TRAFFIC IMPACT AND SITE ACCESS STUDY

PROPOSED RESIDENTIAL SUBDIVISION

Portsmouth, New Hampshire

June 2018

Prepared for

Clipper Traders, LLC

Stephen G. Pernaw & Company, Inc.

Stephen G. Pernaw & Company, Inc.
P.O. Box 1721 • Concord, NH 03302
tel: (603) 731-8500 • fax: (866) 929-6094 • sgp@ pernaw.com
Transportation: Engineering • Planning • Design

TRAFFIC IMPACT AND SITE ACCESS STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
PORTSMOUTH, NEW HAMPSHIRE
June 18, 2018

INTRODUCTION

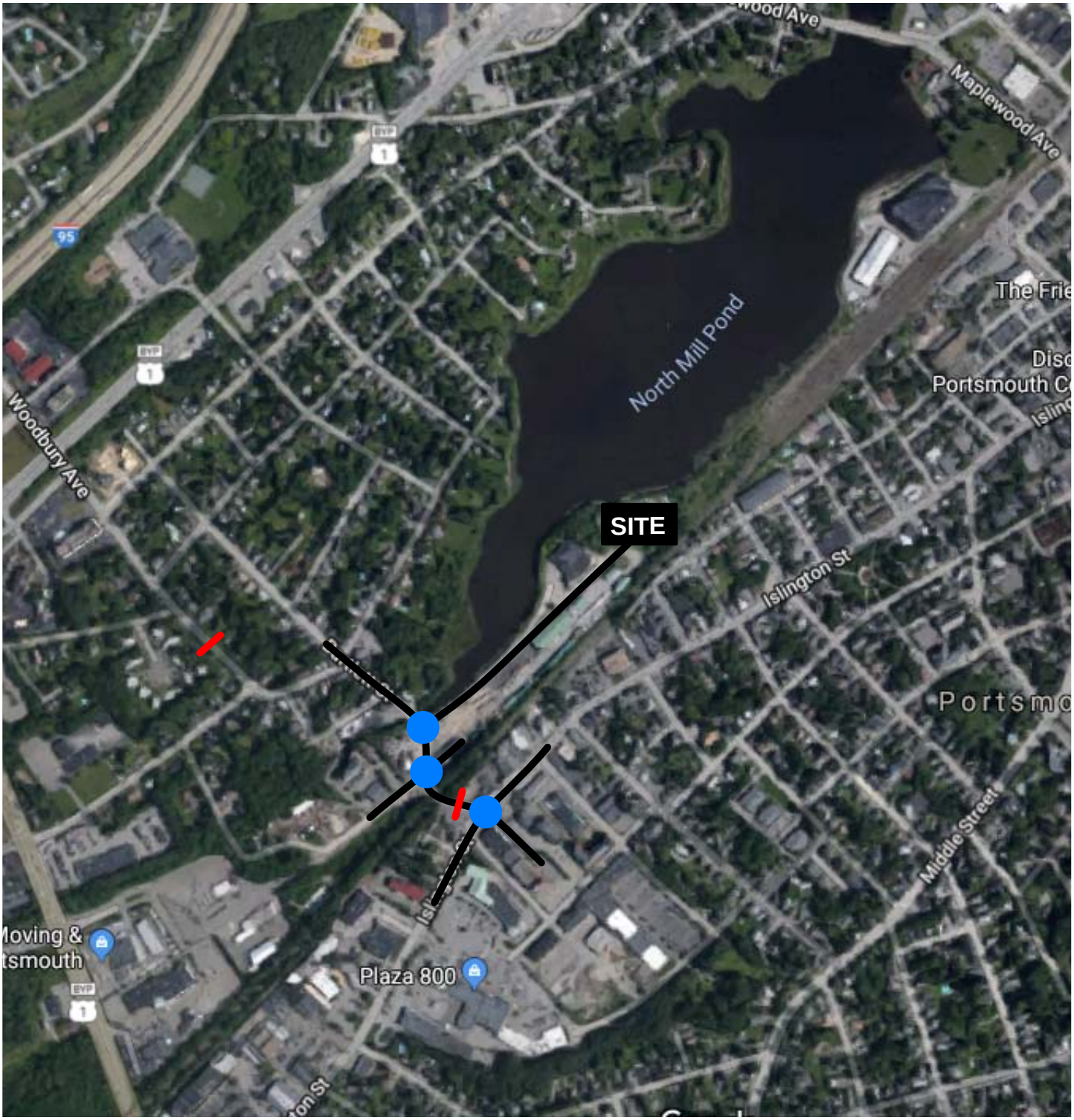
This Traffic Impact and Site Access Study has been prepared for Clipper Traders, LLC in order to assess the traffic impacts associated with the proposed residential subdivision and development located on the south side of North Mill Pond, at the former site of the Boston & Maine Railroad Yard in Portsmouth, New Hampshire. The City of Portsmouth has required this study in conjunction with the proposed zoning change and Site Plan Review process. This report is intended to summarize the data collected, the future traffic projections, the technical analyses and our findings and recommendations relative to traffic operations, capacity, and safety in the study area.

PROPOSAL

The proposed development consists of several parcels (Tax Map 157, Lots 1 and 2; and Tax Map 164, Lots 1, 2, 3, and 4) which will be consolidated and then subdivided into five separate lots. The current proposal calls for the construction of six free-standing buildings with four to forty dwelling units per building. This area currently lies within the office research zone (OR) and a zoning change to character-based zoning (CD4-W) is being sought.

Vehicular access to the development will be provided via the existing shared driveway on the north side of Bartlett Street that currently provides access to Ricci Lumber, Great Rhythm Brewing Company and other commercial entities.

Figure 1 shows the location of the proposed residential subdivision with respect to the area roadway system. Appendix A contains a preliminary concept plan that is the subject of this assessment.



= AUTOMATIC TRAFFIC RECORDER LOCATION (NHDOT)

= TURNING MOVEMENT COUNT LOCATIONS

NORTH

1821A

Figure 1

Site Location

Traffic Impact and Site Access Study, Proposed Residential Development, Portsmouth, New Hampshire

EXISTING CONDITIONS

ROADWAYS

The **Existing Shared Driveway** functions as a two-lane private dead-end street with a general southwest to northeast orientation in the study area. The roadway is delineated with single white edge lines and a worn 4-inch double yellow centerline. It provides access to customers of Ricci Lumber, Ace Hardware, Great Rhythm Brewing Company and a dog care facility. The horizontal alignment of the driveway is essentially straight and the vertical alignment is flat. Ninety-degree on-street parking is provided along the east side of this driveway for the Ricci Lumber business. A 10 mph speed limit sign is posted on this driveway, facing inbound vehicles.

Bartlett Street functions as a local collector road with a general northwest to southeast orientation in the study area; its carries through vehicles between Islington Street and Woodbury Avenue via Dennett Street and Thornton Street. Abutting land uses in the area range from residential to commercial. The horizontal alignment of the roadway is curvilinear and the vertical alignment is essentially flat in the immediate study area. A paved sidewalk is present in most places along both sides of the roadway. The speed limit is posted at 20 mph in both directions.

Cate Street functions as a local collector road with a general north to south direction from its origin at Cottage Street to a sharp corner to the left and then an "S"-curve in its alignment heading to the east where its terminates at Bartlett Street. The horizontal alignment of the roadway is curvilinear and the vertical alignment ranges from flat to rolling in the area. There are no paved sidewalks or speed limit signs along Cate Street.

Islington Street functions as an urban arterial roadway with a general southwest to northeast orientation in the study area; it carries through vehicles between NH Route 33 and downtown Portsmouth. The horizontal alignment of the roadway is curvilinear and the vertical alignment is essentially flat in the study area. Islington Street provides access to numerous commercial sites and retail businesses, as well as many residences. A paved sidewalk is present along both sides of the roadway.

INTERSECTIONS

The **Bartlett Street/Existing Shared Driveway** intersection functions as a typical three-leg "T" intersection and the Existing Shared Driveway approach does not operate under traffic signal control (no stop sign, no stop line). The approach lanes are designated accordingly:

SB: One shared left-right lane
WB: One shared through-right lane
EB: One shared left-through lane

As noted previously, ninety-degree parking stalls for Ricci Lumber business are located adjacent to this intersection, on the east side of the shared driveway. There are no marked crosswalks at this intersection.

The **Bartlett Street/Cate Street** intersection functions as a typical three-leg "T" intersection; however there is an existing parking lot driveway located across from Cate Street that was not utilized during the traffic count periods. The Cate Street approach currently operates under STOP sign control. The existing lane configuration at this intersection is delineated as follows:

NB: One shared left-right lane
WB: One shared left-through lane
EB: One shared through-right lane

Although not formally designated with two approach lanes, the Cate Street approach to Bartlett Street is flared to the extent that left and right turning vehicles are able to queue side-by-side on occasion. Crosswalks are not present at this intersection.

The **Islington Street/Bartlett Street/Pharmacy Driveway** intersection functions as a four-leg intersection that operates under traffic signal control. The signal heads are currently post-mounted or span wire-mounted. The existing lane configuration at this intersection is delineated as follows:

EB: One shared left-through lane, one exclusive right-turn lane
WB: One shared left-through-right lane
NB: One exclusive left-turn lane, one shared through-right lane
SB: One shared left-through lane, one exclusive right-turn lane

This traffic signal utilizes a fully-actuated controller that operates with three basic signal phases and an exclusive pedestrian phase (when actuated): 1) the Islington Street southbound approach (with permitted left turns) and northbound through-right movements, 2) Islington Street northbound left turns (lagging phase) with northbound through-right movements, and then 3) the Bartlett Street and pharmacy driveway approaches run concurrently. This controller operated with an 82-second (AM) and 90-second (PM) average cycle length during the peak hour periods.

Three crosswalks are present and extend across the southbound, westbound and eastbound approaches. The exclusive pedestrian phase was utilized only occasionally during the peak hour periods.

TRAFFIC VOLUMES

Research at the New Hampshire Department of Transportation (NHDOT) revealed that short-term automatic traffic recorder counts were conducted on Bartlett Street (west of Islington Street) in September of 2017 and Woodbury Ave (north of Cottage Street) in September of 2016. These count stations are located a short distance west and east of the subject site.

The NHDOT data shows that Bartlett Street (south of the subject site) carried an Annual Average Daily Traffic (AADT) volume of 16,414 vpd in 2017, down from 17,860 vpd in 2016. Woodbury Avenue carried approximately 6,277 vpd in 2017, up slightly from 6,154 vpd in 2016. Data from the automatic traffic recorder counts is summarized graphically on Page 7. This data demonstrates that traffic demand consistently reaches peak levels during weekday evening commuter period. Appendix B contains a summary of the NHDOT count data.

To establish current travel patterns and traffic volumes in the study area, Pernaw & Company, Inc. simultaneously conducted turning movement and vehicle classification counts on a weekday morning and afternoon in April 2018 at the three study area intersections. These counts were conducted on Thursday, April 5th from 7:00 to 9:00 AM and from 3:00 to 6:00 PM. The new 2018 count data for the study area is summarized on Figure 2. Several facts and conclusions are evident from this data.

- At the **Bartlett Street/Existing Shared Driveway** intersection, the traffic flow reached peak levels from 7:30 to 8:30 AM and from 4:45 to 5:45 PM. Bartlett Street (west of the Shared Driveway) carried 807 (AM) and 1,081 (PM) vehicles during the peak hour periods and the majority (57%) traveled in the eastbound direction during both periods. Truck traffic accounted for approximately 4-percent (AM) and 1-percent (PM) of the traffic flow entering the Bartlett Street/Existing Shared Driveway intersection during these peak hour periods.

  The existing Shared Driveway accommodated 166 (AM) and 120 (PM) vehicles during the peak hour periods. The heavier directional flow was inbound during the AM peak hour (57%) and outbound during the PM peak hour (57%).

  Although there are no crosswalks at this intersection, the pedestrian count revealed that eight persons were observed crossing the Shared Driveway approach to Bartlett Street during the AM and PM peak hour periods.

- At the **Bartlett Street/Cate Street** intersection, the traffic flow reached peak levels from 8:00 to 9:00 AM and from 4:45 AM to 5:45 PM. This intersection accommodated 964 (AM) and 1,211 (PM) vehicles during these periods. Cate Street carried 164 (AM) and 166 (PM) vehicles during the peak hour periods. The predominant turning movement patterns were between points east on Bartlett Street and points south on Cate Street. Truck traffic accounted for approximately 3-percent (AM) and 1-percent (PM) of the traffic flow entering the Bartlett Street/Cate Street intersection during the peak hour periods.

  The pedestrian count revealed that 24 persons were observed crossing the various approaches during the AM and PM peak hour periods (no crosswalks present).

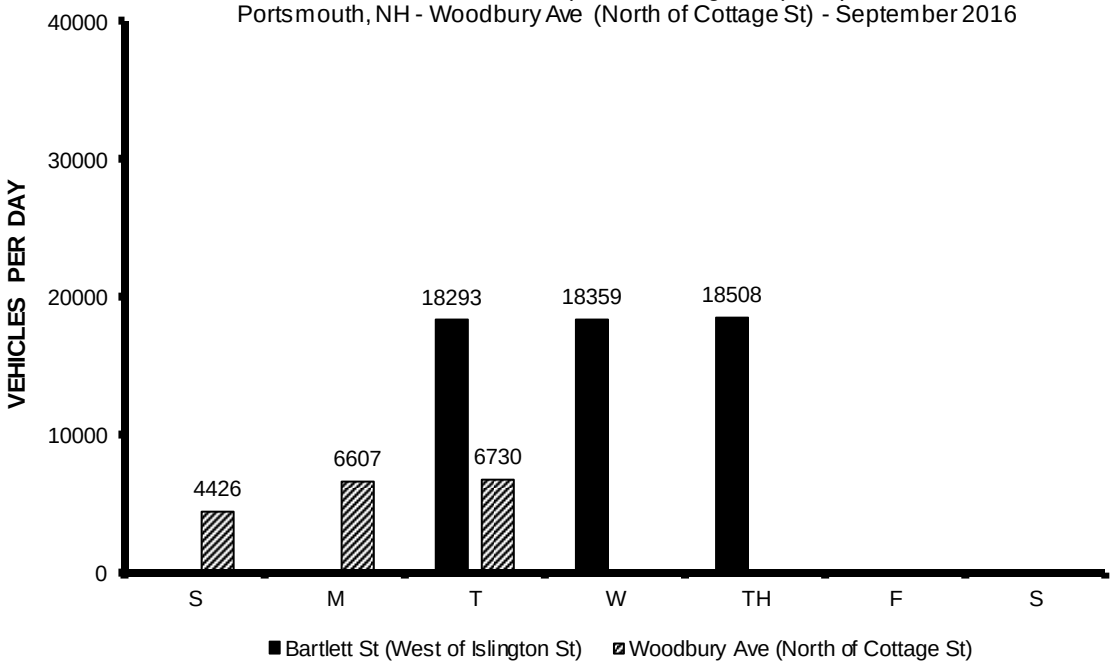
- At the **Islington Street/Bartlett Street/Pharmacy Driveway** intersection, the traffic flow reached peak levels from 7:45 to 8:45 AM and 4:45 to 5:45 PM. This intersection accommodated 1,327 (AM) and 1,758 (PM) vehicles during the peak hour periods. Bartlett Street accommodated 914 (AM) and 1,154 (PM) vehicles during the peak hour periods. Similarly, the Pharmacy Driveway accommodated 51 (AM) and 90 (PM) vehicles. Truck traffic accounted for approximately 3-percent (AM) and 1-percent (PM) of the traffic flow entering the Islington Street/Bartlett Street/Pharmacy Driveway intersection during the peak hour periods.

  Crosswalks are present and extend across the southbound, westbound and eastbound approaches. During the AM and PM peak hour periods, a total of 13 persons were observed crossing the southbound approach, 68 persons were observed crossing the westbound approach and four persons were observed crossing the eastbound approach. No one was observed crossing the Islington Street northbound approach (no crosswalk present).

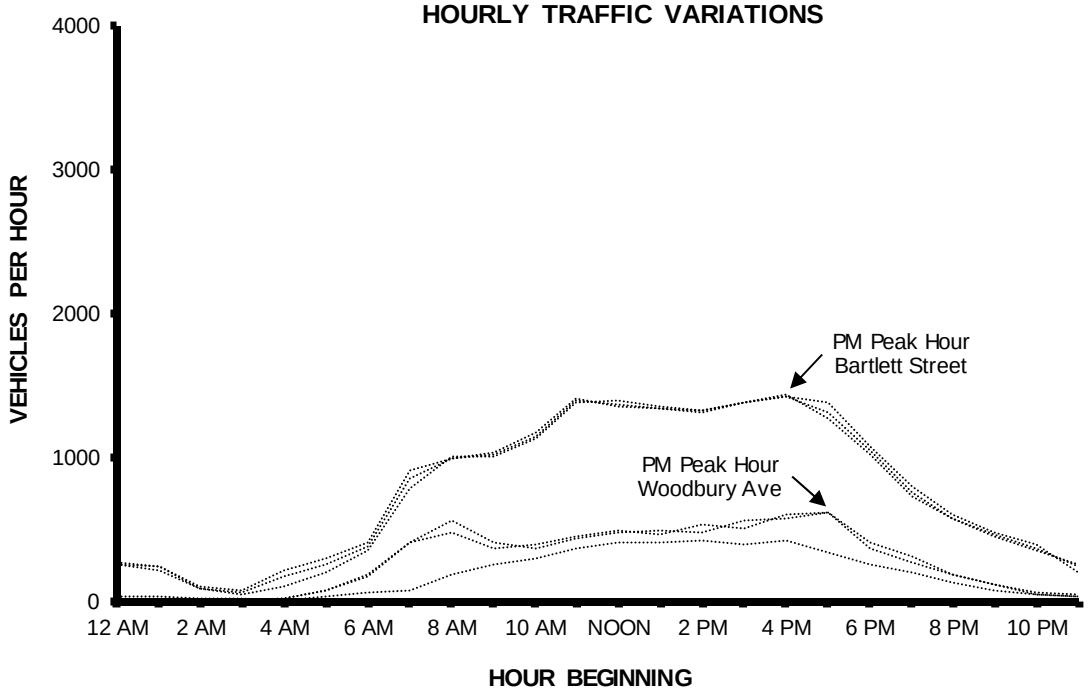
The detail sheets summarizing the raw turning movement count data are included in Appendix C. This new count data is summarized on Figure 2.

DAILY TRAFFIC VARIATIONS

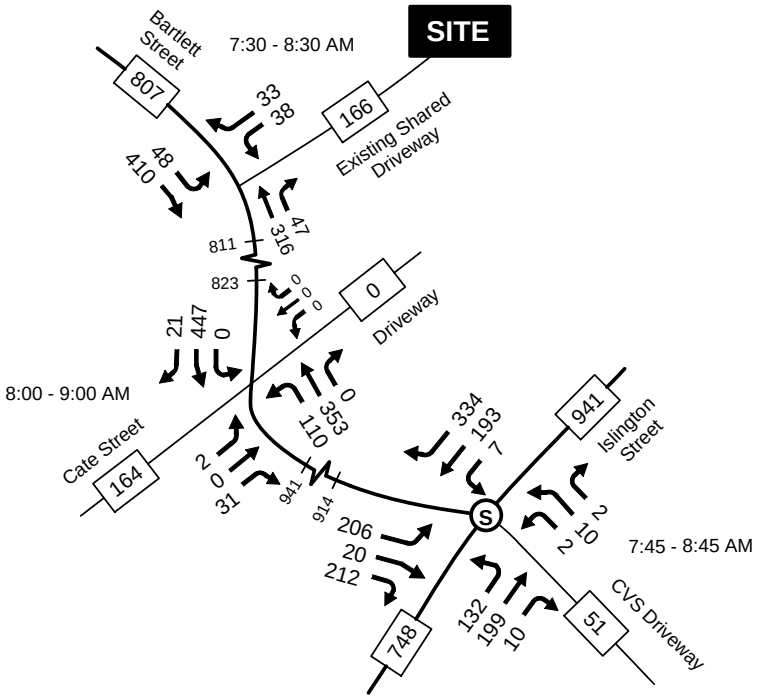
Portsmouth, NH - Bartlett St (West of Islington St) - September 2017
Portsmouth, NH - Woodbury Ave (North of Cottage St) - September 2016



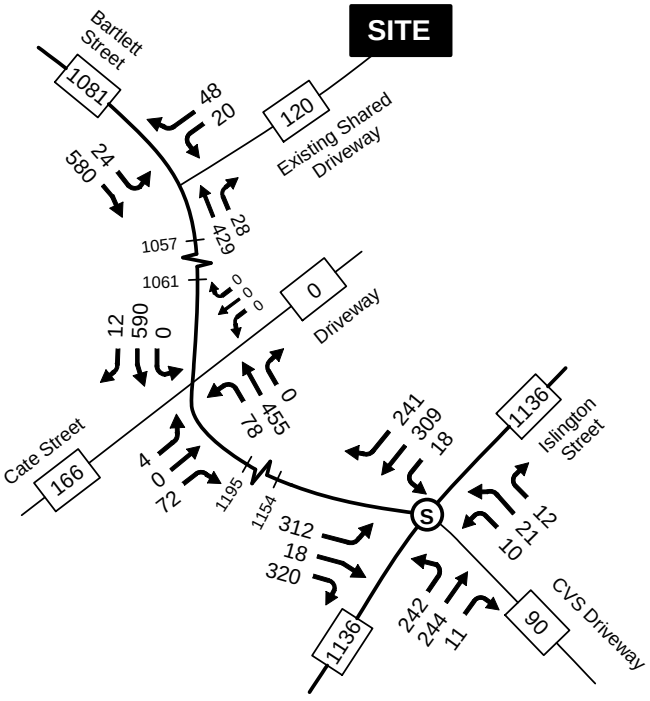
HOURLY TRAFFIC VARIATIONS



AM Peak Hour
Thursday, April 5, 2018
7:30 - 8:30 AM
7:45 - 8:45 AM
8:00 - 9:00 AM



PM Peak Hour
Thursday, April 5, 2018
4:45 - 5:45 PM



N

1821A

Figure 2

2018 Existing Traffic Volumes

Traffic Impact and Site Access Study, Proposed Residential Subdivision, Portsmouth, New Hampshire

NO-BUILD TRAFFIC VOLUMES

In order to identify the net impact that the proposed residential development will have in the study area, future traffic projections with and without the proposed residential development are necessary. The future traffic projections without the proposed development are referred to as "No-Build" traffic projections.

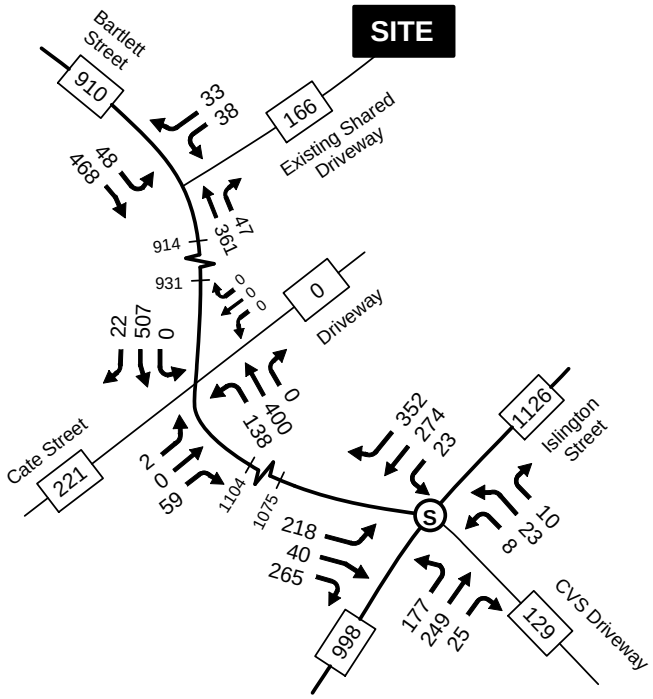
The No-Build traffic volumes for 2020 and 2030 are summarized schematically on Figure 3 and Figure 4. These projections are based on the April 2018 traffic volumes, a 1-percent annual background traffic growth rate (compounded annually) to account for normal growth in the area, and peak-month seasonal adjustment factors of 1.03 (AM) and 1.04 (PM).

The No-Build projections also account for four other pending development projects that were identified at the "scope meeting" that was conducted with city staff.

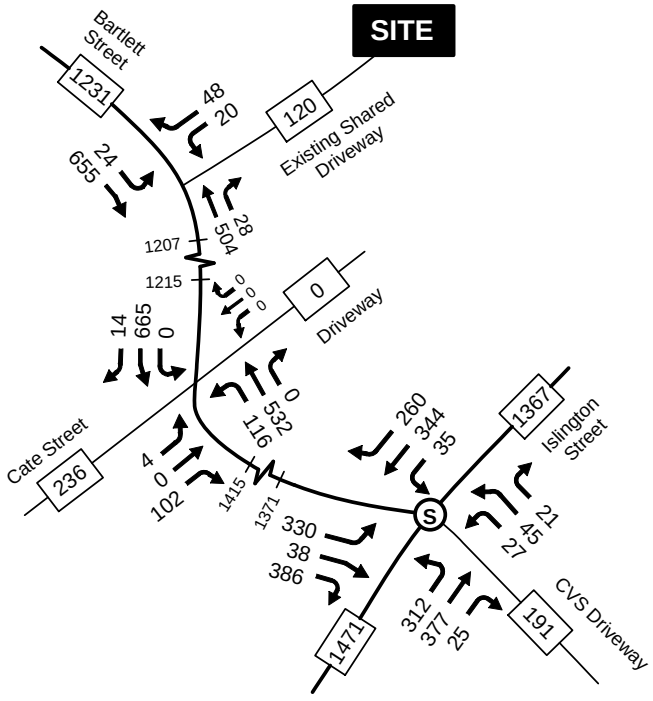
- Proposed Multi-Family Development – new 31-unit townhouse development on Cate Street, Portsmouth, NH
- Proposed Subdivision Road – new road to connect Borthwick Avenue and Islington Street in Portsmouth, NH
- Proposed Apartments – new 92-unit apartment development at 145 Brewery Lane, Portsmouth, NH
- Proposed Mixed-Use Development – new mixed-use development at 110 Brewery Lane, Portsmouth, NH

These traffic projections are intended to reflect worst-case, peak-month, peak-hour conditions. Calculations pertaining to the derivation of the annual background traffic growth rate and the seasonal adjustment factors are contained in Appendix D. Appendix E contains the diagrams for the four other development projects.

AM Peak Hour



PM Peak Hour



N

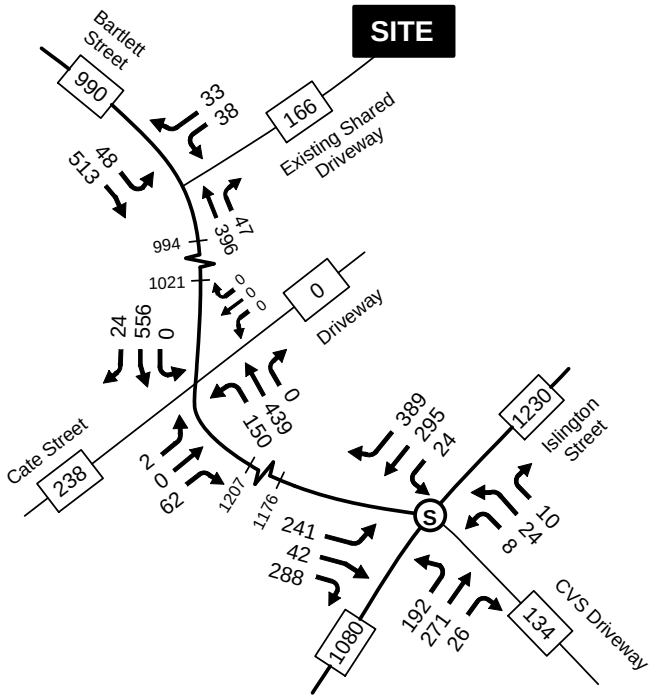
1821A

Figure 3

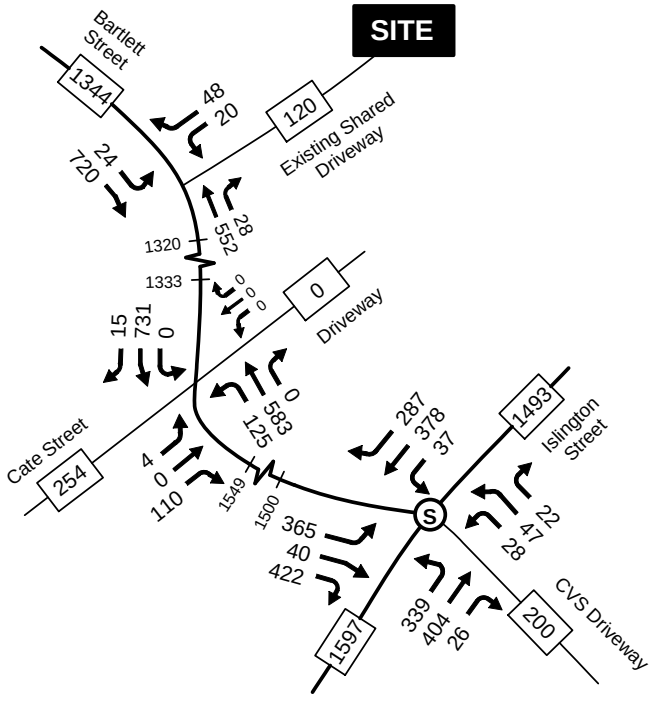
2020 No-Build Traffic Volumes

Traffic Impact and Site Access Study, Proposed Residential Subdivision, Portsmouth, New Hampshire

AM Peak Hour



PM Peak Hour



N

1821A

Figure 4

2030 No-Build Traffic Volumes

Traffic Impact and Site Access Study, Proposed Residential Subdivision, Portsmouth, New Hampshire

TRIP GENERATION

To estimate the quantity of vehicle trips that will be produced by the proposed residential development, Pernaw & Company, Inc. considered the standardized trip-generation rates and equations published by the Institute of Transportation Engineers (ITE) [1]. Based upon ITE Land Use Code LUC 221 – Multi-Family Housing (Mid-Rise) the overall development is expected to generate approximately 41 vehicle-trips during the weekday AM peak hour and 53 vehicle-trips during the weekday PM peak hour, on an average weekday basis. These results are based upon consideration of both the trip "rate" and "equation" method, and 120 dwelling units as the independent variable. The following table summarizes the anticipated trip-generating characteristics of the proposed residential development.

Table 1 — Trip Generation Summary - Clipper Traders

		120 Dwelling Units [1]
Weekday Total [2]		
	Entering	326 veh
	Exiting	326 veh
	Total	652 trips
Weekday AM Peak Hour [2]		
	Entering	11 veh
	Exiting	30 veh
	Total	41 trips
Weekday PM Peak Hour [2]		
	Entering	32 veh
	Exiting	21 veh
	Total	53 trips

[1] ITE LUC 221 Multi-Family Housing (Mid-Rise)
[2] Trip Equation Method
[3] Trip Rate Method

All vehicle-trips associated with the proposed residential development will be "primary" trips, or new trips to the area. Appendix F contains the trip generation computations for the proposed residential development, along with a diagram that summarizes the distribution of the primary trips at the various study area intersections.

[1] Institute of Transportation Engineers, *Trip Generation*, tenth edition (Washington, D.C., 2017).

BUILD TRAFFIC PROJECTIONS

In order to identify the net impact that site traffic will have in the study area, future traffic projections with and without the proposed development are necessary. The future traffic projections with the proposed residential units are referred to as "Build" traffic projections.

The Build traffic volume projections for 2020 and 2030 are summarized schematically on Figure 5 and Figure 6, respectively. These projections are based on the No-Build projections, the trip generation estimates contained in Table 1 and the expectation that the primary trips will be distributed in the following manner:

To/From	Percentage
Bartlett Street - West	50%
Bartlett Street - East	50%
	100%

These percentages were based on analysis of the travel patterns observed entering and exiting the existing Shared Driveway on Bartlett Street, as well as our knowledge of the local area.

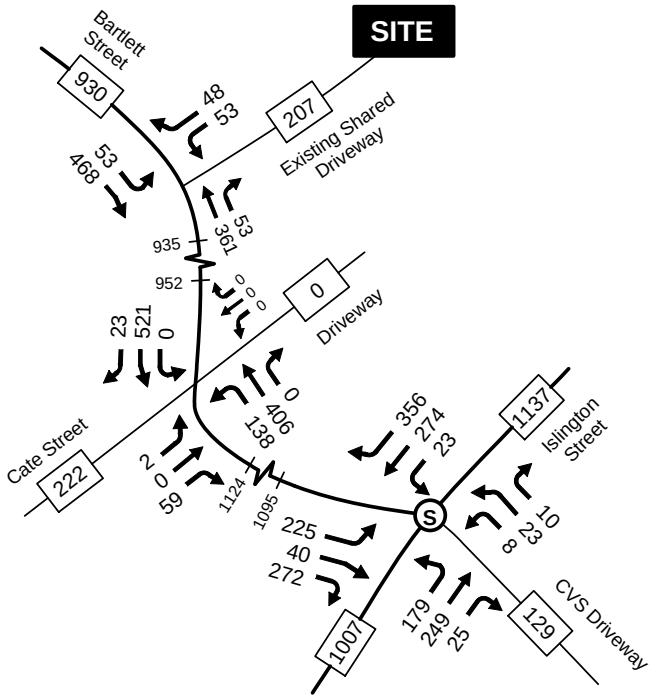
IMPACT SUMMARY

The net impact that the proposed residential development will have on area roadway and intersection traffic volumes can be estimated by comparing the No-Build traffic projections with the Build projections. A comparison for the two peak hour cases is summarized on Figure 7.

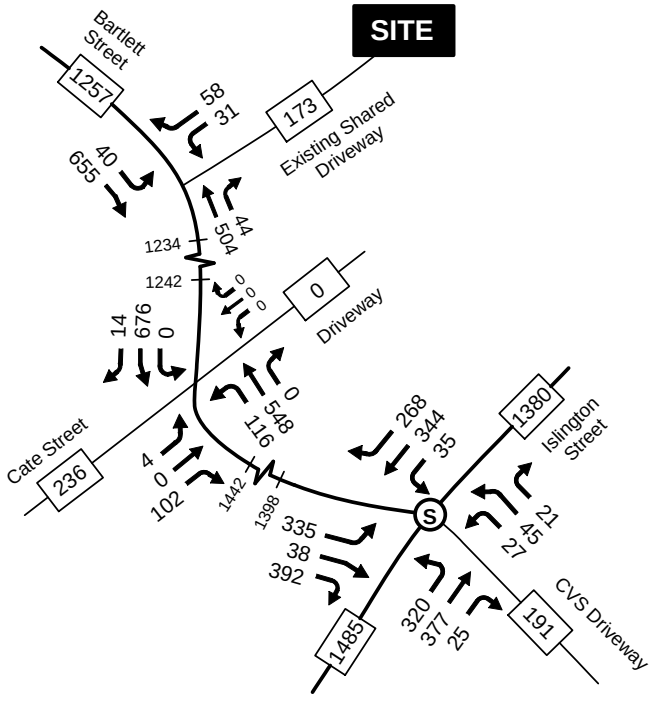
In terms of roadway segments, this analysis shows that the greatest impact in terms of magnitude will occur during the PM peak hour period on the section of Bartlett Street, west of the existing Shared Driveway intersection. The traffic volume on this roadway segment is projected to increase +2% (+26 vehicles) during the worst-case PM peak hour period. During the AM peak hour the impacts to roadway volumes will be slightly less with an increase of +20 vehicles; which corresponds to a +2% increase.

In terms of intersection utilization (total vehicles entering), the Bartlett Street/Existing Shared Driveway intersection is expected to accommodate +53 additional vehicles during the PM peak hour period. This +4% increase translates into approximately one additional vehicle every minute on average, during the highest traffic hour of the day. The Bartlett Street/Islington Street intersection is projected to accommodate +27 vehicles (+1%) during the PM peak hour period. The net increases during the AM peak hour will be lower than during the PM peak hour.

AM Peak Hour



PM Peak Hour



N

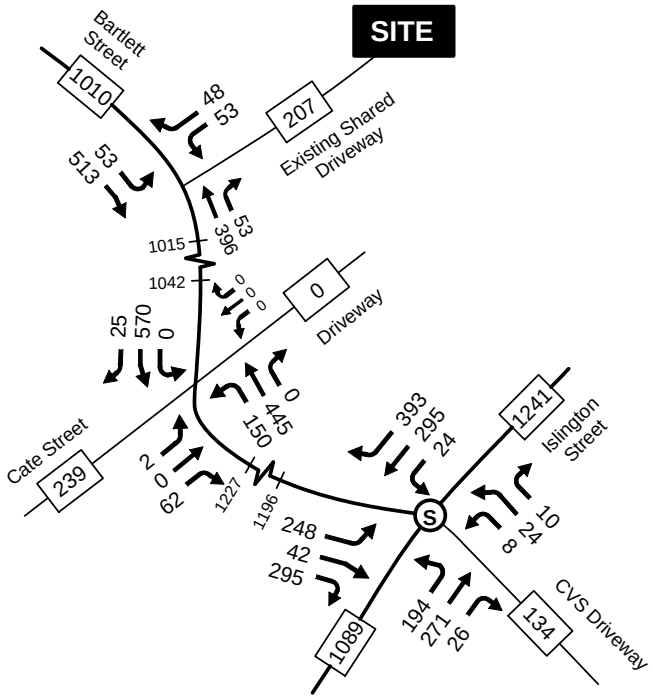
1821A

Figure 5

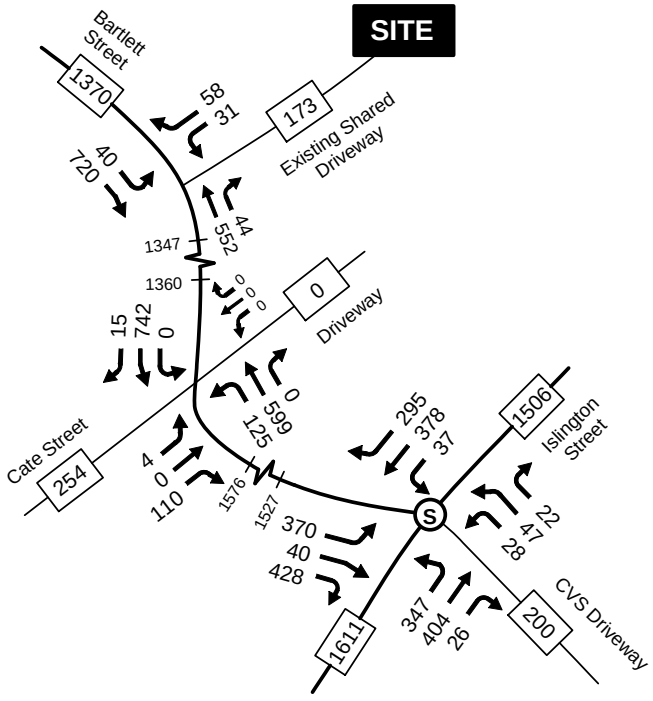
2020 Build Traffic Volumes

Traffic Impact and Site Access Study, Proposed Residential Subdivision, Portsmouth, New Hampshire

AM Peak Hour



PM Peak Hour



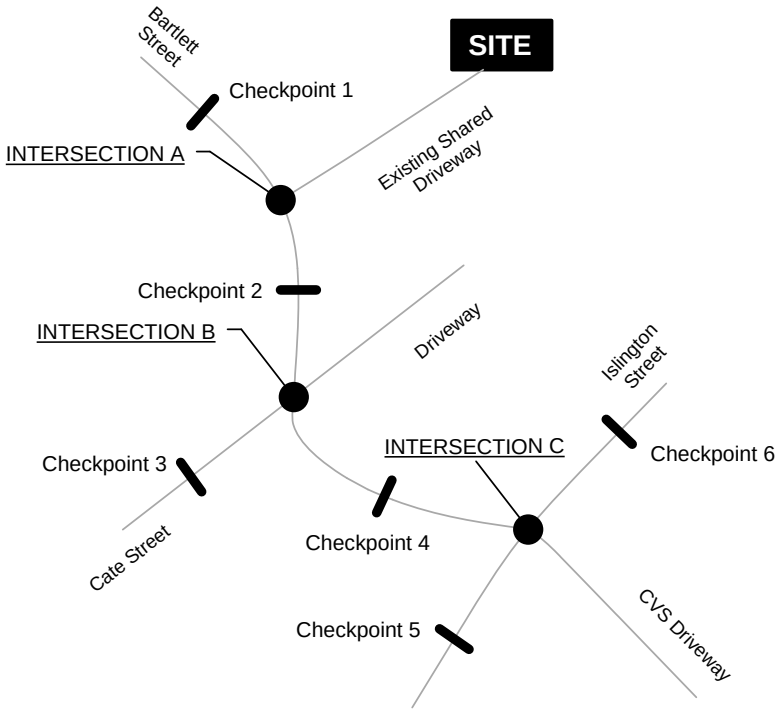
N

1821A

Figure 6

2030 Build Traffic Volumes

Traffic Impact and Site Access Study, Proposed Residential Subdivision, Portsmouth, New Hampshire



AM Peak Hour					PM Peak Hour				
Location	2020 No-Build	2020 Build	Change	% Change	Location	2020 No-Build	2020 Build	Change	% Change
Intersection A	995	1036	+41 veh	4%	Intersection A	1279	1332	+53 veh	4%
Intersection B	1128	1149	+21 veh	2%	Intersection B	1433	1460	+27 veh	2%
Intersection C	1664	1684	+20 veh	1%	Intersection C	2200	2227	+27 veh	1%
Checkpoint 1	910	930	+20 veh	2%	Checkpoint 1	1231	1257	+26 veh	2%
Checkpoint 2	914	935	+21 veh	2%	Checkpoint 2	1207	1234	+27 veh	2%
Checkpoint 3	221	222	+1 veh	0%	Checkpoint 3	236	236	0 veh	0%
Checkpoint 4	1104	1124	+20 veh	2%	Checkpoint 4	1415	1442	+27 veh	2%
Checkpoint 5	998	1007	+9 veh	1%	Checkpoint 5	1471	1485	+14 veh	1%
Checkpoint 6	1126	1137	+11 veh	1%	Checkpoint 6	1367	1380	+13 veh	1%

N

1821A

Figure 7

2020 Impact Summary

Traffic Impact and Site Access Study, Proposed Residential Subdivision, Portsmouth, New Hampshire

TRAFFIC OPERATIONS AND SAFETY

INTERSECTION CAPACITY – UNSIGNALIZED INTERSECTIONS

The short-range and long-range traffic projections were utilized to assess traffic operations at the **Bartlett Street/Existing Shared Driveway** and the **Bartlett Street/Cate Street** intersections. These intersections were analyzed according to the methodologies of the *Highway Capacity Manual*[2] as replicated by the latest edition of the *Synchro Traffic Signal Timing Software (Version 8)*, which also performs unsignalized intersection capacity analyses.

Capacity and Level of Service (LOS) calculations pertaining to unsignalized intersections address the quality of service for those vehicles turning into and out of intersecting side streets. The availability of adequate gaps in the traffic stream on the major street (Bartlett Street) actually controls the potential capacity for vehicle movements to and from the minor approaches (Existing Shared Driveway and Cate Street). Levels of Service are simply letter grades (A-F), which categorize the vehicle delays associated with specific turning maneuvers. Table 2 describes the criteria used in this analysis. Calculations pertaining to these analyses are included in Appendix G.

Table 2 — Level-of-Service Criteria for Unsignalized Intersections

Level of Service	Control Delay (seconds/vehicle)
A	≤ 10.0
B	> 10.0 and ≤ 15.0
C	> 15.0 and ≤ 25.0
D	> 25.0 and ≤ 35.0
E	> 35.0 and ≤ 50.0
F	> 50.0

Source: Transportation Research Board, Highway Capacity Manual 2010.

It should be noted that this methodology is not capable of accounting for the vehicle queues that were observed on Bartlett Street that extended back from the traffic signal at Islington Street. This occurred occasionally during the PM peak hour; more so at the Cate Street intersection and to a lesser extent at the Shared Driveway. Nevertheless, driver courtesy was observed in several instances that enabled certain vehicles to turn during congested moments.

[2] Transportation Research Board, *Highway Capacity Manual* (Washington, D.C., 2010).

The results of the analysis for the **Bartlett Street/Existing Shared Driveway** intersection are summarized on Table 3, and demonstrate that the departure movements from the Existing Shared Driveway will operate at LOS D (2020) and LOS E (2030) or higher during all hours of the day with the residential development in full operation. The left-turn arrival movement from Bartlett Street (on to the existing Shared Driveway) will operate at LOS A during all hours of the day through the horizon year and beyond with the development fully occupied. In all cases this intersection is expected to operate below capacity through 2030 with the proposed residential development fully occupied; subject to the occasional restrictions due to vehicle queuing on Bartlett Street.

Table 3

STOP-Controlled Intersection Capacity Analysis
Bartlett Street / Existing Shared Driveway

	Weekday AM Peak Hour				Weekday PM Peak Hour			
	Delay [1]	V/C [2]	LOS [3]	Queue [4]	Delay [1]	V/C [2]	LOS [3]	Queue [4]
Bartlett Street - EB Left-Turns								
2018 Existing	9	0.05	A	<1	8	0.02	A	<1
2020 No Build	9	0.05	A	<1	9	0.03	A	<1
2020 Build	9	0.06	A	<1	9	0.04	A	<1
2030 No Build	9	0.05	A	<1	9	0.03	A	<1
2030 Build	9	0.06	A	<1	9	0.05	A	<1
Existing Shared Driveway - SB Left & Right Turns								
2018 Existing	20	0.30	C	1	18	0.27	C	1
2020 No Build	24	0.35	C	2	21	0.32	C	1
2020 Build	29	0.50	D	3	29	0.48	D	3
2030 No Build	27	0.39	D	2	25	0.37	C	2
2030 Build	35	0.57	E	3	37	0.56	E	3

[1] HCM Control Delay (seconds per vehicle), [2] HCM Volume to Capacity Ratio, [3] HCM Level of Service, [4] HCM 95th Percentile Queue (vehicles)

The results of the analysis for the **Bartlett Street/Cate Street** intersection are summarized on Table 4, and demonstrate that the departure movements from Cate Street will operate at LOS C or higher through the horizon year and beyond with the development fully occupied. The left-turn arrival movement from Bartlett Street on to Cate Street will operate at LOS B or higher during all hours of the day through the horizon year and beyond with the development fully occupied. The actual delays for certain left-turn movements from Bartlett Street to Cate Street may be longer during the PM peak hour due to the extent of vehicle queuing on Bartlett Street (and driver courtesy). In all cases this intersection will operate below capacity through 2030 and beyond with the proposed residential development fully occupied.

Table 4

STOP-Controlled Intersection Capacity Analysis
Bartlett Street / Cate Street

	Weekday AM Peak Hour				Weekday PM Peak Hour			
	Delay [1]	V/C [2]	LOS [3]	Queue [4]	Delay [1]	V/C [2]	LOS [3]	Queue [4]
Bartlett Street - WB Left-Turns								
2018 Existing	9	0.12	A	<1	9	0.09	A	<1
2020 No Build	9	0.16	A	1	10	0.15	A	1
2020 Build	9	0.16	A	1	10	0.15	A	1
2030 No Build	10	0.18	A	1	10	0.17	B	1
2030 Build	10	0.18	A	1	10	0.17	B	1
Cate Street - NB Left & Right Turns								
2018 Existing	13	0.07	B	<1	15	0.21	C	1
2020 No Build	14	0.14	B	1	19	0.33	C	1
2020 Build	14	0.15	B	1	19	0.34	C	2
2030 No Build	15	0.16	B	1	22	0.40	C	2
2030 Build	15	0.17	C	1	23	0.41	C	2

[1] HCM Control Delay (seconds per vehicle), [2] HCM Volume to Capacity Ratio, [3] HCM Level of Service, [4] HCM 95th Percentile Queue (vehicles)

INTERSECTION CAPACITY – SIGNALIZED INTERSECTIONS

The **Islington Street/Bartlett Street/Pharmacy Driveway** signalized intersection was analyzed utilizing the methods of the *Highway Capacity Manual 2010*[3], as replicated by *Synchro Traffic Signal Timing Software (Version 10).* A traffic flow rate, capacity, Level of Service (LOS), and delay estimate was determined for each critical traffic movement, lane group, and for the overall intersection. Levels of Service are simply letter grades (A-F) that categorize the vehicle delays associated with specific turning maneuvers. The following table describes the criteria used in the analysis of signalized intersections.

Table 5 – Level-of-Service Criteria for Signalized Intersections

Level of Service	Control Delay (seconds/vehicle)
A	≤ 10.0
B	> 10.0 and ≤ 20.0
C	> 20.0 and ≤ 35.0
D	> 35.0 and ≤ 55.0
E	> 55.0 and ≤ 80.0
F	> 80.0

Source: Transportation Research Board, Highway Capacity Manual 2010.

Table 6 summarizes the results of the analysis for the **Islington Street/Bartlett Street** intersection and it shows that the overall intersection will operate well below capacity and at LOS C during the AM Peak Hour through 2030 with the residential development fully occupied. During the PM peak hour this intersection will be operating close to capacity and at LOS D in 2020 regardless of the proposed residential development. By 2030 the PM peak hour traffic volumes are projected to exceed the overall capacity of the intersection and it will operate at an overall LOS E, both with and without the proposed residential development. It should be noted that these results pertain to peak-month conditions only; and the highest 15-minute interval within that peak hour. Favorably, site traffic (+20-27 vehicles) increases the overall volume-to-capacity ratio of the intersection by only one or two percentage points during the peak hour periods. It should be noted that this intersection is slated for reconstruction and upgrading of the signal system in the near future.

The calculations pertaining to these analyses are included in Appendix H.

[3] Transportation Research Board, *Highway Capacity Manual* (Washington, D.C., 2010).

Stephen G. Pernaw & Company, Inc.

Table 6

Signal-Controlled Intersection Capacity Analysis Summary
Islington Street / Bartlett Street / Pharmacy Driveway

	2018 Existing				2020 No-Build				2020 Build				2030 No-Build				2030 Build			
	V/C [1]	Delay [2]	LOS [3]	Queue Avg/95th [4]	V/C [1]	Delay [2]	LOS [3]	Queue Avg/95th [4]	V/C [1]	Delay [2]	LOS [3]	Queue Avg/95th [4]	V/C [1]	Delay [2]	LOS [3]	Queue Avg/95th [4]	V/C [1]	Delay [2]	LOS [3]	Queue Avg/95th [4]
Weekday AM Peak Hour																				
Bartlett Street - EB LT&TH	0.68	23.3	C	3 (10)	0.74	29.4	C	4 (12)	0.76	31.7	C	4 (13)	0.83	38.4	D	5 (14)	0.84	39.6	D	5 (14)
Bartlett Street - EB RT	0.15	17.0	B	0 (2)	0.19	20.0	C	0 (3)	0.19	20.6	C	0 (3)	0.22	21.6	C	0 (3)	0.24	21.7	C	0 (3)
Pharmacy Dwy - WB LT&TH&RT	0.03	14.9	B	0 (1)	0.08	17.9	B	0 (2)	0.08	18.5	B	0 (2)	0.09	19.2	B	0 (2)	0.09	19.2	B	0 (2)
Islington Street - NB LT	0.53	22.8	C	2 (5)	0.72	35.4	D	3 (9)	0.69	33.3	C	3 (9)	0.77	40.7	D	3 (10)	0.78	41.8	D	3 (10)
Islington Street - NB TH&RT	0.27	8.6	A	1 (5)	0.34	10.2	B	2 (7)	0.34	10.0	B	2 (7)	0.36	10.3	B	3 (8)	0.36	10.3	B	3 (8)
Islington Street - SB LT&TH	0.52	19.1	B	2 (7)	0.68	25.4	C	4 (11)	0.68	26.1	C	4 (12)	0.69	26.1	C	5 (13)	0.69	26.1	C	5 (13)
Islington Street - SB RT	0.23	18.5	B	0 (3)	0.25	20.6	C	0 (3)	0.25	21.1	C	0 (3)	0.27	20.9	C	0 (3)	0.28	21.0	C	0 (3)
Overall	**0.61**	**18.0**	**B**		**0.73**	**22.5**	**C**		**0.73**	**23.0**	**C**		**0.77**	**24.9**	**C**		**0.78**	**25.3**	**C**	
Cycle Length	**75.0**				**90.0**				**90.0**				**90.0**				**90.0**			
Weekday PM Peak Hour																				
Bartlett Street - EB LT&TH	0.81	34.6	C	5 (15)	1.10	114.3	F	10 (23)	1.09	108.3	F	10 (23)	1.23	161.0	F	12 (26)	1.26	173.4	F	13 (26)
Bartlett Street - EB RT	0.27	20.8	C	0 (4)	0.50	31.6	C	3 (9)	0.50	30.9	C	3 (9)	0.59	33.6	C	4 (11)	0.61	34.1	C	4 (12)
Pharmacy Dwy - WB LT&TH&RT	0.11	18.2	B	1 (1)	0.41	29.3	C	3 (4)	0.39	28.4	C	2 (4)	0.49	30.5	C	3 (4)	0.50	30.8	C	3 (4)
Islington Street - NB LT	0.83	45.3	D	4 (12)	1.05	106.0	F	9 (20)	1.08	112.5	F	9 (21)	1.14	136.2	F	10 (22)	1.17	145.0	F	11 (23)
Islington Street - NB TH&RT	0.30	10.9	B	2 (7)	0.43	13.5	B	5 (13)	0.44	14.1	B	6 (13)	0.46	13.8	B	6 (14)	0.46	13.8	B	6 (14)
Islington Street - SB LT&TH	0.75	31.3	C	5 (14)	0.78	37.9	D	9 (20)	0.82	42.5	D	9 (21)	0.91	52.3	D	10 (37)	0.91	52.3	D	10 (23)
Islington Street - SB RT	0.17	22.3	C	0 (3)	0.18	25.9	C	0 (3)	0.18	26.6	C	0 (3)	0.21	26.1	C	0 (3)	0.21	26.2	C	0 (3)
Overall	**0.81**	**27.3**	**C**		**0.97**	**52.2**	**D**		**0.99**	**53.2**	**D**		**1.09**	**67.7**	**E**		**1.10**	**70.8**	**E**	
Cycle Length	**90.0**				**120.0**				**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

AUXILIARY TURN LANES

Determining the appropriate design of the existing shared driveway intersection should take into account the hourly traffic volumes and turning movement patterns, vehicle types and speeds, and the projected Level of Service and capacity analysis results. These intersections were also analyzed to determine the ideal approach lane configuration for providing efficient traffic operations.

Left-Turn Treatment – The type of treatment needed to accommodate left-turning vehicles from any street or highway to an intersecting side street (or driveway) can range from no treatment where turning volumes are low; to the provision of a bypass lane for through traffic to travel around left-turning vehicles; to the addition of a formal center turn lane used exclusively by left-turning vehicles for deceleration and storage while waiting to complete their maneuvers.

Analysis of the 2020 traffic volume projections using NCHRP 457 guidelines is summarized below and confirms that left-turn treatment is advisable at both intersections without the proposed residential development. This means that the residential development is not triggering the need for improvements along Bartlett Street. The calculations pertaining to this analysis are included in Appendix I.

Table 7 — Left-Turn Lane Warrants Analysis - 2020

	2020 AM Peak Hour		2020 PM Peak Hour	
	No Build	Build	No Build	Build
BARTLETT ST / SHARED DRIVEWAY				
Left-Turn Volume (EB)	48	53	24	40
Advancing Volume (EB)	516	521	679	695
Opposing Volume (WB)	408	414	532	548
Percent Lefts	9.3%	10.2%	3.5%	5.8%
Speed (mph)	20	20	20	20
Limiting Advancing Volume (veh/hr)	461	440	638	496
Conclusion				
Left-Turn Treatment Warranted	**YES**	**YES**	**YES**	**YES**
BARTLETT ST / CATE ST				
Left-Turn Volume (WB)	138	138	116	116
Advancing Volume (WB)	538	544	648	664
Opposing Volume (EB)	529	544	679	690
Percent Lefts	25.7%	25.4%	17.9%	17.5%
Speed (mph)	20	20	20	20
Limiting Advancing Volume (veh/hr)	271	267	265	264
Conclusion				
Left-Turn Treatment Warranted	**YES**	**YES**	**YES**	**YES**

Right-Turn Treatment – The type of treatment needed to accommodate right-turning vehicles from any street or highway to any intersecting side street (or driveway) can range from a corner radius only, where turning volumes are low; to the provision of a short 10:1 right-turn taper; to the addition of an exclusive right-turn lane, where turning volumes and through traffic volumes are significant.

Analysis of the 2030 Build traffic volume projections and NCHRP 457 guidelines is summarized in Table 8 and confirms that right-turn treatment is not warranted at either the Shared Driveway or Cate Street intersections on Bartlett Street. This finding means that the existing travel lane on Bartlett Street will continue to function adequately as a shared through-right lane for vehicles entering both the subject site and Cate Street. The calculations pertaining to these analyses are also included in Appendix I.

Table 8 — Right-Turn Lane Warrants Analysis - 2030

	2030 AM Build Volumes	2030 PM Build Volumes
BARTLETT ST / SHARED DRIVEWAY		
Right-Turn Volume (WB)	53	44
Total Approach Volume (WB)	449	596
Speed (mph)	20	20
Limiting RT Volume (veh/hr)	>1000	>1000
Conclusion		
Add Right-Turn Bay	**NO**	**NO**
BARTLETT ST / CATE ST		
Right-Turn Volume (EB)	25	15
Total Approach Volume (EB)	595	757
Speed (mph)	20	20
Limiting RT Volume (veh/hr)	>1000	>1000
Conclusion		
Add Right-Turn Bay	**NO**	**NO**

Minor-Road Approach Analysis – The type of treatment needed to accommodate exiting vehicles from the minor-road approach at a stop-controlled intersection can range from a single lane (shared left-right lane) in low-volume conditions, to two exit lanes (exclusive left-turn lane and exclusive right-turn lane) where turning volumes and through traffic volumes a significant, to multiple exit lanes in extreme cases.

Analysis of the Shared Driveway and Cate Street intersections on Bartlett Street using the 2030 traffic volumes and NCHRP 457 guidelines is summarized on Table 9 below. The analysis demonstrates that providing one shared left-right lane on these minor approaches to Bartlett Street is sufficient for the anticipated traffic volumes. The calculations pertaining to this analysis are also included in Appendix I.

Table 9 — Minor-Road Approach Geometry - 2030

	2030 AM Build Volumes	2030 PM Build Volumes
BARTLETT ST / SHARED DRIVEWAY		
Major-Road Volume (EB-WB)	1015	1756
% Right-Turns on Minor (SB)	48%	65%
Minor-Road Approach Volume	101	89
Limiting Minor-Road Volume (veh/hr)	196	101
Conclusion		
Consider TWO Approach Lanes	**NO**	**NO**
BARTLETT ST / CATE ST		
Major-Road Volume (EB-WB)	1190	1481
% Right-Turns on Minor (NB)	97%	97%
Minor-Road Approach Volume	64	114
Limiting Minor-Road Volume (veh/hr)	331	265
Conclusion		
Consider TWO Approach Lanes	**NO**	**NO**

STUDY FINDINGS AND RECOMMENDATIONS

Based on the existing conditions data collected along Bartlett Street and at the three study area intersections, the anticipated traffic increases from the proposed residential development and the analysis of future traffic levels in the study area, Pernaw & Company, Inc. concludes that:

1. Traffic levels at the **Bartlett Street/Existing Shared Driveway** intersection reached peak periods from 7:30 to 8:30 AM in the morning and from 4:45 to 5:45 PM in the evening in April 2018. This intersection accommodated 892 vehicles (AM) and 1,129 vehicles (PM) during the peak hour periods. The existing Shared Driveway accommodated 166 (AM) and 120 (PM) vehicles during those respective peak periods. The heavier directional flow was inbound during the AM peak hour (57%) and outbound during the PM peak hour (57%).

2. The results of the trip generation analysis indicate that the proposed 120-unit residential development will generate approximately 41 vehicle-trips during the weekday AM peak hour; and 53 vehicles trips during the weekday PM peak hour. Most trips will be outbound during the AM peak and inbound during the PM peak hour; which is opposite from those currently using the shared driveway.

3. The greatest impact that site traffic will have on roadway volumes in the study area will occur along Bartlett Street, east of the subject site. This section of roadway is expected to see increases of approximately +21 (AM) and +27 (PM) vehicles during the peak periods. This translates into increases of +2% (AM) during both peak hour periods. Changes of this magnitude are comparable to the changes that typically occur due to random traffic flow from one day to the next.

4. The intersection capacity and Level of Service analysis pertaining to the **Bartlett Street/Existing Shared Driveway** intersection demonstrate that the departure movements from the Existing Shared Driveway will operate at LOS D (2020) and LOS E (2030) or higher during all hours of the day with the subject site fully occupied. The left-turn arrival movement from Bartlett Street on to the existing Shared Driveway will operate at LOS A during all hours of the day through the horizon year and beyond with the development fully occupied. The analysis demonstrates that this intersection will operate below capacity through 2030 with the proposed residential development. However, this finding must be tempered in that left-turn departures from the shared driveway are subject to temporary blockages due to queuing at the Islington Street traffic signal that are not reflected in this analysis.

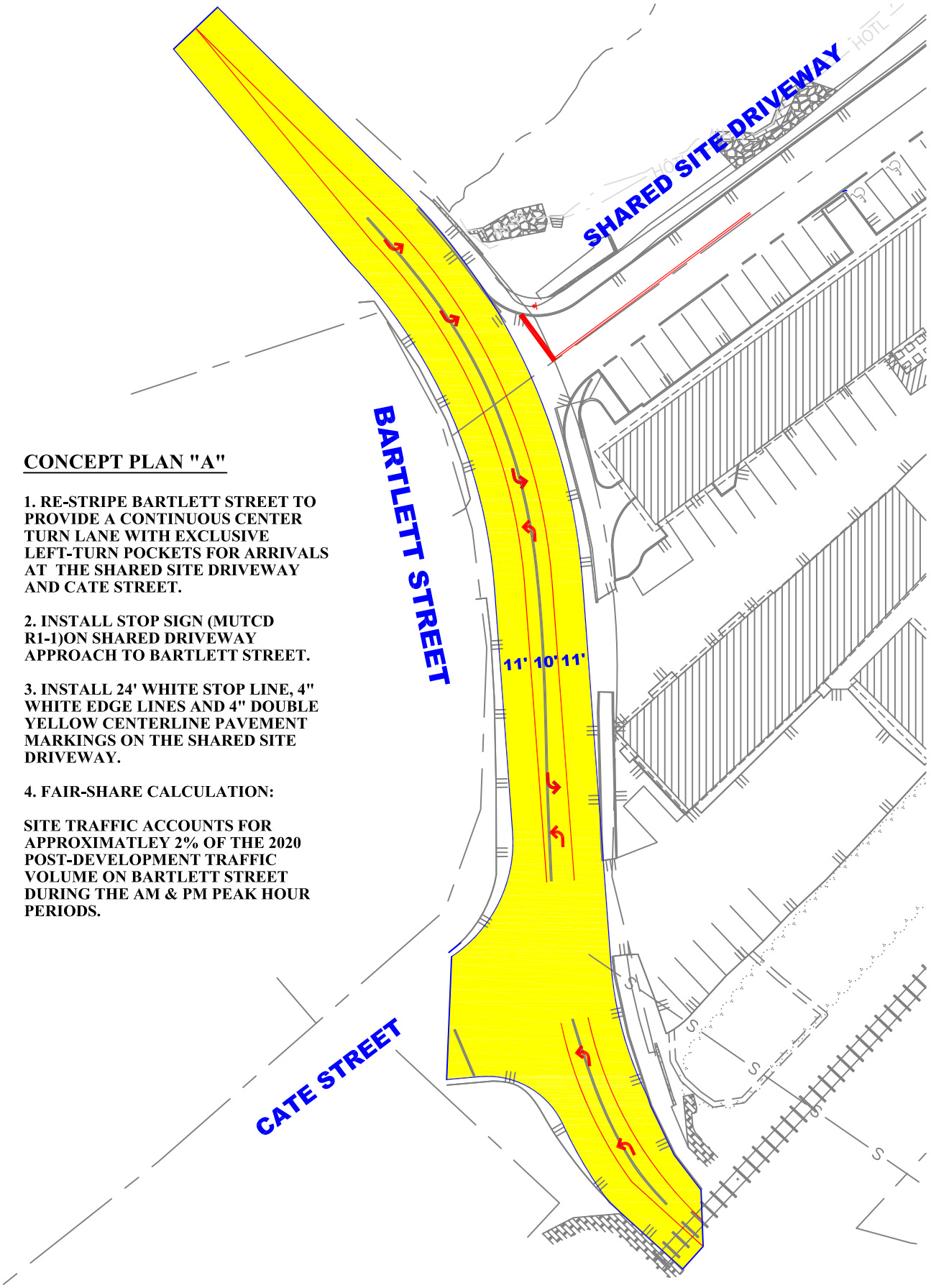
5. The intersection capacity and Level of Service analysis pertaining to the **Bartlett Street/Cate Street** intersection demonstrate that the departure movements from Cate Street will operate at LOS C or higher through the horizon year and beyond with the development fully occupied. The left-turn arrival movement from Bartlett Street on to Cate Street will operate at LOS B or higher during all hours of the day through the horizon year and beyond with the development fully occupied. Again, left-turn arrivals and departures at Cate Street are subject to temporary blockages due to queuing on Bartlett Street due to the traffic signal Islington Street.

6. The capacity analyses of the **Islington Street/Bartlett Street/Pharmacy Driveway** intersection confirms that the overall intersection will operate well below capacity and at LOS C during the AM Peak Hour through 2030 with the residential development fully occupied. During the PM peak hour this intersection will be operating close to capacity and at LOS D in 2020 regardless of the proposed residential development. By 2030 the PM peak hour traffic volumes are projected to exceed the overall capacity of the intersection and it will operate at an overall LOS E, both with and without the proposed residential development. Favorably, site traffic (PM = +27 vehicles) increases the overall volume-to-capacity ratio of the intersection by only one or two percentage points during the peak hour periods. It should be noted that this intersection is slated for reconstruction and upgrading of the signal system in the near future.

7. The 2020 No-Build traffic volumes satisfy the NCHRP 457 guidelines for left-turn treatment on Bartlett Street at both the Shared Driveway and Cate Street intersections. This means it is advisable to re-stripe Bartlett Street to provide left-turn "pockets" for vehicles turning left from Bartlett Street at these locations (see Exhibit 1) regardless of the proposed development. In terms of cost sharing, it should be noted that site traffic represents approximately 2% of the peak hour traffic volume on this section of Bartlett Street.

8. The 2030 Build traffic volumes do not satisfy the NCHRP 457 guidelines for right-turn treatment on Bartlett Street at both the Shared Driveway and Cate Street intersections. The existing travel lanes on Bartlett Street will function adequately as a shared through-right lane at both intersections.

9. The 2030 Build traffic volumes do not satisfy the NCHRP 457 guidelines for providing dual exit lanes on the existing Shared Driveway and Cate Street approaches to Bartlett Street. A single shared left-right departure lane is sufficient for the anticipated traffic volumes.



CONCEPT PLAN "A"

1. RE-STRIPE BARTLETT STREET TO PROVIDE A CONTINUOUS CENTER TURN LANE WITH EXCLUSIVE LEFT-TURN POCKETS FOR ARRIVALS AT THE SHARED SITE DRIVEWAY AND CATE STREET.

2. INSTALL STOP SIGN (MUTCD R1-1)ON SHARED DRIVEWAY APPROACH TO BARTLETT STREET.

3. INSTALL 24' WHITE STOP LINE, 4" WHITE EDGE LINES AND 4" DOUBLE YELLOW CENTERLINE PAVEMENT MARKINGS ON THE SHARED SITE DRIVEWAY.

4. FAIR-SHARE CALCULATION:

SITE TRAFFIC ACCOUNTS FOR APPROXIMATLEY 2% OF THE 2020 POST-DEVELOPMENT TRAFFIC VOLUME ON BARTLETT STREET DURING THE AM & PM PEAK HOUR PERIODS.

PROPOSED RESIDENTIAL DEVELOPMENT
PORTSMOUTH, NEW HAMPSHIRE
CLIPPER TRADERS, LLC

BARTLETT STREET
CONCEPT PLAN "A"

DRAWN:	SCALE:
CAP	1" = 50'
DESIGNED:	JOB NO.
SGP	1821A
CHECKED:	DATE:
SGP	6/18/18

TRANSPORTATION
• ENGINEERING
• PLANNING
• DESIGN

SGP

Stephen G. Pernaw & Co. Inc.
PO Box 1721, Concord, NH 03302
Phone: (603) 731-8500, Fax: (866) 929-6094
E-Mail: sgp@pernaw.com