55.5		16.2	63.6	
Actuated g/C Ratio	0.20	0.20	0.19	0.07	0.07	0.05	0.07	0.46		0.13	0.53	
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	343	345	300	120	103	76	118	1617		236	1856	
v/s Ratio Prot	0.18	c0.18	0.01	c0.03	0.01	0.01	0.02	c0.41		c0.12	0.35	
v/s Ratio Perm												
v/c Ratio	0.87	0.88	0.07	0.48	0.22	0.11	0.31	0.89		0.88	0.65	
Uniform Delay, d1	46.3	46.4	40.3	54.0	53.0	54.4	53.3	29.4		51.0	20.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		0.90	0.76	
Incremental Delay, d2	20.1	21.4	0.1	3.0	1.1	0.6	1.5	7.6		25.2	1.5	
Delay (s)	66.4	67.8	40.4	57.1	54.1	55.1	54.8	37.0		71.1	16.9	
Level of Service	E	E	D	E	D	E	D	D		E	B	
Approach Delay (s)		63.2			55.0			37.4			24.7	
Approach LOS		E			D			D			C	
Intersection Summary												
HCM 2000 Control Delay			39.1			HCM 2000 Level of Service				D		
HCM 2000 Volume to Capacity ratio			0.89									
Actuated Cycle Length (s)			120.0			Sum of lost time (s)				20.0		
Intersection Capacity Utilization			80.0%			ICU Level of Service				D		
Analysis Period (min)			15									
c Critical Lane Group												

Timings

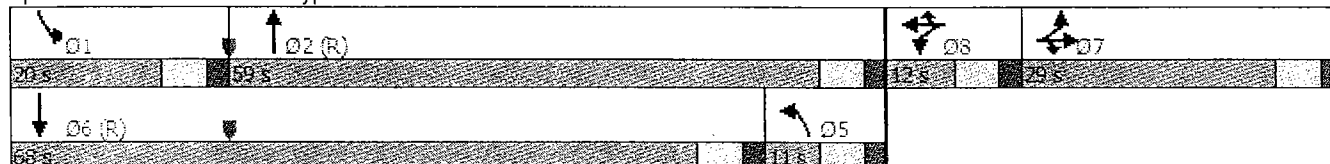
2: US1 Bypass & Borthwick Avenue/Cate Street Extension

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations										
Traffic Volume (vph)	485	14	87	52	11	288	36	1380	200	1034
Future Volume (vph)	485	14	87	52	11	288	36	1380	200	1034
Turn Type	Split	NA	Prot	Split	NA	Prot	Prot	NA	Prot	NA
Protected Phases	7	7	7	8	8	8	5	2	1	6
Permitted Phases										
Detector Phase	7	7	7	8	8	8	5	2	1	6
Switch Phase										
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	11.0	11.0	11.0	11.0	11.0	11.0	11.0	16.0	11.0	16.0
Total Split (s)	29.0	29.0	29.0	12.0	12.0	12.0	11.0	59.0	20.0	68.0
Total Split (%)	24.2%	24.2%	24.2%	10.0%	10.0%	10.0%	9.2%	49.2%	16.7%	56.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	0.0	-2.0	-2.0	0.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	6.0	4.0	4.0	6.0	4.0	4.0	4.0	4.0
Lead/Lag	Lag	Lag	Lag	Lead	Lead	Lead	Lag	Lag	Lead	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	None	C-Min	None	C-Min
Act Effct Green (s)	24.3	24.3	22.3	8.0	8.0	6.0	10.5	55.6	16.2	66.1
Actuated g/C Ratio	0.20	0.20	0.19	0.07	0.07	0.05	0.09	0.46	0.14	0.55
v/c Ratio	0.87	0.88	0.23	0.49	0.67	0.65	0.24	0.89	0.88	0.63
Control Delay	71.2	72.4	1.2	68.2	24.6	17.1	55.0	37.5	76.8	16.4
Queue Delay	11.5	12.6	0.0	0.0	4.7	5.0	0.0	2.4	0.0	0.2
Total Delay	82.7	85.0	1.2	68.2	29.4	22.0	55.0	39.8	76.8	16.6
LOS	F	F	A	E	C	C	D	D	E	B
Approach Delay		71.6			32.0			40.2		25.3
Approach LOS		E			C			D		C

Intersection Summary











Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 16 (13%), Referenced to phase 2:NBT and 6:SBT; Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.89
 Intersection Signal Delay: 39.6
 Intersection Capacity Utilization 80.0%
 Analysis Period (min) 15
 Intersection LOS: D
 ICU Level of Service D

Splits and Phases: 2: US1 Bypass & Borthwick Avenue/Cate Street Extension



Queues

2: US1 Bypass & Borthwick Avenue/Cate Street Extension

										
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	298	303	105	58	166	166	37	1434	208	1223
v/c Ratio	0.87	0.88	0.23	0.49	0.67	0.65	0.24	0.89	0.88	0.63
Control Delay	71.2	72.4	1.2	68.2	24.6	17.1	55.0	37.5	76.8	16.4
Queue Delay	11.5	12.6	0.0	0.0	4.7	5.0	0.0	2.4	0.0	0.2
Total Delay	82.7	85.0	1.2	68.2	29.4	22.0	55.0	39.8	76.8	16.6
Queue Length 50th (ft)	234	240	0	44	9	0	26	524	136	417
Queue Length 95th (ft)	#340	#346	0	90	#94	51	64	634	m#256	m125
Internal Link Dist (ft)		916			388			250		304
Turn Bay Length (ft)	225		225	150			200		150	
Base Capacity (vph)	353	355	463	120	247	258	153	1619	236	2025
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	201
Spillback Cap Reductn	41	41	0	0	38	47	0	96	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.96	0.96	0.23	0.48	0.79	0.79	0.24	0.94	0.88	0.67

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.