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Transportation: Engineering • Planning • Design

DRAFT TRAFFIC IMPACT AND SITE ACCESS STUDY
PROPOSED MIXED-USE SITE
PORTSMOUTH, NEW HAMPSHIRE
July 18, 2018

INTRODUCTION

This "Traffic Impact and Site Access Study" has been prepared for Torrington Properties, Inc. in order to assess the traffic impacts associated with the proposed residential/commercial development located on the east side of US1 Bypass at the site of the Frank Jones Center, a wedding, event and conference center in Portsmouth, New Hampshire. The City of Portsmouth has required this study in conjunction with the 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.

A traffic study "scope" meeting was conducted with the NHDOT and City representatives on April 27, 2018. As a result of that meeting, the analysis periods were identified as the Weekday PM and Saturday Midday peak periods, and the study area was expanded to include several intersections:

- US1 Bypass/Cottage Street/Coakley Road
- US1 Bypass/Borthwick Avenue
- US1 Bypass/Existing Site Driveway (Right-In/Right-Out only)
- Islington Street/Bartlett Street/Pharmacy Driveway
- Bartlett Street/Cate Street
- Bartlett Street/Existing Shared Driveway (Ricci Lumber, Great Rhythm Brewing)
- Cate Street Extension/Proposed Site Driveway A
- Cate Street Extension/Proposed Site Driveway B
- Cate Street Extension/Proposed Site Driveway C

The City also requested: 1) supplemental counts on Woodbury Avenue (at the US1 Bypass Ramps and Franklin Avenue) for planning purposes, and 2) pedestrian and bicycle count data. The NHDOT requested that "lane utilization" be monitored on the US1 Bypass northbound approach to the Cottage Street/Coakley Road signalized intersection, given the upstream influence of the Portsmouth Traffic Circle.

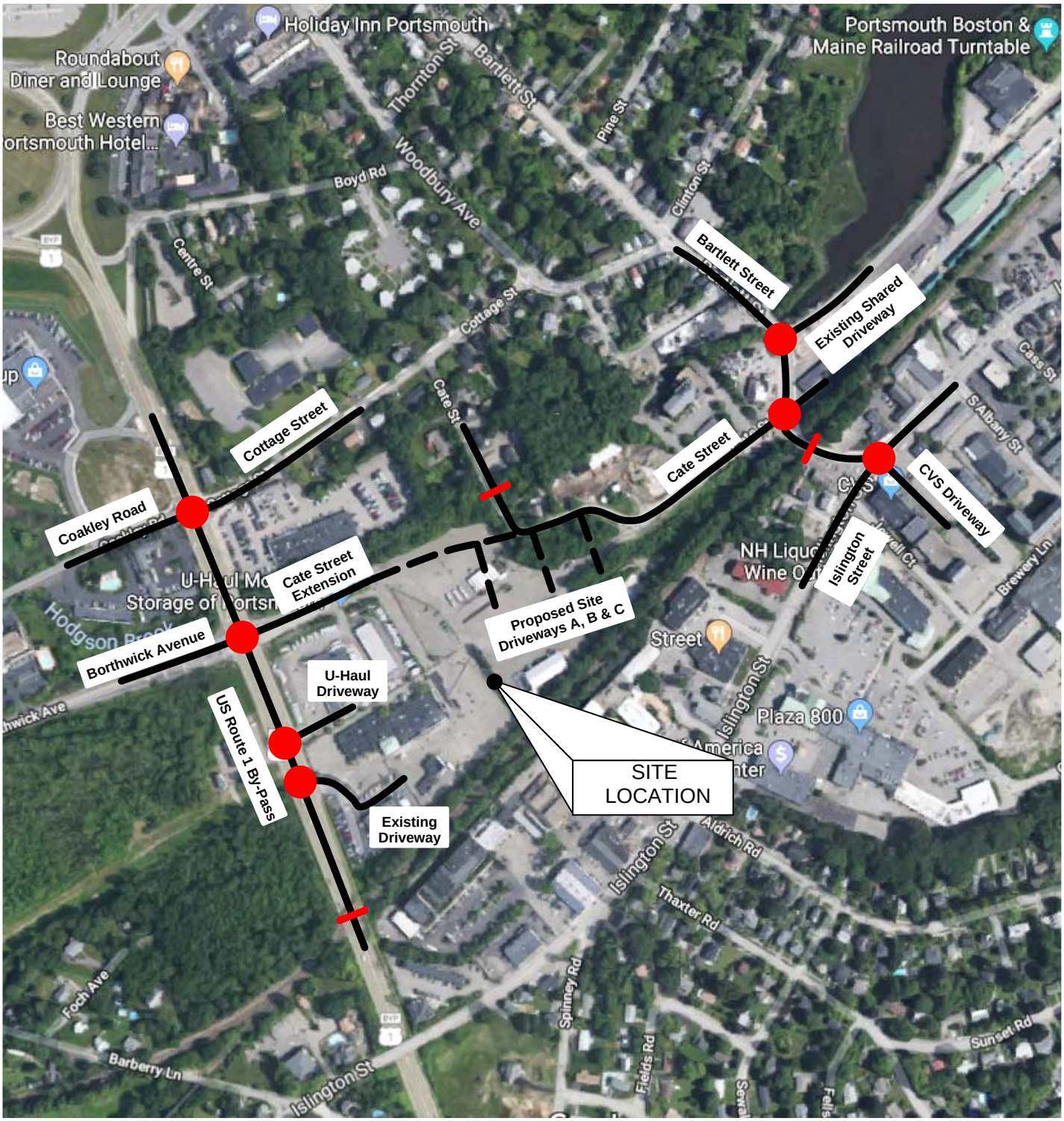
PROPOSAL

The subject site currently lies within the Mixed Residential District (G1–Gateway Corridor) on Lots 163-33, 165-2, 172-1, and 173-2. The proposed development involves razing the existing structures and constructing several new residential/commercial buildings that will contain: 325 mid-rise apartments, 17 townhomes, 22 ksf retail/restaurants, and 22 ksf office of space.

The proposed development also implements the City's long-range plan to realign and extend Cate Street through the subject site to intersect with the US1 Bypass at the Borthwick Avenue signalized intersection. The existing bridge on Cate Street will be converted to a pedestrian-only bridge. A multipurpose path for bikes and pedestrians will be constructed along Hodgson Brook as well as a sidewalk on the development side of the extended roadway. For the purposes of this report only, the new roadway is named "Cate Street Extension."

Vehicular access to the development will continue to be provided via the existing Right-In/Right-Out Driveway on the Bypass, as well as three proposed site driveways that will intersect the south side of Cate Street Extension.

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



= AUTOMATIC TRAFFIC RECORDER LOCATION (NHDOT)

= INTERSECTION TURNING MOVEMENT COUNT LOCATION

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Figure 1

Site Location

Traffic Impact and Site Access Study, Proposed Multi-Use Site, Portsmouth, New Hampshire

EXISTING CONDITIONS

ROADWAYS

The **US1 Bypass** functions as a four-lane arterial highway with a general north-south orientation in the study area that extends from the Traffic Circle (and points north in Maine), past the subject site, to US1 in Portsmouth. This roadway will provide access to the site via the Borthwick Avenue signalized intersection, as well as via the existing Right-In/Right-Out Site Driveway. The speed limit is posted at 35 mph on the Bypass.

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. The horizontal alignment of the roadway is curvilinear and the vertical alignment is essentially flat in the 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 **US1/Cottage Street/Coakley Road** intersection functions as a typical four-leg intersection that operates under traffic signal control. The approach lanes at this intersection are designated accordingly:

NB: One exclusive left-turn lane, one exclusive through lane, one shared through-right lane
SB: One exclusive left-turn lane, one exclusive through lane, one shared through-right lane
EB: One shared left-through-right lane
WB: 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: 1) northbound and southbound left turns, 2) northbound and southbound through-right movements, and 3) the Cottage Street and Coakley Road approaches run concurrently. This controller is programmed to operate with a 120-second (PM) and 110-second (SAT) cycle length during the peak hour periods, and is coordinated with the signal system to the south.

The **US1/Borthwick Avenue** intersection also functions as a typical four-leg intersection that operates under traffic signal control. The approach lanes at this intersection are designated accordingly:

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

This traffic signal utilizes a fully-actuated controller that operates with four basic signal phases: 1) northbound and southbound left turns, 2) northbound and southbound through-right movements, 3) eastbound departures from Borthwick Avenue and 4) westbound departures from Borthwick Avenue (future Cate Street Extension). This controller is coordinated with the traffic signal system to the north and it is programmed to operate with a 120-second (PM) and 110-second (SAT) cycle length during the peak hour periods.

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 a 90-second average cycle length during both 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.

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 utilized minimally 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 **Bartlett Street/Existing Shared Driveway** intersection functions as a typical three-leg "T" intersection and the Existing Shared Driveway approach operates with no traffic control devices (no stop sign, no pavement markings). The approach lanes are designated accordingly:

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

The **US1 Bypass/Existing Site Driveway** intersection functions as an atypical three-leg "T" intersection where the use of the site driveway is limited to right-turn arrivals and right-turn departures (due to the median island on the Bypass). The approach lanes are designated accordingly:

WB: One right-turn exit only lane
NB: One exclusive through lane and one shared through-right lane

The **Cate Street Extension/Proposed Site Driveway A, B, & C** intersections will function as typical three-leg "T" intersections with one shared lane on each approach. Each site driveway approach will operate under stop sign control and will be delineated with a short section of four-inch double-yellow centerline and an 18-inch white stop line.

TRAFFIC VOLUMES

Research at the New Hampshire Department of Transportation (NHDOT) revealed that short-term automatic traffic recorder counts were conducted on: 1) US1 Bypass (under B&M railroad) in August-September 2015, 2) Bartlett Street (west of Islington Street) in September 2017, and 3) Cate Street (at Hodgson Brook) in September of 2017. These count stations are located a short distance from the subject site.

The NHDOT data shows that the US1 Bypass carried an Annual Average Daily Traffic (AADT) volume of 21,848 vehicles per day (vpd) in 2017. Similarly, Bartlett Street carried an AADT volume of 16,414 vpd and Cate Street carried 1,420 vpd in 2017. Data from the automatic traffic recorder counts is summarized graphically on Page 9 and shows the daily and hourly variations in traffic demand in the study area. Except for Cate Street, the hourly rate of traffic flow reached peak levels during the 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 at the six existing study area intersections on Thursday, May 24th from 3:00 to 6:00 PM and on Saturday, May 26 from 11:00 AM to 3:00 PM. The new 2018 balanced count data for the study area intersections is summarized on Figure 3A & 3B. Several facts and conclusions are evident from this data.

- The highest traffic hour for the overall study area system occurred from 4:30 to 5:30 PM at which time the volume of traffic on the Bypass ranged from 2,117 vehicles south of the site to 2,273 vehicles north of Cottage Street (total both directions). The majority traveled in the northbound direction on the Bypass during this peak hour. During this same hour, Islington Street and Bartlett Street accommodated over 1,100 vehicles. Cate Street (south of Bartlett Street) carried 151 vehicles, Borthwick Avenue carried 587 vehicles (west of US1 Bypass), and Cottage Street carried 496 vehicles.

- On Saturday the highest traffic hour for the overall study area system occurred from 11:45 AM to 12:45 PM and the roadway volumes were found to be lower than during the weekday PM peak hour. The traffic volume on the Bypass ranged from 1,752 to 1,844 vehicles per hour, Islington Street and Bartlett Street generally carried fewer than 1,000 vehicles (except 1,007 vehicles were observed on Islington Street north of Bartlett Street). Cate Street (south of Bartlett Street) carried 76 vehicles, Borthwick Avenue carried 257 vehicles (west of US1 Bypass), and Cottage Street carried 305 vehicles.

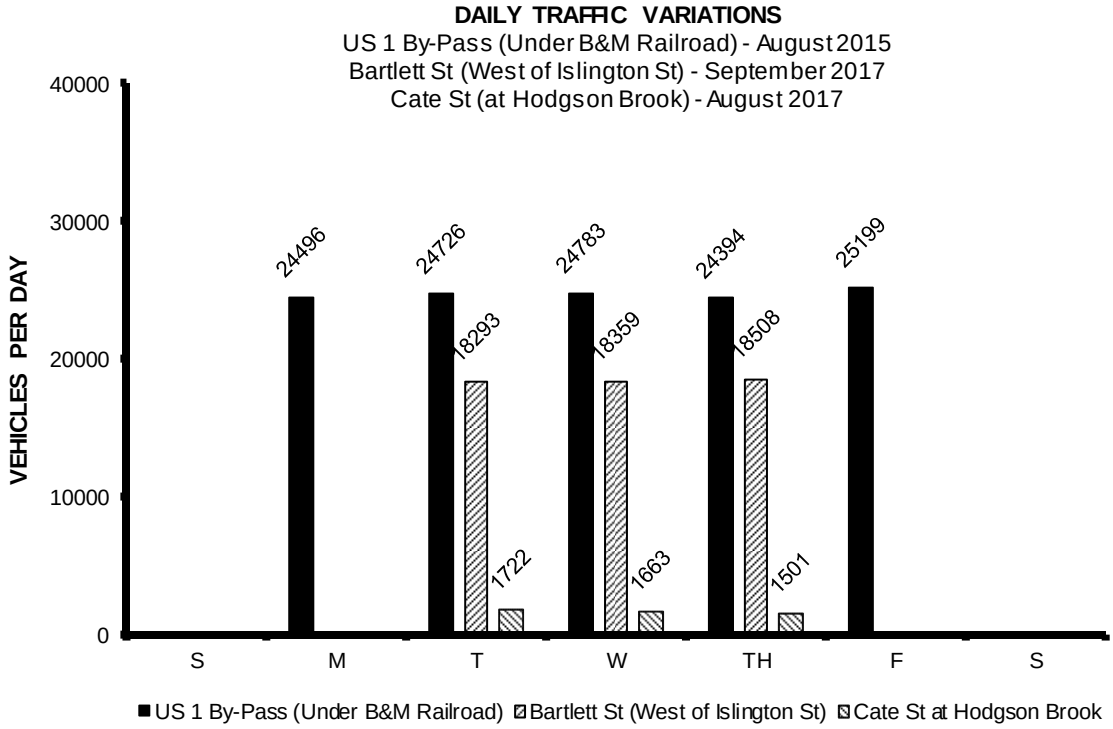
- The section of Borthwick Avenue east of US1 Bypass (where Cate Street will be extended to) carried only 33 (PM) and 40 (SAT) vehicles during the peak hour periods, primarily due to the U-Haul business.

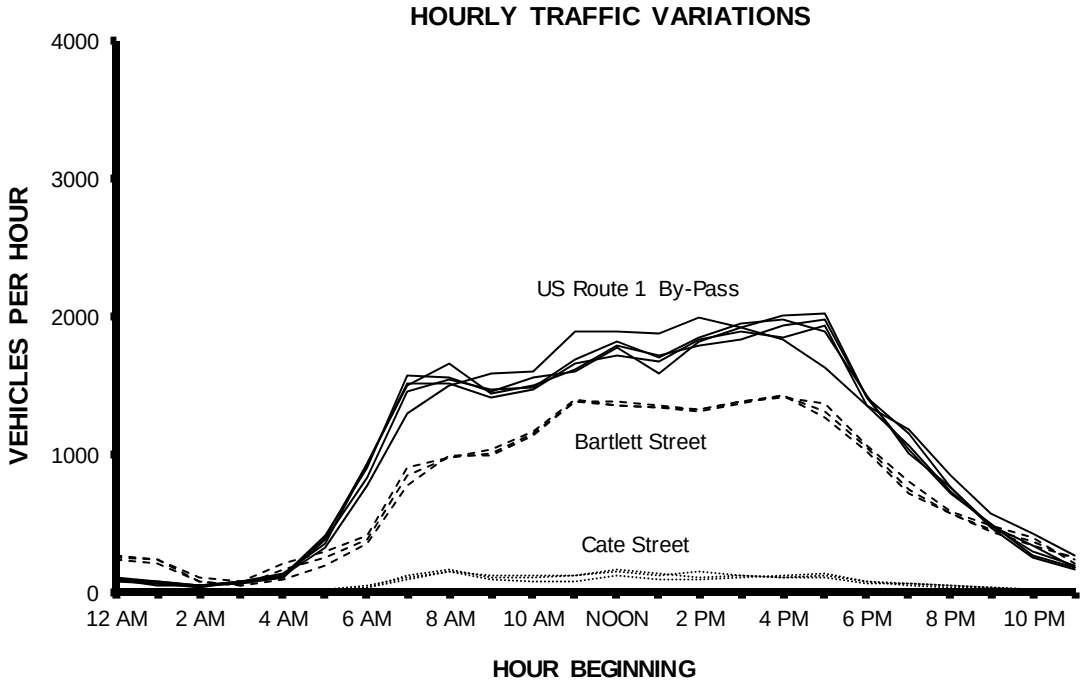
- Truck traffic accounted for approximately 2-3% (PM) and 1% (SAT) of the traffic flow during the peak hour periods at the study area intersections.

- Pedestrian activity was monitored at the study area intersections and was found to be highest at the Islington Street/Bartlett Street intersection with 49 pedestrians observed

during the PM peak hour. The Bartlett Street/Cate Street intersection accommodated 17 pedestrians and there 15 pedestrians observed at the Bartlett Street/Shared Driveway. Pedestrian activity at the two study area intersections on US1 Bypass was nil during the PM peak hour. Comparable pedestrian volumes occurred during the Saturday midday peak hour.

Figure 2A (PM) and Figure 2B (SAT) summarize the raw turning movement count data for each study area intersection and its individual peak hour. Figure 3A (PM) and Figure 3B (SAT) summarize the turning movement volumes for the overall "system" peak hour. The detail sheets summarizing the intersection turning movement count data are included in Appendix C. The pedestrian count data is included in Appendix D.





Source: NHDOT Counter Stations 82379042, 82379052, and 82379111

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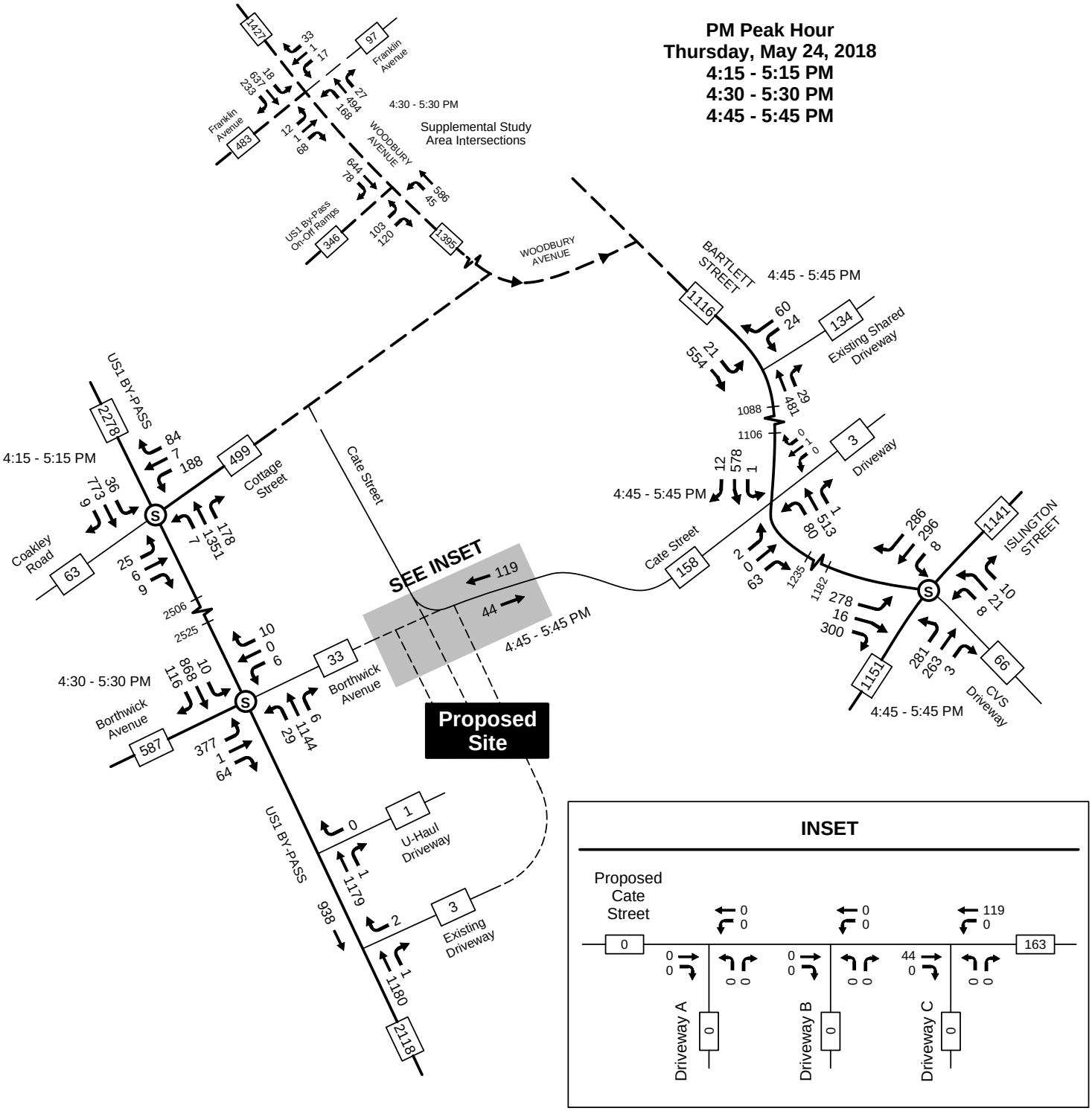

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Figure 2A

2018 Existing Traffic Volumes - PM Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire

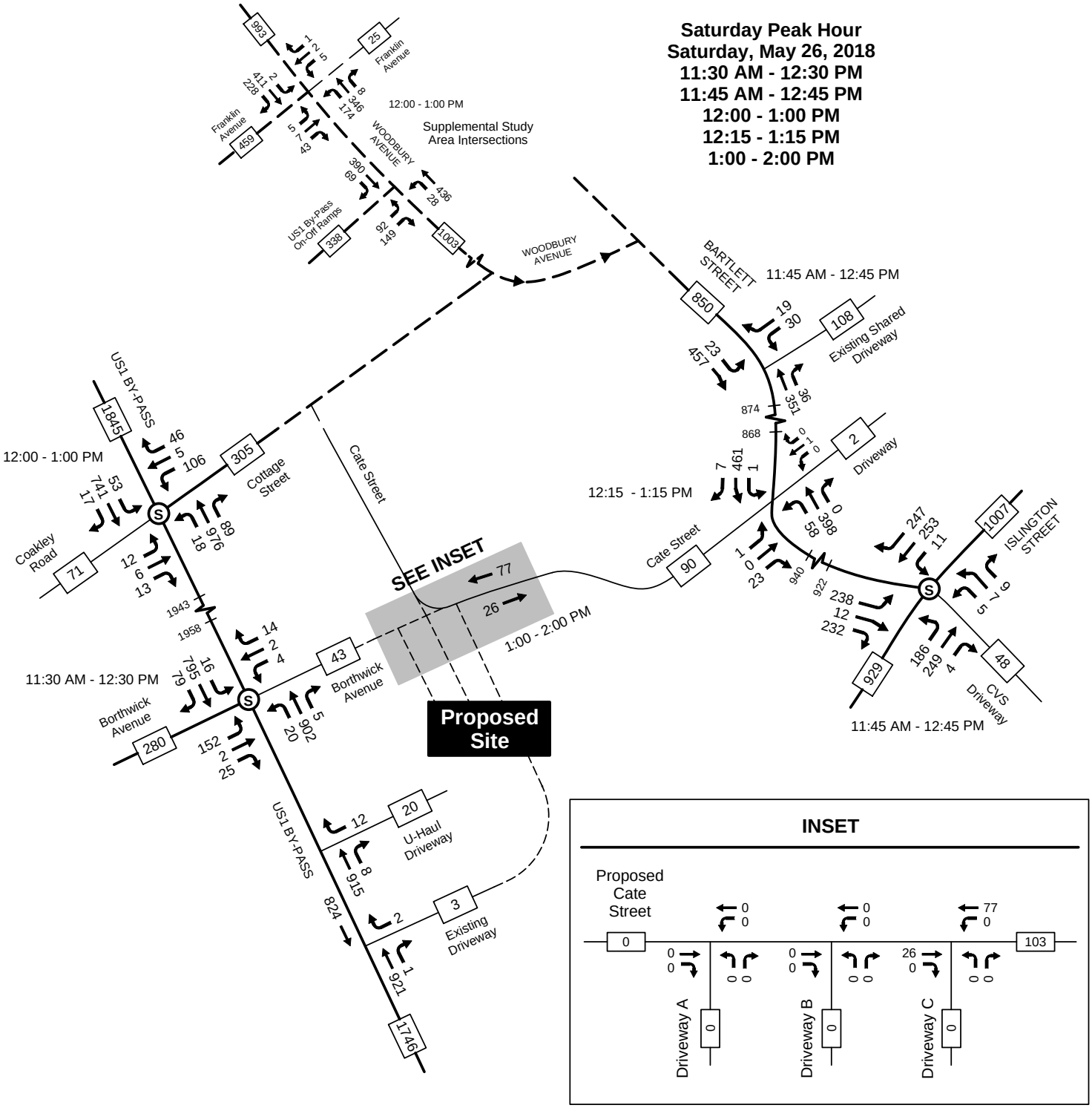

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Figure 2B

2018 Existing Traffic Volumes - Saturday Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire

Pernaw & Company, Inc.

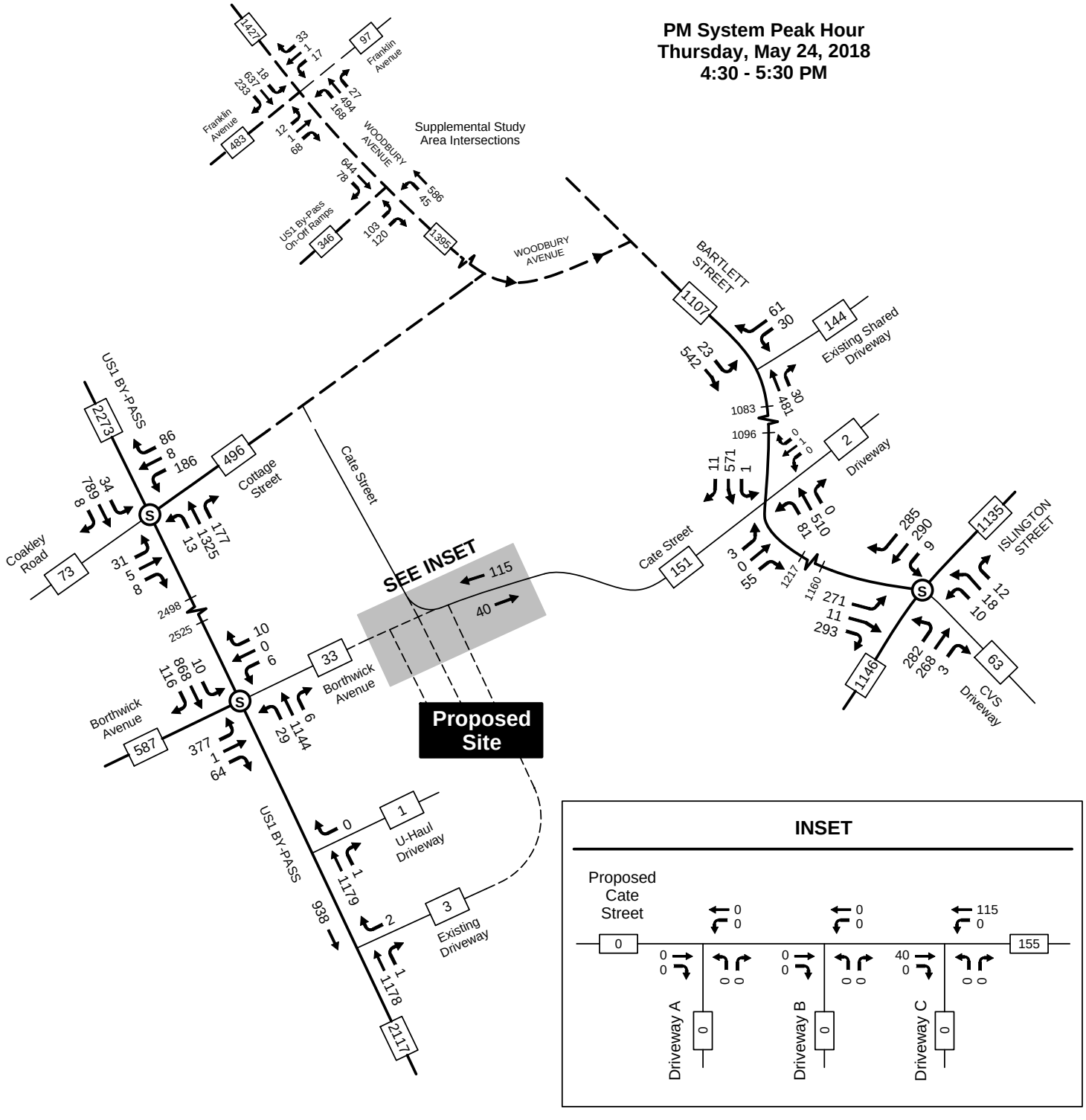

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Figure 3A

2018 Existing Traffic Volumes - PM System Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire

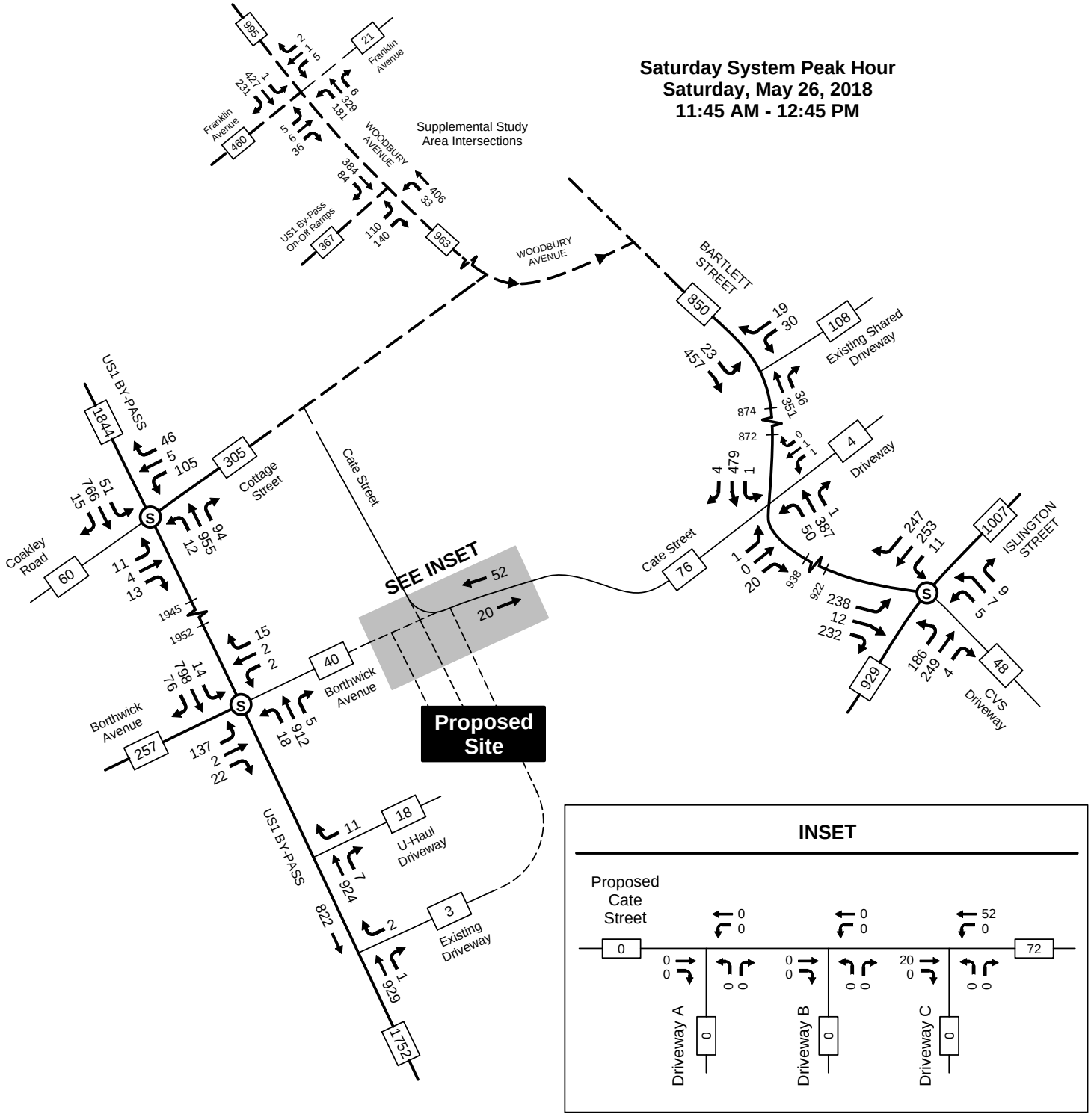

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Figure 3B

2018 Existing Traffic Volumes - Saturday System Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire

NO-BUILD TRAFFIC VOLUMES

In order to identify the net impact that the proposed residential/commercial development will have in the study area, future traffic projections with and without the proposed 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 Figures 4 through 7. These projections are based on the May 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 1.07 (PM) and 1.08 (SAT).

The No-Build projections also account for five other pending development projects that were identified at the "scope meeting."

- Proposed Multi-Family Development – 31-unit townhouse development on Cate Street
- Proposed Office Development – 50,000 sf office building off of Borthwick Avenue
- Proposed Apartments – 92-unit apartment development at 145 Brewery Lane
- Proposed Mixed-Use Development – Mixed-use development at 110 Brewery Lane
- Proposed Residential Development – 120 dwellings off Bartlett Street (Clipper Traders)

The No-Build 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 E. Appendix F contains the diagrams for the five other development projects.

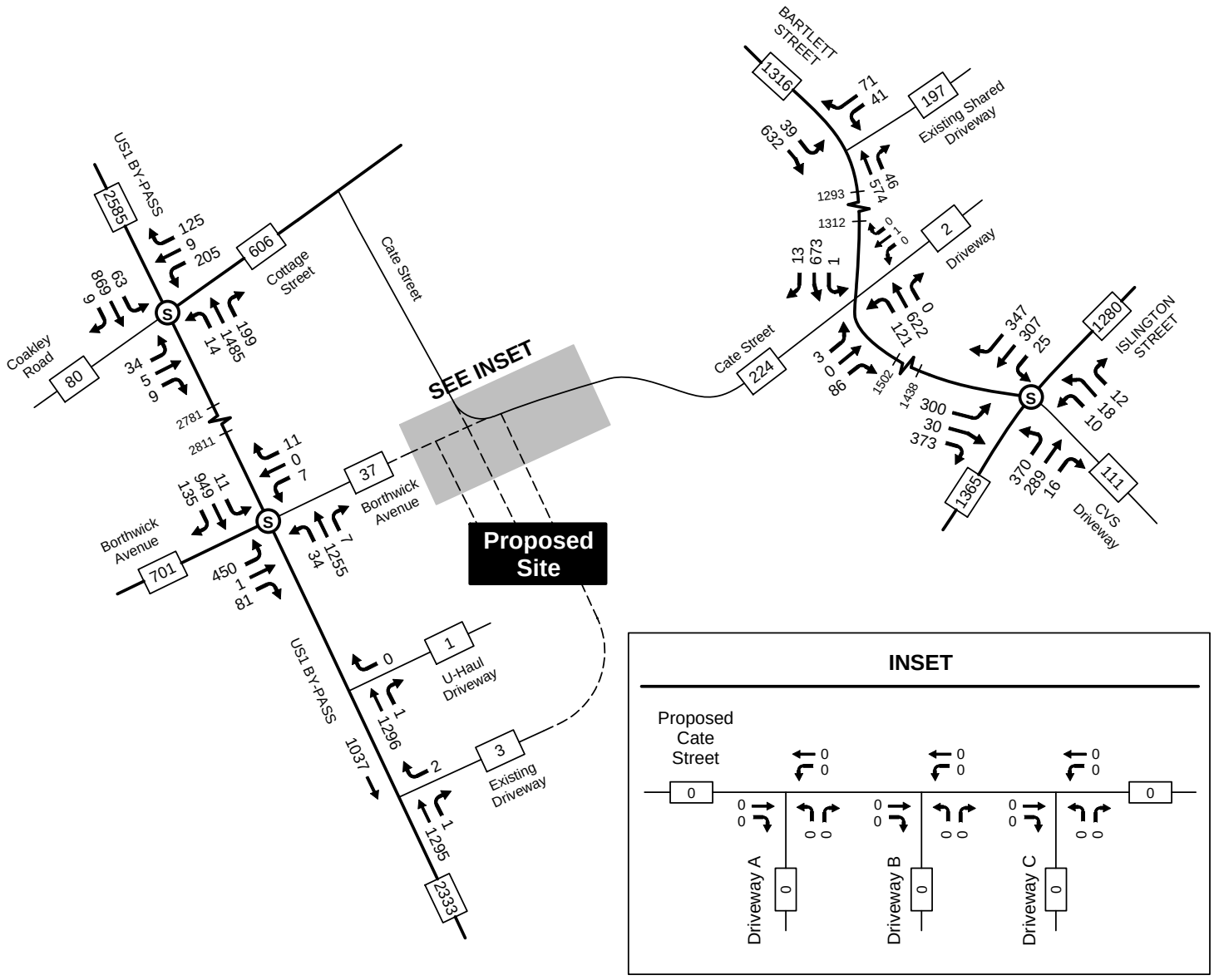

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Figure 4

2020 No-Build Traffic Volumes - PM Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire

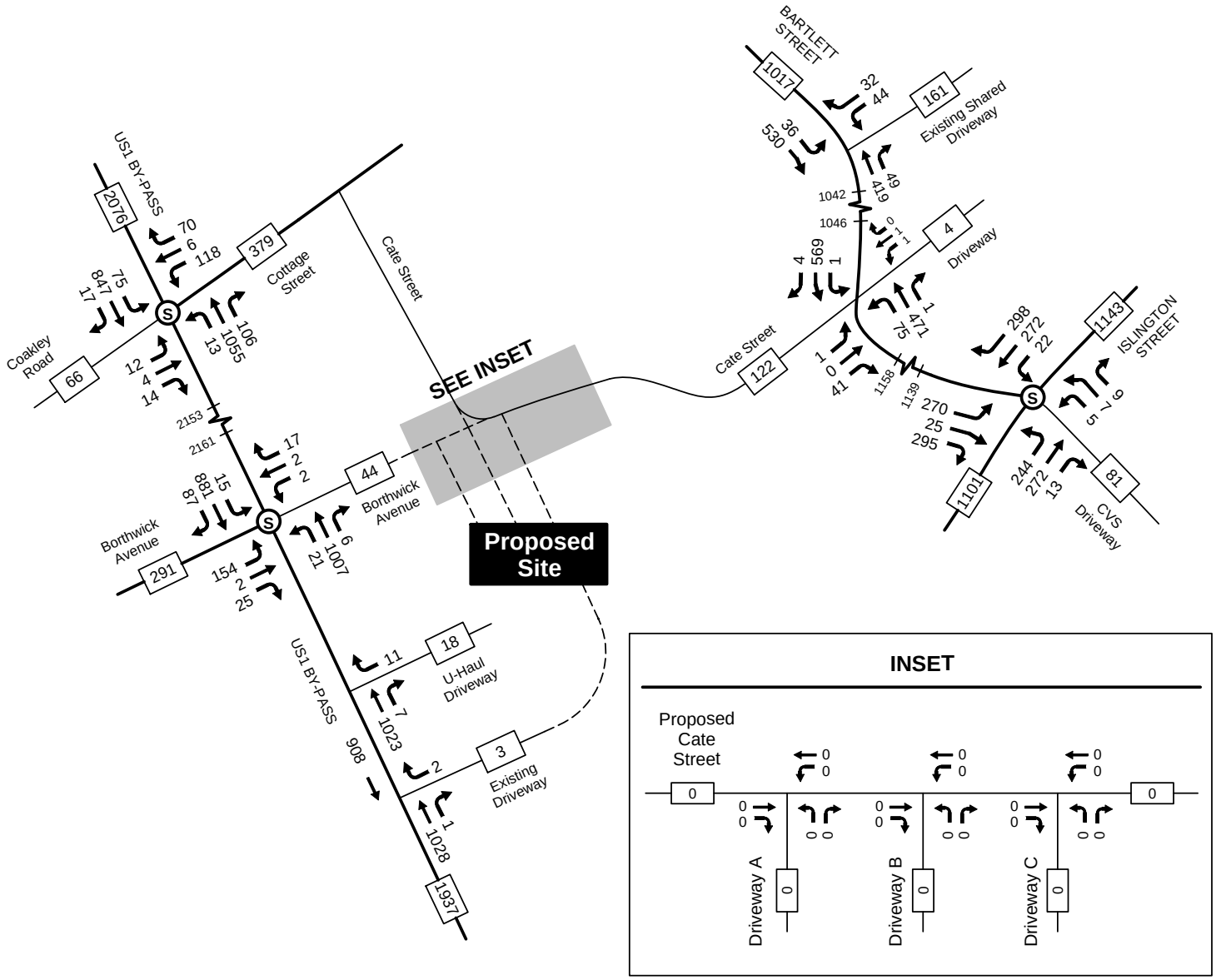

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Figure 5

2020 No-Build Traffic Volumes - Saturday Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire

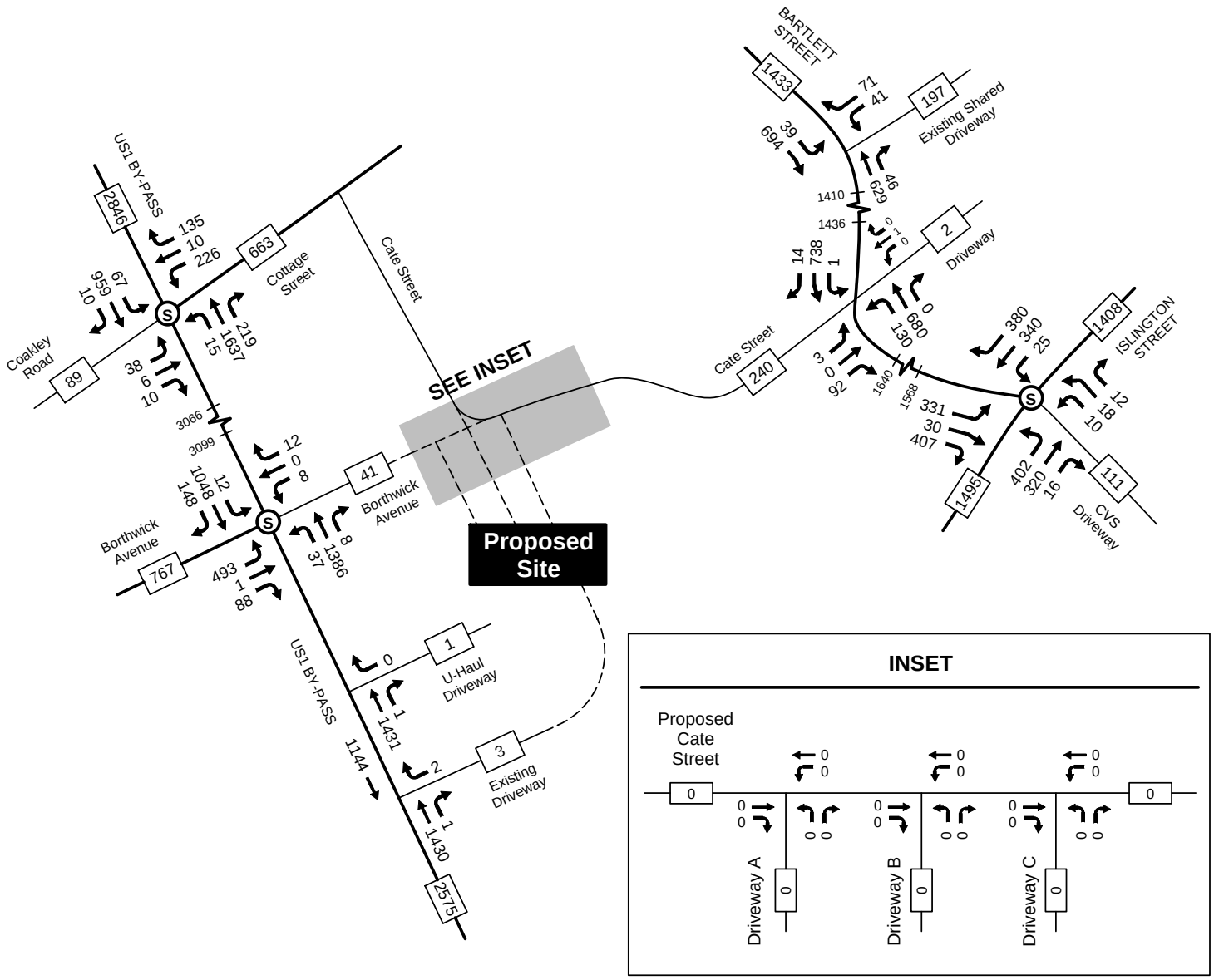

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Figure 6

2030 No-Build Traffic Volumes - PM Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire

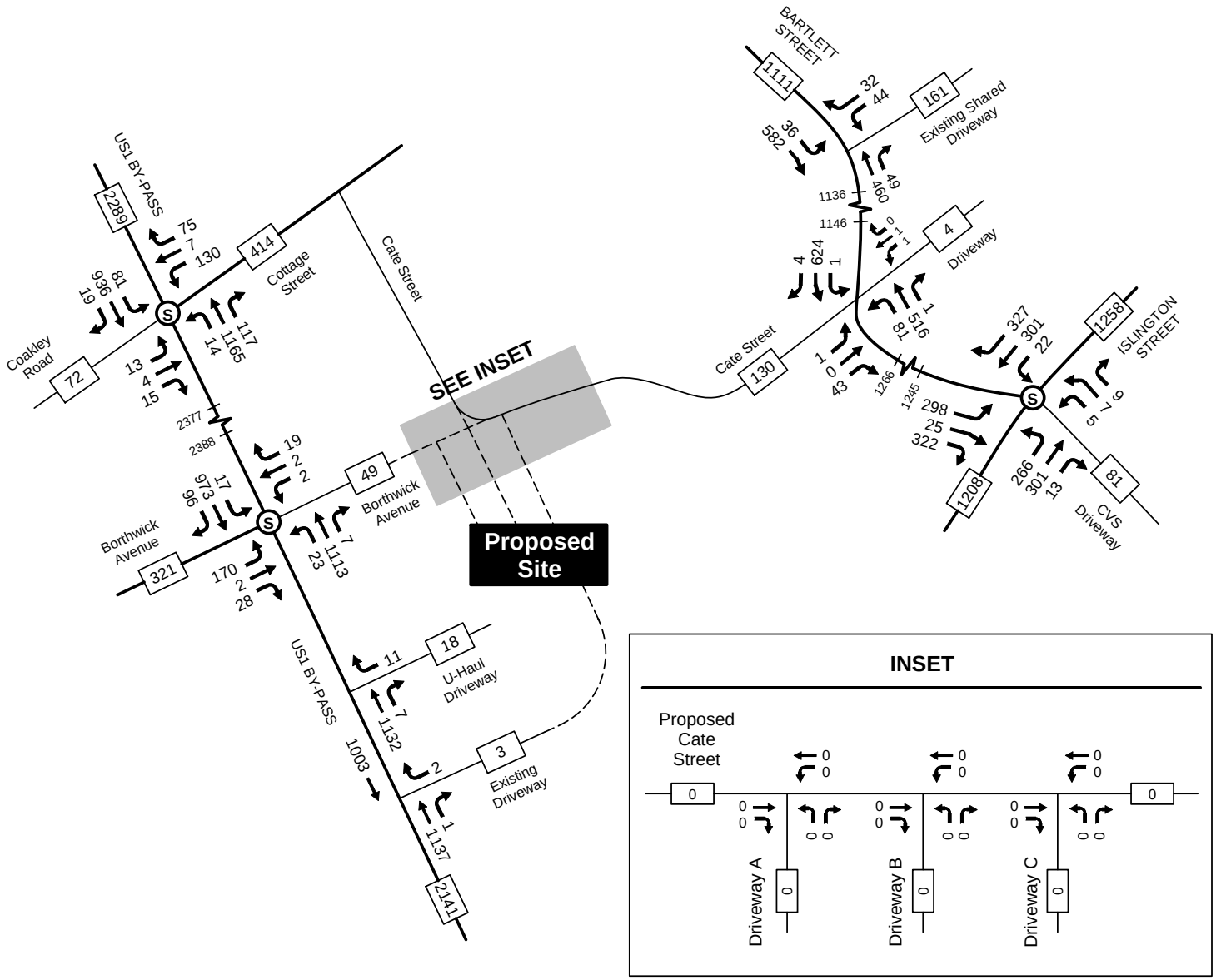

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Figure 7

2030 No-Build Traffic Volumes - Saturday Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire

TRIP GENERATION

In estimating the quantity of vehicle-trips that will be produced by the proposed residential/commercial development, Pernaw & Company, Inc. considered the standardized trip-generation rates and equations published by the Institute of Transportation Engineers (ITE) [1]. In this case the number of dwelling units and the gross floor area of the commercial space were used as the independent variables.

Based upon ITE Land Use Codes (LUC) 220 & 221 – Multi-Family Housing (Low-Rise and Mid-Rise, respectively), the residential portion of the development is expected to generate approximately 149 (PM) and 155 (SAT) vehicle-trips during the peak hour periods. Trips that are generated by residences are considered to be "new" trips to the study area (primary trips).

Based on several ITE LUC (for restaurants, retail and offices), the commercial portion of the development is expected to generate approximately 230 (PM) and 316 (SAT) vehicle-trips during the peak hour periods. Restaurants and retail trips are comprised of both primary trips and "pass-by" trips which are drawn from the existing traffic stream on US1 Bypass.

Table 1A (Page 20) summarizes the results of the trip generation analysis and shows that the overall site will generate approximately 379 (PM) and 471 (SAT) vehicle-trips during the peak hour periods. Table 1B shows the breakdown between the primary trips and the pass by trips.

Table 1B — Trip Composition

	Primary Trips	Pass-By Trips [1]	Total
Weekday PM Peak Hour			
Entering	173 veh	42 veh	215 veh
Exiting	122 veh	42 veh	164 veh
Total	295 trips	84 trips	379 trips
Saturday Peak Hour			
Entering	180 veh	63 veh	243 veh
Exiting	165 veh	63 veh	228 veh
Total	345 trips	126 trips	471 trips

[1] ITE Handbook: LUC 932 = 43%, LUC 820 = 34% (PM) and 26% (SAT)

In mixed-use developments it is reasonable to expect some interaction will occur between certain compatible uses; i.e. some residents and office employees may utilize the eating establishments (and retail use) in the commercial building rather than traveling off-site. According to NCHRP 684 guidelines, approximately 82 of the 379 PM trips (22%) could be subtracted from the trip estimate for the overall site to account for "internal" trips. To introduce conservativeness into the subsequent analyses, the Build traffic projections do not reflect any such "credit" for internal trips. Appendix G contains the derivation of the trip generation estimates.

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

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Table 1A — Trip Generation Summary

	Residential (342 Dwelling Units)		Commercial Building (44,000 sf)					
	Apartments[1]	Townhomes[2]	Office[3]	Restaurant[4]	Cafe[5]	Retail[6]	Food/Beer Hall[7]	Total
Weekday PM Peak Hour								
Entering	84 veh	8 veh	4 veh	42 veh	31 veh	9 veh	37 veh	215 veh
Exiting	53 veh	4 veh	23 veh	26 veh	26 veh	10 veh	22 veh	164 veh
Total	137 trips	12 trips	27 trips	68 trips	57 trips	19 trips	59 trips	379 trips
Saturday Peak Hour								
Entering	70 veh	6 veh	6 veh	40 veh	75 veh	12 veh	34 veh	243 veh
Exiting	73 veh	6 veh	6 veh	38 veh	61 veh	11 veh	33 veh	228 veh
Total	143 trips	12 trips	12 trips	78 trips	136 trips	23 trips	67 trips	471 trips

[1] ITE Land Use Code 221 - Multifamily Housing (Mid-Rise) 325 Dwelling Units
[2] ITE Land Use Code 220 - Multifamily Housing (Low-Rise) 17 Dwelling Units
[3] ITE Land Use Code 710 - General Office Building (approximate gross floor area = 22,000 sf)
[4] ITE Land Use Code 932 - High-Turnover (Sit-Down) Restaurant (approximate gross floor area = 7,000 sf)
[5] ITE Land Use Code 930 - Fast Casual Restaurant (approximate gross floor area = 4,000 sf)
[6] ITE Land Use Code 820 - Shopping Center (approximate gross floor area = 5,000 sf)
[7] ITE Land Use Code 932 - High-Turnover (Sit-Down) Restaurant (approximate gross floor area = 6,000 sf)

TRAFFIC DIVERSION

It is important to note that this development project will result in two separate and distinct impacts; the first being due to "trip generation" (the distribution of primary trips throughout the study area) and the second due "traffic diversion" as a result of the new connection to US1 Bypass (aka: Cate Street Extension). Providing this new connection has the potential to alter the prevailing travel patterns for some drivers in the study area (non-site traffic). Both traffic increases and decreases will occur in the study area as certain drivers will divert from their existing travel route to use the new roadway (depending upon the driver's origin/destination). The diagrams below illustrate several examples where traffic diversion is expected to occur.

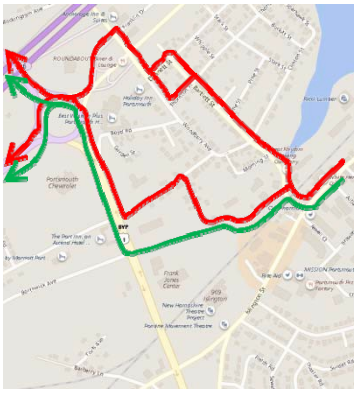
Trip Diversion Pattern 1 – (Traffic Circle area to Islington Street-NB)

Current travel routes (red):

a. Traffic Circle to Woodbury- Bartlett-Islington NB.
b. Traffic Circle to US1Byp-Cottage-Woodbury-Bartlett-Islington NB.
c. Traffic Circle to US1Byp-Cottage-Cate-Islington NB.

Future travel routes (green):

a. Traffic Circle to US1Byp-Cate St. Extension-Bartlett-Islington NB



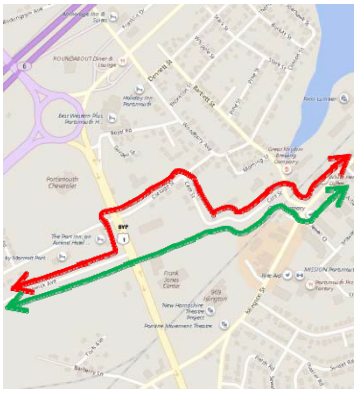
Trip Diversion Pattern 2 – (Islington Street SB to Traffic Circle area)

Current travel routes (red):

a. Islington SB to Bartlett-Thornton/Dennett-Woodbury-Franklin.
b. Islington SB to Bartlett-Cate-Cottage-US1Byp.

Future travel routes (green):

a. Islington SB to Bartlett-Cate-Cate St. Extension-US1Byp.



Trip Diversion Pattern 3 – (Borthwick Avenue to/from Islington Street)

Current travel routes (red):

a. Islington SB to Bartlett-Cate-Cottage-US1Byp-Borthwick.
b. Borthwick to US1Byp-Cottage-Cate-Bartlett-Islington.

Future travel routes (green):

a. Islington SB to Bartlett-Cate-Cate St. Extension-Borthwick.
b. Borthwick to Cate St. Extension-Cate-Bartlett-Islington.

Trip Diversion Pattern 4 – (US1Byp.to/from Cate Street)

Current travel routes (red):

a. US1Byp. to Cottage-Cate.
b. Cate to Cottage-US1Byp.

Future travel routes (green):

a. US1Byp to Cate St. Extension-Cate.
b. Cate to Cate St. Extension-US1Byp.

Trip Diversion Pattern 5 – (Traffic Circle area to/from Shared Driveway)

Current travel routes (red):

a. Shared Driveway to Bartlett-Thornton/ Dennett-Woodbury-Franklin-Traffic Circle.
b. Traffic Circle to Woodbury-Thornton/Dennett-Woodbury-Shared Driveway.

Future travel routes (green):

a. Shared Driveway to Bartlett-Cate-Cate St. Extension-US1Byp.
b. US1Byp. to Cate St. Extension-Cate-Bartlett-Shared Driveway.

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 both the proposed residential/commercial units in full operation and the Cate Street Extension in place are referred to as "Build" traffic projections.

The Build traffic volume projections for 2020 and 2030 are summarized schematically on Figures 8 through 11. These projections are based on the No-Build projections, the trip generation estimates contained in Table 1A and Table 1B, the anticipated traffic diversion patterns described earlier, and the expectation that the primary trips will be distributed in the following manner:

To/From Gateway:	Commercial Distribution	Residential Distribution
Gateway A - US1 Bypass (South)	21%	34%
Gateway B - Borthwick Avenue (West)	2%	3%
Gateway C - Coakley Road (West)	0%	0%
Gateway D - US1 Bypass (North)	71%	51%
Gateway E - Bartlett Street (North)	1%	1%
Gateway F - Islington Street (Northeast)	4%	9%
Gateway G - Isington Street (Southwest)	1%	2%
Total	100%	100%

These percentages were based on an analysis of area wide travel patterns from the U.S. Census Bureau - Center for Economic Studies, as well as our knowledge of the local area (see Appendix G). The pass-by trips were distributed in proportion to the approach volumes observed at the US1 Bypass/Borthwick Avenue intersection.

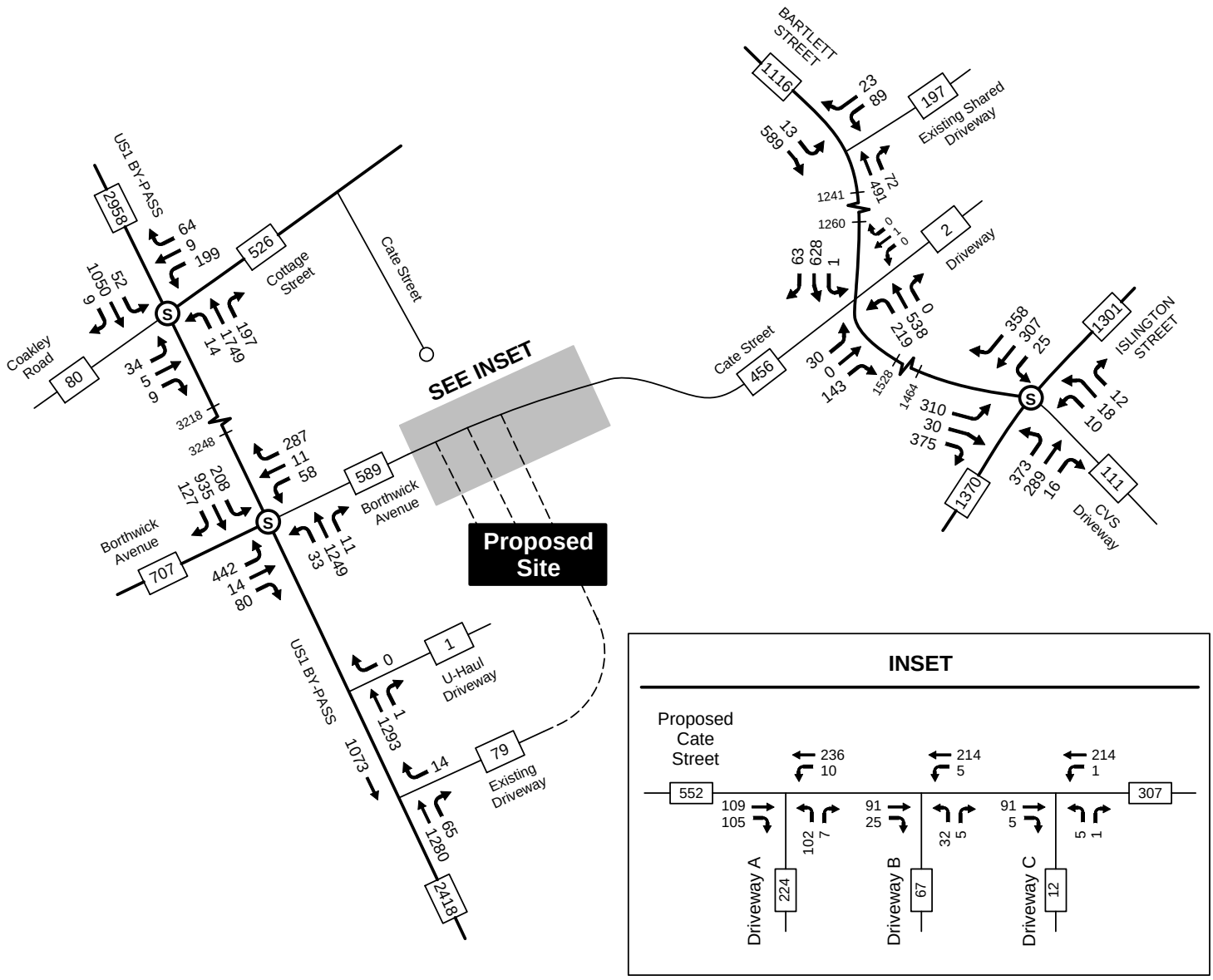


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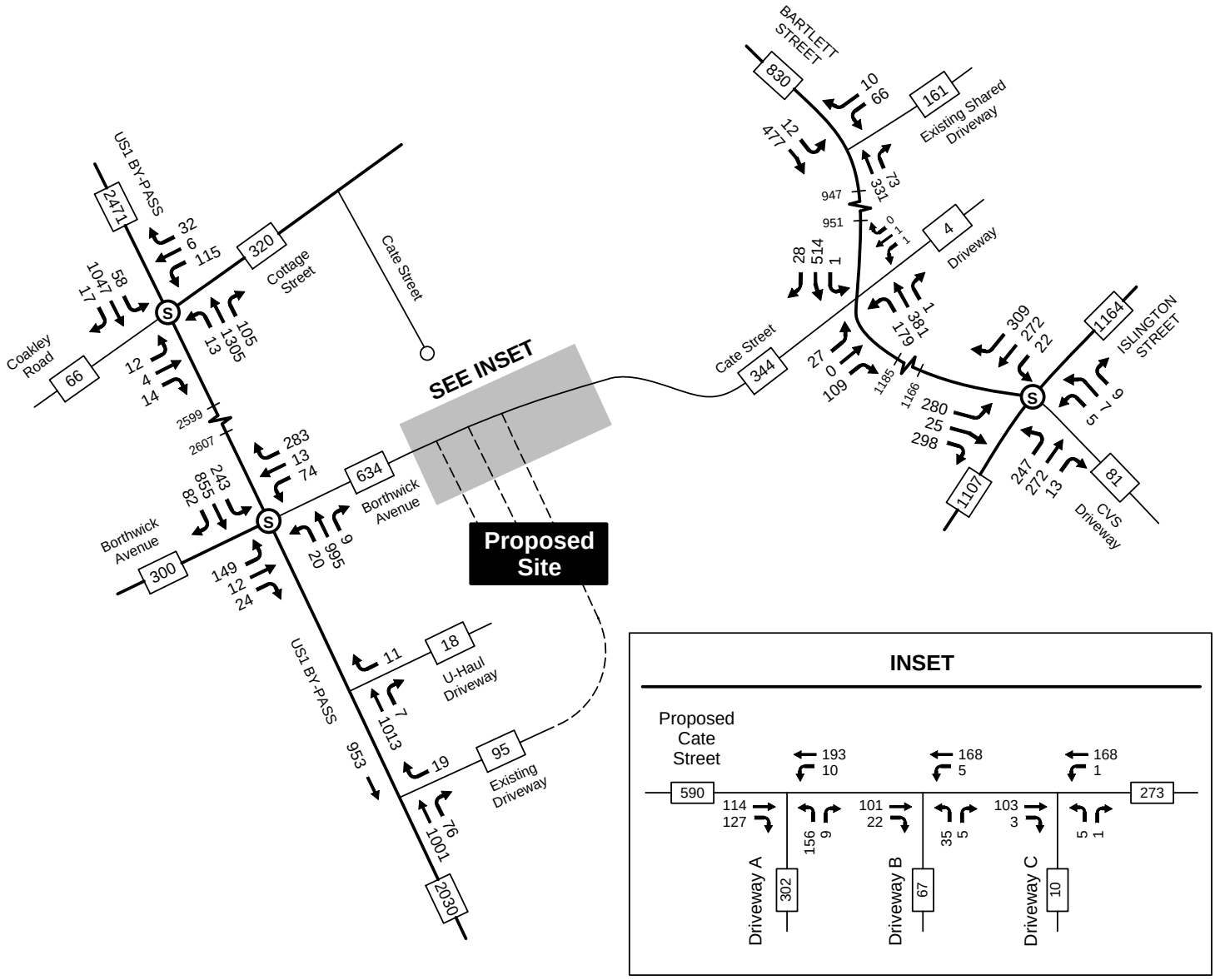
Figure 8

2020 Build Traffic Volumes - PM Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire



NORTH

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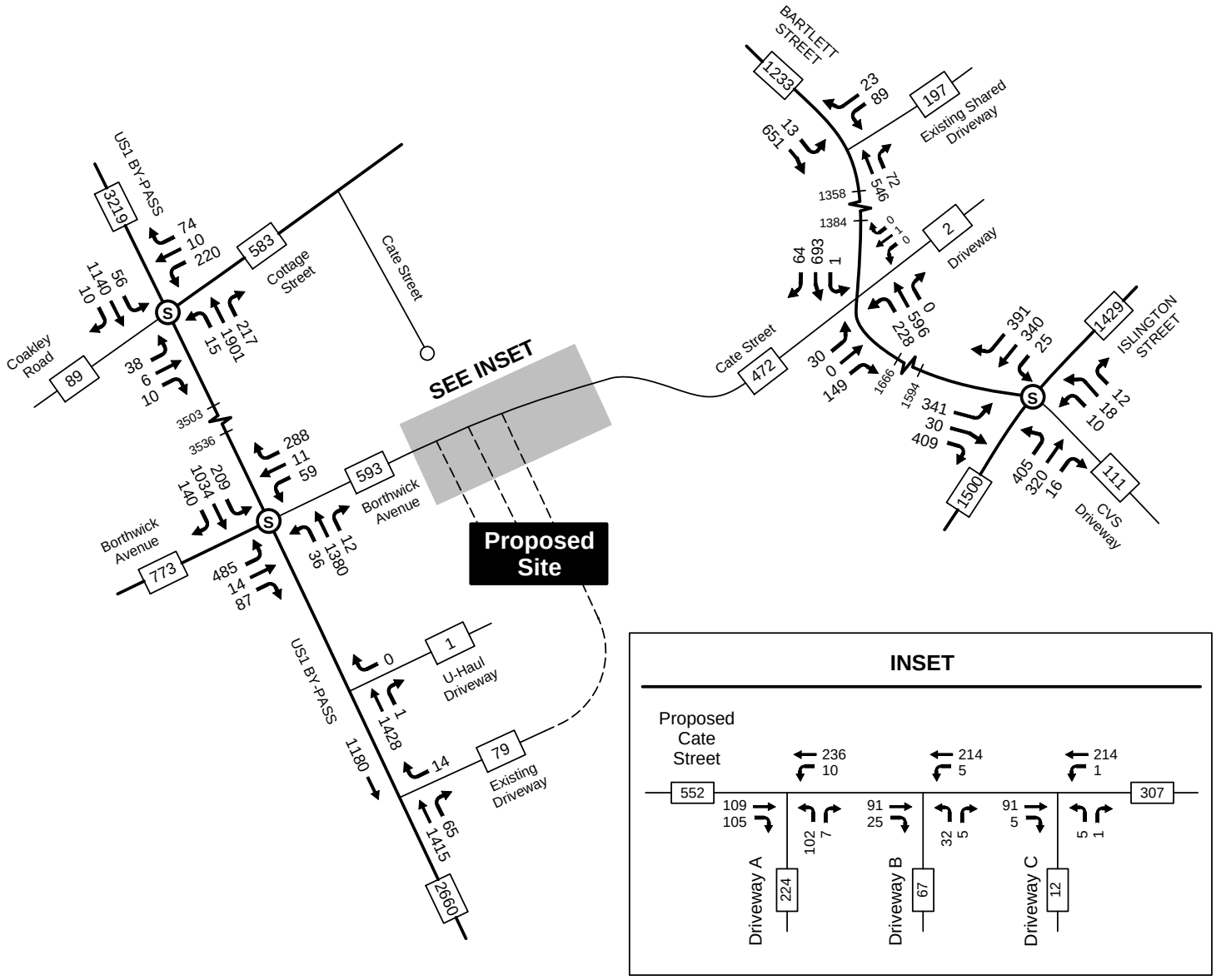
Figure 9

2020 Build Traffic Volumes - Saturday Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire



NORTH

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Figure 10

2030 Build Traffic Volumes - PM Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire

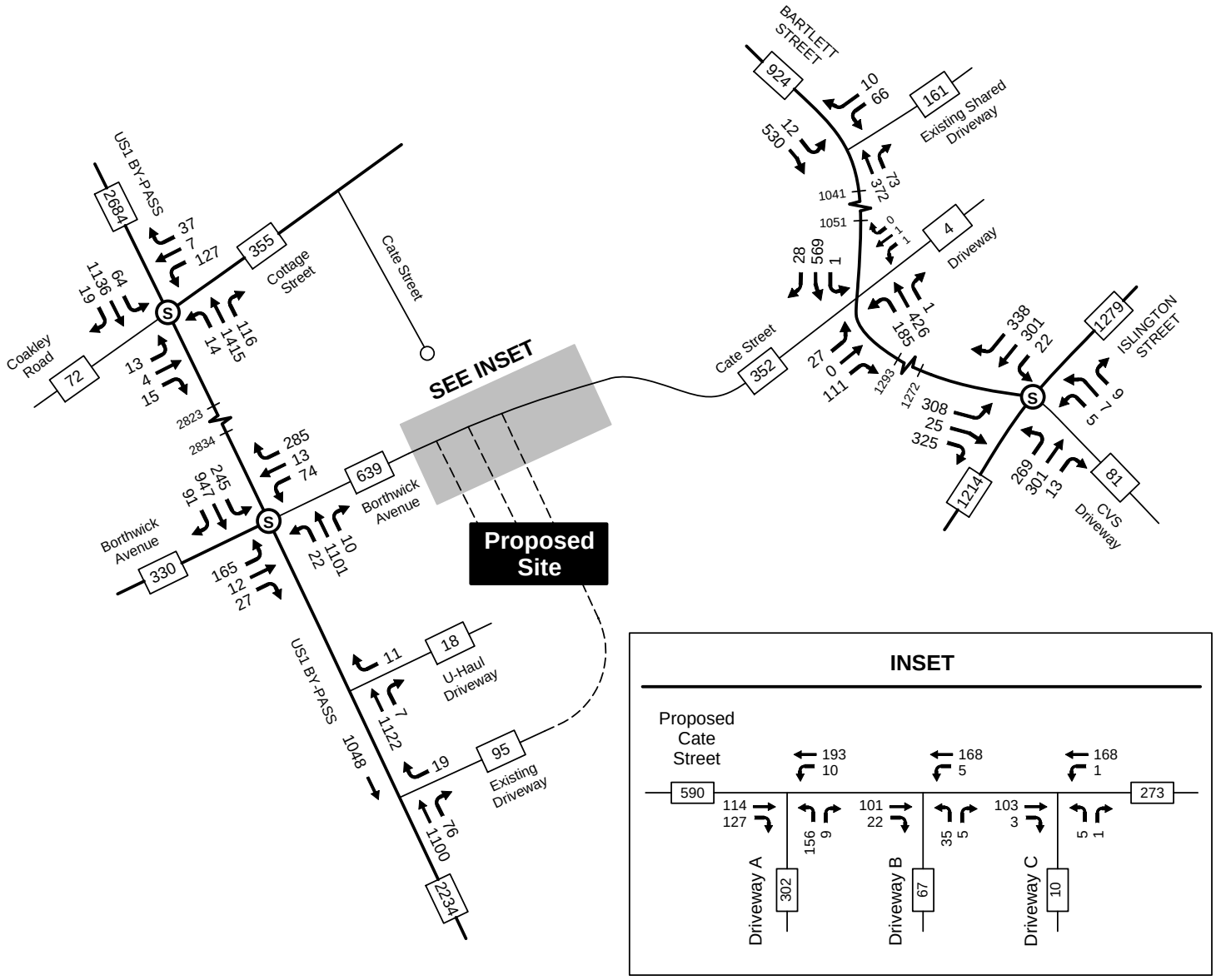

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Figure 11

2030 Build Traffic Volumes - Saturday Peak Hour

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire

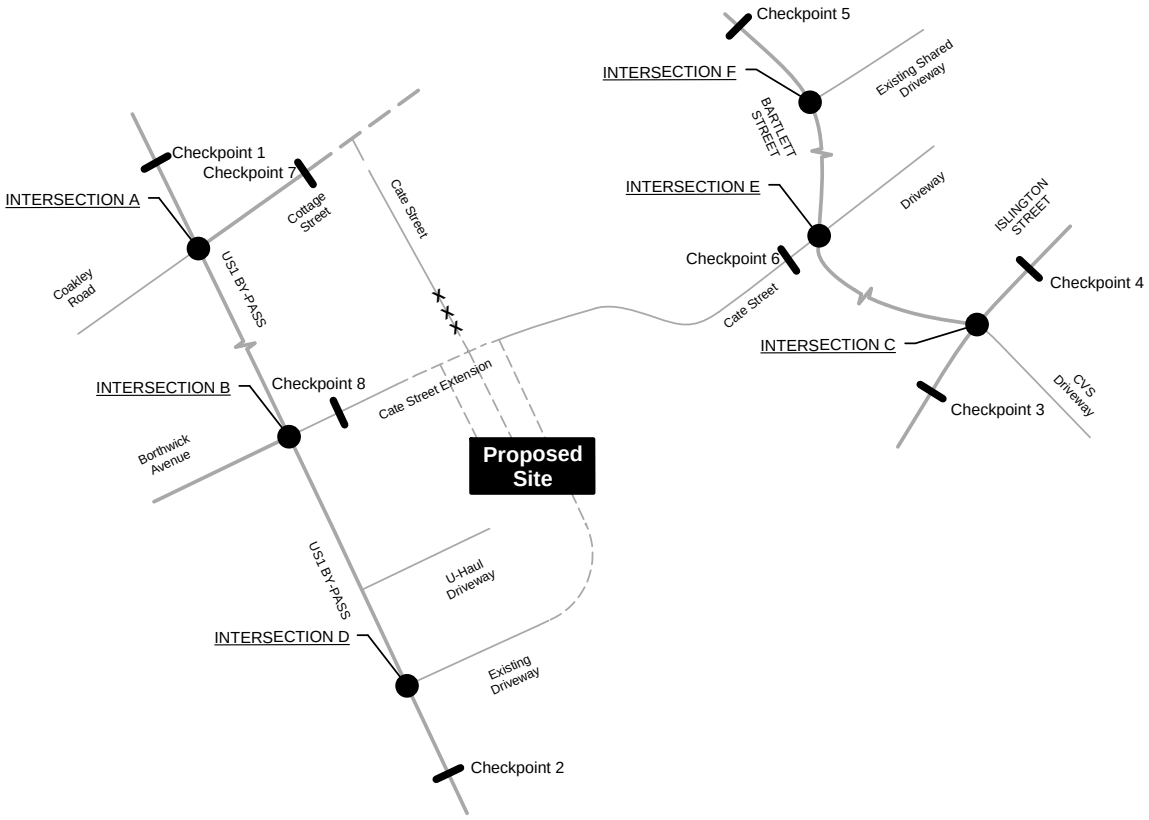
IMPACT SUMMARY

The net impact that the proposed residential/commercial development will have on area roadway and intersection traffic volumes within the study area can be determined by comparing the No-Build traffic projections with the Build projections. A comparison for the two 2020 peak hour cases is summarized on Figure 12.

In terms of roadway segments, the greatest net increase in roadway volumes will occur on US1 Bypass, north of the Cottage Street/Coakley Road intersection during the PM peak hour period. The traffic volume on this roadway segment is projected to increase by +14% (+373 vehicles) during the PM peak hour period and by +19% (+395 vehicles) during the Saturday midday peak hour. The net impact on US1 Bypass south of the site is projected at +4% (PM) and +5% (SAT). Similarly, the impacts on Islington Street are on the order of +2%.

Net traffic decreases are expected on Bartlett Street north of the existing Shared Driveway intersection due to the anticipated traffic diversion as a result of the Cate Street Extension project. Corresponding traffic increases are expected on Cate Street west of Bartlett Street for the same reasons. Obviously, the traffic volume on the section of Cate Street between Cottage Street and the future pedestrian bridge will be limited to those with destinations on this short roadway section.

In terms of intersection utilization (total vehicles entering), the US1 Bypass/Borthwick Avenue/Cate Street Extension intersection is expected to accommodate +437 (PM) and +540 (SAT) additional vehicles during the peak hour periods. This translates into increases of approximately +16% and +24% respectively. Similarly, the US1 Bypass/Cottage Street/Coakley Road intersection is expected to undergo increases of +12% (PM) and +17% (SAT) as a result of the combined impact of site traffic and the new roadway connection to the Bypass. The impacts at the Islington Street/Bartlett Street intersection will be on the order of +1-2% during the peak hour periods.



PM Peak Hour

Location	2020 No-Build	2020 Build	Change	% Change
Intersection A	3026	3391	+365 veh	12%
Intersection B	2811	3248	+437 veh	16%
Intersection C	2097	2123	+26 veh	1%
Intersection D	2335	2432	+97 veh	4%
Intersection E	1520	1623	+103 veh	7%
Intersection F	1403	1277	-126 veh	-9%
Checkpoint 1	2585	2958	+373 veh	14%
Checkpoint 2	2333	2418	+85 veh	4%
Checkpoint 3	1365	1370	+5 veh	0%
Checkpoint 4	1280	1301	+21 veh	2%
Checkpoint 5	1316	1116	-200 veh	-15%
Checkpoint 6	224	456	232 veh	104%
Checkpoint 7	606	526	-80 veh	-13%
Checkpoint 8	37	589	552 veh	-

Saturday Peak Hour

Location	2020 No-Build	2020 Build	Change	% Change
Intersection A	2337	2728	+391 veh	17%
Intersection B	2219	2759	+540 veh	24%
Intersection C	1732	1759	+27 veh	2%
Intersection D	1939	2049	+110 veh	6%
Intersection E	1165	1242	+77 veh	7%
Intersection F	1110	969	-141 veh	-13%
Checkpoint 1	2076	2471	+395 veh	19%
Checkpoint 2	1937	2030	+93 veh	5%
Checkpoint 3	1101	1107	+6 veh	1%
Checkpoint 4	1143	1164	+21 veh	2%
Checkpoint 5	1017	830	-187 veh	-18%
Checkpoint 6	122	344	222 veh	182%
Checkpoint 7	379	320	-59 veh	-16%
Checkpoint 8	44	634	590 veh	-

NORTH

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Figure 12

2020 Impact Summary

Traffic Impact and Site Access Study, Proposed Mixed-Use Site, Portsmouth, New Hampshire

TRAFFIC OPERATIONS AND SAFETY

INTERSECTION CAPACITY – SIGNALIZED INTERSECTIONS

The three signalized intersections in the study area were analyzed utilizing the methods of the *Highway Capacity Manual 2010*[2], 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 2 — 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

Table 3 summarizes the results of the analysis for the **US1 Bypass/Cottage Street/Coakley Road** intersection and it shows that the overall intersection will operate at capacity (v/c = 1.00) and at LOS C during the 2020 PM peak hour with the proposed development fully occupied. Some individual lane groups within the intersection will operate slightly over capacity during this period. By 2030 this intersection will be capacity deficient during the PM peak hour both with (v/c = 1.10) and without (v/c = 1.01) the proposed development. This is an indicator that additional lane capacity is desirable from a long-range standpoint. With the current lane configuration the overall intersection will operate at LOS E during the 2030 PM peak hour (build case). During the 2030 Saturday midday peak hour, this intersection is expected to operate well below capacity (v/c = 0.81) and at LOS B, both with and without the proposed development.

The vehicle queuing analysis shows that minimal storage is needed in the northbound left-turn lane on US1 Bypass (for turns to Coakley Road) during both peak hour periods. Shortening the length of this turn lane will provide more storage for the southbound left-turn movement (to Cate Street Extension) at the signalized intersection to the south.

As requested by the NHDOT, the utilization of each of the two northbound through lanes was monitored during both peak hour periods. As a result of upstream conditions on the Bypass, more drivers favor the left rather than the right through lane. The capacity analyses summarized on Table 3 are based on Lane Utilization Factors of 0.88 (PM) and 0.75 (SAT). This phenomenon affects intersection capacity in a negative way.

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

Table 3

Signal-Controlled Intersection Capacity Analysis Summary
US Route 1 By-Pass / Cottage Street / Coakley Road

	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 PM Peak Hour																				
Coakley Road - EB LT&TH& RT	0.20	37.3	D	1 (2)	0.26	38.4	D	1 (3)	0.35	42.6	D	1 (3)	0.34	39.4	D	2 (3)	0.49	45.7	D	2 (3)
Cottage Street - WB LT&TH	0.83	59.9	E	7 (9)	0.93	79.1	E	9 (11)	1.04	114.8	F	9 (12)	1.03	104.8	F	10 (13)	1.17	156.4	F	11 (14)
Cottage Street - WB RT	0.14	38.1	D	1 (2)	0.29	40.0	D	2 (4)	0.06	40.5	D	0 (1)	0.33	40.2	D	2 (4)	0.10	40.9	D	0 (2)
US1 Bypass - NB LT	0.23	65.3	E	0 (1)	0.27	61.1	E	0 (1)	0.27	51.6	D	0 (1)	0.28	58.1	E	0 (1)	0.28	51.2	D	1 (1)
US1 Bypass - NB 2TH&RT	0.83	18.9	B	13 (27)	0.93	29.0	C	24 (39)	1.03	35.8	D	42 (47)	1.03	46.5	D	40 (45)	1.12	70.2	E	48 (49)
US1 Bypass - SB LT	0.45	60.2	E	1 (2)	0.71	79.3	E	2 (4)	0.59	65.3	E	2 (3)	0.76	86.0	F	2 (5)	0.63	69.6	E	2 (4)
US1 Bypass - SB 2TH&RT	0.36	10.9	B	5 (8)	0.39	11.1	B	5 (9)	0.45	10.2	B	6 (10)	0.44	11.8	B	6 (10)	0.49	10.7	B	7 (11)
Overall	**0.81**	**22.1**	**C**		**0.92**	**30.3**	**C**		**1.00**	**34.9**	**C**		**1.01**	**42.5**	**D**		**1.10**	**58.4**	**E**	
Cycle Length	**120.0**				**120.0**				**120.0**				**120.0**				**120.0**			
Saturday Peak Hour																				
Coakley Road - EB LT&TH& RT	0.10	40.1	D	1 (1)	0.11	39.9	D	1 (1)	0.12	41.3	D	1 (1)	0.12	39.6	D	1 (1)	0.13	40.6	D	1 (1)
Cottage Street - WB LT&TH	0.58	46.6	D	3 (5)	0.64	49.6	D	4 (6)	0.68	53.6	D	4 (6)	0.70	52.4	D	4 (7)	0.72	55.8	E	4 (7)
Cottage Street - WB RT	0.03	41.2	D	0 (0)	0.05	41.1	D	0 (1)	0.02	42.2	D	0 (0)	0.05	40.8	D	0 (2)	0.03	41.5	D	0 (0)
US1 Bypass - NB LT	0.17	72.3	E	0 (1)	0.19	66.2	E	0 (1)	0.22	57.8	E	0 (1)	0.23	67.4	E	0 (1)	0.23	55.3	E	0 (1)
US1 Bypass - NB 2TH&RT	0.61	9.4	A	12 (18)	0.69	11.0	B	15 (4)	0.79	9.0	A	5 (6)	0.75	13.5	B	18 (6)	0.86	10.7	B	5 (8)
US1 Bypass - SB LT	0.37	49.4	D	1 (3)	0.50	50.0	D	2 (4)	0.52	53.6	D	2 (4)	0.61	56.4	E	2 (5)	0.64	62.7	E	2 (5)
US1 Bypass - SB 2TH&RT	0.34	7.2	A	3 (8)	0.38	7.5	A	4 (8)	0.46	7.4	A	5 (9)	0.42	7.9	A	5 (9)	0.50	8.2	A	6 (11)
Overall	**0.58**	**13.4**	**B**		**0.66**	**14.9**	**B**		**0.75**	**12.6**	**B**		**0.73**	**16.6**	**B**		**0.81**	**14.1**	**B**	
Cycle Length	**110.0**				**110.0**				**110.0**				**110.0**				**110.0**			

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

Table 4 summarizes the results of the analysis for the **US1 Bypass/Borthwick Avenue/Cate Street Extension** intersection and it shows that the overall intersection will operate below capacity (v/c = 0.92) and at LOS D during the 2020 PM peak hour period with the proposed development in full operation. By 2030 the overall intersection will operate at capacity (v/c = 1.00) during the PM peak hour and at LOS E. This is an indicator that additional lane capacity is desirable from a long-range standpoint. During the 2030 Saturday midday peak hour, this intersection will operate below capacity (v/c = 0.85) and at LOS D with the proposed development and the current lane configuration.

The vehicle queuing analysis shows that additional storage is needed in the southbound left-turn lane on US1 Bypass (for turns to Cate Street Extension) during both peak hour periods. Lengthening this turn lane is possible by shortening the storage for the northbound left-turn movement (to Coakley Road) at the signalized intersection to the north.

Table 5 summarizes the results of the analysis for the **Islington Street/Bartlett Street/Pharmacy Driveway** intersection and it shows that the overall intersection will operate slightly above capacity (v/c = 1.03) and at LOS D during the 2020 PM peak hour period with the proposed development in full operation. By 2030 this intersection will be capacity deficient during the PM peak hour both with (v/c = 1.12) and without (v/c = 1.11) the proposed development. Although this is an indicator that additional lane capacity is desirable, the City's current plans to reconstruct this intersection and upgrade the traffic signal system do not include additional travel lanes. Right-of-way availability appears to be a constraint. Increasing the traffic signal cycle length has the potential to increase intersection capacity; however longer vehicle queues usually result.

During the 2030 Saturday midday peak hour, this intersection will operate below capacity (v/c = 0.89) and at LOS C with the proposed development and the current lane configuration.

The calculations pertaining to the signalized intersection capacity analyses are included in Appendix I.

Stephen G. Pernaw & Company, Inc.

Table 4

Signal-Controlled Intersection Capacity Analysis Summary
US Route 1 By-Pass / Borthwick Avenue / Cate Street Extension

	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 PM Peak Hour																				
Borthwick Avenue - EB LT	0.68	50.4	D	7 (9)	0.73	50.5	D	8 (11)	0.90	75.0	E	9 (13)	0.77	52.2	D	9 (12)	0.96	88.0	F	10 (15)
Borthwick Avenue - EB LT&TH	0.68	50.4	D	7 (9)	0.73	50.5	D	8 (11)	0.88	71.8	E	9 (13)	0.77	52.2	D	9 (12)	0.97	90.4	F	10 (15)
Borthwick Avenue - EB RT	0.05	40.8	D	0 (0)	0.06	38.7	D	0 (0)	0.06	42.3	D	0 (0)	0.07	37.9	D	0 (1)	0.07	42.2	D	0 (0)
Cate Street Extension - WB LT	0.11	56.8	E	0 (1)	0.12	56.9	E	0 (1)	0.25	46.4	D	2 (4)	0.12	55.8	E	0 (1)	0.28	47.4	D	2 (4)
Cate Street Extension - WB TH&RT	0.01	55.8	E	0 (0)	0.01	55.8	E	0 (0)	0.91	85.6	F	6 (13)	0.01	55.0	D	0 (0)	1.04	122.8	F	7 (15)
US1 Bypass - NB LT	0.33	57.1	E	1 (2)	0.38	57.4	E	1 (2)	0.47	60.8	E	1 (2)	0.47	60.0	E	1 (3)	0.51	61.7	E	1 (3)
US1 Bypass - NB 2TH&RT	0.56	14.9	B	7 (17)	0.63	17.8	B	9 (20)	0.92	45.6	D	20 (26)	0.73	22.0	C	16 (24)	0.99	54.9	D	23 (30)
US1 Bypass - SB LT	0.23	63.7	E	0 (1)	0.26	73.7	E	0 (1)	0.88	72.8	E	6 (11)	0.22	71.6	E	0 (1)	0.94	86.2	F	6 (11)
US1 Bypass - SB 2TH&RT	0.50	10.9	B	6 (10)	0.57	14.6	B	8 (7)	0.62	20.9	C	9 (17)	0.65	19.0	B	15 (20)	0.68	21.9	C	13 (19)
Overall	**0.57**	**20.8**	**C**		**0.65**	**23.8**	**C**		**0.92**	**47.6**	**D**		**0.72**	**27.4**	**C**		**1.00**	**56.9**	**E**	
Cycle Length	**120.0**				**120.0**				**120.0**				**120.0**				**120.0**			
Saturday Peak Hour																				
Borthwick Avenue - EB LT	0.49	46.1	D	3 (4)	0.51	45.7	D	3 (4)	0.67	55.7	E	4 (4)	0.54	46.0	D	4 (4)	0.74	61.8	E	4 (5)
Borthwick Avenue - EB LT&TH	0.49	46.1	D	3 (4)	0.51	45.7	D	3 (4)	0.70	58.6	E	4 (4)	0.54	45.8	D	4 (4)	0.79	68.3	E	4 (5)
Borthwick Avenue - EB RT	0.02	43.5	D	0 (0)	0.02	42.6	D	0 (0)	0.02	45.4	D	0 (0)	0.03	42.0	D	0 (0)	0.03	45.6	D	0 (0)
Cate Street Extension - WB LT	0.03	49.3	D	0 (0)	0.03	49.3	D	0 (0)	0.34	40.5	D	3 (3)	0.03	49.7	D	0 (0)	0.34	40.3	D	3 (4)
Cate Street Extension - WB TH&RT	0.05	49.4	D	0 (1)	0.05	49.4	D	0 (1)	0.82	60.7	E	5 (5)	0.05	49.8	D	0 (1)	0.86	65.1	E	6 (6)
US1 Bypass - NB LT	0.24	52.0	D	1 (1)	0.27	52.2	D	1 (2)	0.34	55.1	E	1 (2)	0.32	53.6	D	1 (2)	0.38	55.7	E	1 (2)
US1 Bypass - NB 2TH&RT	0.43	11.3	B	5 (12)	0.48	12.4	B	6 (14)	0.75	33.0	C	14 (17)	0.53	13.0	B	7 (15)	0.83	36.0	D	16 (19)
US1 Bypass - SB LT	0.19	55.0	E	0 (1)	0.20	59.6	E	0 (1)	0.83	64.0	E	6 (13)	0.25	60.0	E	0 (1)	0.85	68.9	E	6 (13)
US1 Bypass - SB 2TH&RT	0.43	8.3	A	5 (7)	0.49	9.5	A	4 (6)	0.54	13.9	B	5 (7)	0.54	9.7	A	6 (6)	0.60	14.3	B	6 (7)
Overall	**0.41**	**15.0**	**B**		**0.46**	**16.0**	**B**		**0.79**	**35.7**	**D**		**0.51**	**16.4**	**B**		**0.85**	**37.8**	**D**	
Cycle Length	**110.0**				**110.0**				**110.0**				**110.0**				**110.0**			

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

Stephen G. Pernaw & Company, Inc.

Table 5

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 PM Peak Hour																				
Bartlett Street - EB LT&TH	0.76	28.8	C	4 (9)	1.08	99.1	F	7 (12)	1.12	110.5	F	7 (13)	1.19	136.7	F	8 (14)	1.22	149.9	F	8 (14)
Bartlett Street - EB RT	0.20	18.6	B	0 (2)	0.43	23.4	C	1 (4)	0.45	23.7	C	1 (5)	0.54	24.8	C	2 (7)	0.56	25.4	C	2 (7)
Pharmacy Dwy - WB LT&TH&RT	0.08	16.4	B	0 (1)	0.11	19.6	B	0 (1)	0.11	19.6	B	0 (1)	0.12	19.7	B	0 (1)	0.13	19.7	B	0 (1)
Islington Street - NB LT	0.76	30.3	C	5 (9)	1.00	69.0	E	7 (13)	0.95	54.6	D	7 (13)	1.09	94.5	F	9 (14)	1.10	97.6	F	9 (14)
Islington Street - NB TH&RT	0.29	7.2	A	2 (4)	0.30	5.5	A	2 (3)	0.30	5.5	A	2 (3)	0.33	5.7	A	2 (4)	0.33	5.7	A	2 (4)
Islington Street - SB LT&TH	0.70	25.7	C	5 (8)	0.65	21.3	C	5 (8)	0.68	23.0	C	5 (8)	0.72	23.3	C	6 (9)	0.72	23.3	C	6 (9)
Islington Street - SB RT	0.21	20.1	C	0 (2)	0.25	17.6	B	0 (2)	0.26	18.4	B	0 (2)	0.28	17.8	B	0 (2)	0.28	17.9	B	0 (2)
Overall	**0.85**	**21.7**	**C**		**1.01**	**38.8**	**D**		**1.03**	**38.6**	**D**		**1.11**	**49.5**	**D**		**1.12**	**52.5**	**D**	
Cycle Length	**90.0**				**90.0**				**90.0**				**90.0**				**90.0**			
Saturday Peak Hour																				
Bartlett Street - EB LT&TH	0.62	18.0	B	3 (6)	0.73	25.9	C	5 (9)	0.73	25.4	C	5 (9)	0.81	31.7	C	5 (11)	0.84	34.0	C	5 (11)
Bartlett Street - EB RT	0.16	14.4	B	0 (2)	0.23	17.9	B	0 (2)	0.24	17.6	B	0 (2)	0.30	18.7	B	1 (3)	0.31	18.8	B	1 (3)
Pharmacy Dwy - WB LT&TH&RT	0.04	12.4	B	0 (1)	0.04	15.2	B	0 (1)	0.04	14.9	B	0 (1)	0.04	15.6	B	0 (1)	0.04	15.6	B	0 (1)
Islington Street - NB LT	0.65	25.6	C	2 (6)	0.73	31.8	C	4 (8)	0.75	33.4	C	4 (8)	0.81	37.8	D	4 (9)	0.81	38.7	D	5 (9)
Islington Street - NB TH&RT	0.28	7.2	A	2 (3)	0.30	7.9	A	2 (4)	0.30	8.3	A	2 (4)	0.32	8.0	A	3 (4)	0.32	8.0	A	3 (4)
Islington Street - SB LT&TH	0.59	18.3	B	3 (6)	0.64	22.4	C	5 (7)	0.65	23.6	C	5 (8)	0.68	23.7	C	5 (8)	0.68	23.7	C	5 (8)
Islington Street - SB RT	0.18	16.3	B	0 (2)	0.22	19.0	B	0 (2)	0.22	19.6	B	0 (2)	0.24	18.9	B	0 (2)	0.25	19.0	B	0 (2)
Overall	**0.74**	**16.2**	**B**		**0.80**	**20.5**	**C**		**0.81**	**21.0**	**C**		**0.87**	**22.6**	**C**		**0.89**	**23.2**	**C**	
Cycle Length	**80.0**				**90.0**				**90.0**				**90.0**				**90.0**			

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

TRAFFIC MITIGATION POSSIBILITES

The previous capacity analyses have demonstrated that there is a long-range need to increase intersection capacity at the three signalized intersections in the study area to accommodate the anticipated 2030 PM peak hour traffic volumes. Based on an evaluation of several alternatives, it is recommended the following mitigation measures be considered:

A. US1 Bypass/Cottage Street/Coakley Road

a. Add exclusive right-turn lane on the US1 Bypass northbound approach to the signal.
b. Change existing shared through-right lane to an exclusive through lane.
c. Shorten northbound left-turn lane to 50-feet.

B. US1 Bypass/Borthwick Avenue/Cate Street Extension

a. Delineate the westbound approach with a shared left-through-right lane, and an exclusive right-turn lane.
b. Lengthen southbound left-turn lane
c. Increase traffic signal cycle length to 120-seconds.

C. Islington Street/Bartlett Street/Pharmacy Driveway

a. Increase traffic signal cycle length to 120-seconds.

Table 6 summarizes the results of the mitigation analyses for the 2030 Weekday PM peak hour case. The mitigation measures cited above have the potential to lower the overall intersection v/c ratio at the US1 Bypass/Cottage Street/Coakley Road intersection from v/c = 1.10 (existing lanes) to v/c = 1.01 (with additional lane). Similarly, the US1 Bypass/Borthwick Avenue/Cate Street Extension intersection changes from v/c = 1.00 (existing lanes) to v/c = 0.95 (with additional lane). Increasing the traffic signal cycle length at the Islington Street/Bartlett Street/Pharmacy Driveway will lower the v/c ratio from v/c = 1.12 (90-second cycle) to v/c = 0.98 (120-second cycle).

The calculations pertaining to the mitigation analyses are also included in Appendix I.

Table 6

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

	2030 No-Build				2030 Build				2030 Build w/Mitigation			
	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]
US1 Bypass/Cottage St/Coakley Rd												
Coakley Road - EB LT&TH& RT	0.34	39.4	D	2 (3)	0.49	45.7	D	2 (3)	0.39	41.9	D	2 (3)
Cottage Street - WB LT&TH	1.03	104.8	F	10 (13)	1.17	156.4	F	11 (14)	1.07	122.0	F	10 (13)
Cottage Street - WB RT	0.33	40.2	D	2 (4)	0.10	40.9	D	0 (2)	0.10	39.3	D	0 (2)
US1 Bypass - NB LT	0.28	58.1	E	0 (1)	0.28	51.2	D	1 (1)	0.28	52.1	D	0 (1)
US1 Bypass - NB 2TH&RT	1.03	46.5	D	40 (45)	1.12	70.2	E	48 (49)	-	-	-	-
US1 Bypass - NB 2TH	-	-	-	-	-	-	-	-	1.02	30.5	C	40 (45)
US1 Bypass - NB RT	-	-	-	-	-	-	-	-	0.24	7.7	A	2 (3)
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	10.7	B	7 (11)	0.51	11.7	B	7 (12)
Overall	**1.01**	**42.5**	**D**		**1.10**	**58.4**	**E**		**1.01**	**31.6**	**C**	
Cycle Length	**120.0**				**120.0**				**120.0**			
US1 Bypass/Borthwick Ave/Cate St Extension												
Borthwick Avenue - EB LT	0.77	52.2	D	9 (12)	0.96	88.0	F	10 (15)	0.92	76.9	E	10 (15)
Borthwick Avenue - EB LT&TH	0.77	52.2	D	9 (12)	0.97	90.4	F	10 (15)	0.93	78.8	E	10 (15)
Borthwick Avenue - EB RT	0.07	37.9	D	0 (1)	0.07	42.2	D	0 (0)	0.07	41.4	D	0 (0)
Cate Street Extension - WB LT	0.12	55.8	E	0 (1)	0.28	47.4	D	2 (4)	-	-	-	-
Cate Street Extension - WB TH&RT	0.01	55.0	D	0 (0)	1.04	122.8	F	7 (15)	-	-	-	-
Cate Street Extension - WB TH	-	-	-	-	-	-	-	-	0.95	110.0	F	5 (12)
Cate Street Extension - WB RT	-	-	-	-	-	-	-	-	0.16	51.5	D	0 (3)
US1 Bypass - NB LT	0.47	60.0	E	1 (3)	0.51	61.7	E	1 (3)	0.51	61.7	E	1 (3)
US1 Bypass - NB 2TH&RT	0.73	22.0	C	16 (24)	0.99	54.9	D	23 (30)	0.93	43.6	D	22 (28)
US1 Bypass - SB LT	0.22	71.6	E	0 (1)	0.94	86.2	F	6 (11)	0.94	88.1	F	6 (11)
US1 Bypass - SB 2TH&RT	0.65	19.0	B	15 (20)	0.68	21.9	C	13 (19)	0.65	18.8	B	11 (18)
Overall	**0.72**	**27.4**	**C**		**1.00**	**56.9**	**E**		**0.97**	**47.4**	**D**	
Cycle Length	**110.0**				**110.0**				**120.0**			
Islington St/Bartlett St/Pharmacy Driveway												
Bartlett Street - EB LT&TH	1.19	136.7	F	8 (14)	1.22	149.9	F	8 (14)	0.98	72.2	E	10 (17)
Bartlett Street - EB RT	0.54	24.8	C	2 (7)	0.56	25.4	C	2 (7)	0.59	32.4	C	4 (9)
Pharmacy Dwy - WB LT&TH&RT	0.12	19.7	B	0 (1)	0.13	19.7	B	0 (1)	0.09	24.8	C	1 (2)
Islington Street - NB LT	1.09	94.5	F	9 (14)	1.10	97.6	F	9 (14)	0.98	71.3	E	11 (18)
Islington Street - NB TH&RT	0.33	5.7	A	2 (4)	0.33	5.7	A	2 (4)	0.34	8.7	A	4 (6)
Islington Street - SB LT&TH	0.72	23.3	C	6 (9)	0.72	23.3	C	6 (9)	0.76	36.0	D	9 (13)
Islington Street - SB RT	0.28	17.8	B	0 (2)	0.28	17.9	B	0 (2)	0.28	26.6	C	0 (2)
Overall	**1.11**	**49.5**	**D**		**1.12**	**52.5**	**D**		**0.98**	**41.3**	**D**	
Cycle Length	**90.0**				**90.0**				**120.0**			

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

INTERSECTION CAPACITY – UNSIGNALIZED INTERSECTIONS

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 or driveways. The availability of adequate gaps in the traffic stream on the major street actually controls the potential capacity for vehicle movements to and from the minor approaches. Levels of Service are simply letter grades (A-F), which categorize the vehicle delays associated with specific turning maneuvers. Table 7 describes the criteria used in this analysis. Calculations pertaining to these analyses are included in Appendix J.

Table 7 — 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.

The three unsignalized study area intersections were analyzed according to the methodologies of the *Highway Capacity Manual*[3] as replicated by the latest edition of the *Synchro Traffic Signal Timing Software (Version 10)*, which also performs unsignalized intersection capacity analyses.

Table 8 summarizes the result for the **US1 Bypass/Existing Site Driveway** intersection. At this intersection, the only applicable traffic movement (with a conflicting traffic stream) is the right-turn departure movement from the site. The analyses demonstrate that this movement will operate well below capacity (v/c = 0.05) and at LOS C or higher through 2030 with the site in full operation. The calculations pertaining to these analyses are found in Appendix J.

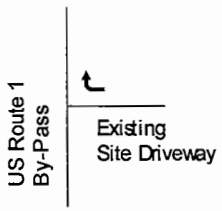
[3] Transportation Research Board, *Highway Capacity Manual* (Washington, D.C., 2010).

Table 8

STOP-Controlled Intersection Capacity Analysis
US Route 1 By-Pass / Existing Site Driveway

	Weekday PM Peak Hour				Saturday Peak Hour			
	Delay [1]	V/C [2]	LOS [3]	Queue [4]	Delay [1]	V/C [2]	LOS [3]	Queue [4]
Existing Site Driveway - WB Right Turns								
2018 Existing	13.1	0.01	B	<1	11.8	0.00	B	<1
2020 No Build	13.9	0.01	B	<1	12.4	0.01	B	<1
2020 Build	14.6	0.04	B	<1	13.0	0.05	B	<1
2030 No Build	14.9	0.01	B	<1	13.0	0.01	B	<1
2030 Build	15.7	0.04	C	<1	13.7	0.05	B	<1

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



It should be noted that this methodology is not capable of accounting for the vehicle queues that were temporarily 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.

The results of the analysis for the **Bartlett Street/Cate Street** intersection are summarized on Table 9A, and demonstrate that the departure movements from the Cate Street approach will operate well over capacity during the 2030 PM peak hour period as a result of site traffic (and diverted traffic). Departures from this approach will change from LOS D to LOS F during this period, and long vehicle queues on the minor approach will form. These findings are an indicator that physical improvements to this intersection are needed in order to accommodate site traffic.

Three mitigation alternatives were evaluated for this intersection. Table 9B schematically shows the layout of each alternative, as well as an evaluation of traffic operations during the 2030 PM peak hour period.

A. Alternative Configuration A - Re-stripe the northbound Bartlett Street approach to provide an exclusive left-turn pocket for turns on to Cate Street.

B. Alternative Configuration B - Re-align the Cate Street and Bartlett Street northbound approach to create a "through street" with stop sign control on the Bartlett Street southbound approach.

C. Alternative Configuration C – Same as Configuration B with additional right-turn slip ramp.

Table 9A

STOP-Controlled Intersection Capacity Analysis
Bartlett Street / Cate Street / Parking Lot Driveway

	Weekday PM Peak Hour				Saturday Peak Hour			
	Delay [1]	V/C [2]	LOS [3]	Queue [4]	Delay [1]	V/C [2]	LOS [3]	Queue [4]
Bartlett Street - NB Left Turns								
2018 Existing	9.2	0.10	A	<1	8.6	0.05	A	<1
2020 No Build	10.0	0.17	B	1	9.1	0.09	A	<1
2020 Build	11.0	0.31	B	1	9.5	0.20	A	1
2030 No Build	10.5	0.19	B	1	9.3	0.10	A	<1
2030 Build	11.7	0.34	B	2	9.9	0.22	A	1
Cate Street - EB Left-Through-Right-Turns								
2018 Existing	16.1	0.19	C	1	12.5	0.06	B	<1
2020 No Build	21.9	0.36	C	2	14.0	0.12	B	<1
2020 Build	>300.0	1.67	F	17	42.9	0.68	E	5
2030 No Build	26.9	0.44	D	2	15.0	0.14	C	1
2030 Build	>300.0	2.38	F	21	66.2	0.81	F	6
Parking Lot Drivew ay - WB Left-Through-Right-Turns								
2018 Existing	37.8	0.01	E	<1	24.7	0.02	C	<1
2020 No Build	68.3	0.02	F	<1	36.9	0.03	E	<1
2020 Build	114.4	0.03	F	<1	56.4	0.05	F	<1
2030 No Build	95.2	0.03	F	<1	45.4	0.04	E	<1
2030 Build	169.3	0.05	F	<1	72.9	0.07	F	<1
Bartlett Street - SB Left-Turns								
2018 Existing	8.7	0.00	A	<1	8.2	0.00	A	<1
2020 No Build	9.1	0.00	A	<1	8.5	0.00	A	<1
2020 Build	8.8	0.00	A	<1	8.2	0.00	A	<1
2030 No Build	9.4	0.00	A	<1	8.6	0.00	A	<1
2030 Build	9.0	0.00	A	<1	8.3	0.00	A	<1

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

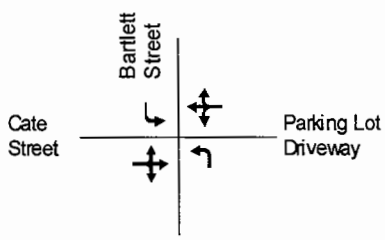


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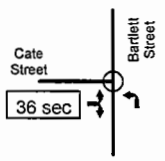
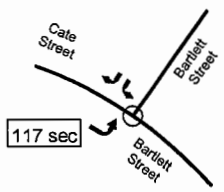
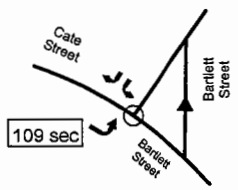
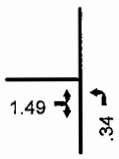
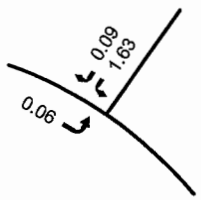
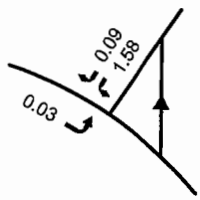
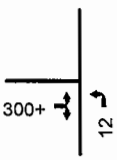
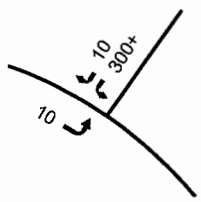
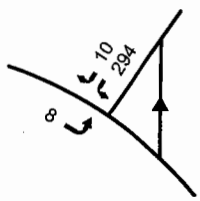
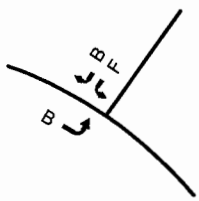
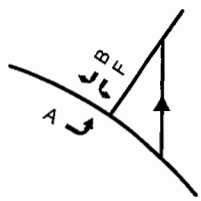
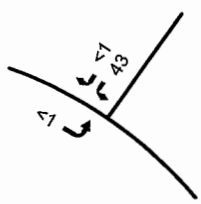
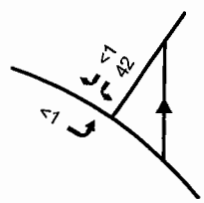
Table 9B

Alternative Mitigation Evaluation - 2030 PM Peak Hour
Bartlett Street / Cate Street

	Alternative Configuration A	Alternative Configuration B	Alternative Configuration C
1. Overall Intersection Delay (sec):			
2. Volume to Capacity Ratio:			
3. Movement Delay (sec):			
4. Level of Service:			
5. 95th Percentile Queue (veh):			

Alternative Configuration A = Add Northbound Left-Turn Lane on Bartlett Street for turns to Cate Street
Alternative Configuration B = Realign Bartlett Street Approach to Cate Street
Alternative Configuration C = Realign Bartlett Street Approach to Cate Street with "Slip Ramp"

Although there are advantages and disadvantages associated with each alternative configuration that requires city review/input, it appears that Configuration A results the least overall intersection delay. As a short-range measure, this alternative could be enhanced by providing two approach lanes on Cate Street (one shared left-through lane, one exclusive right-turn lane).

The analysis of these alternative intersection layouts are contained in Appendix K.

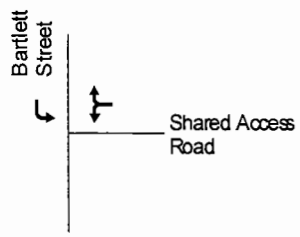
The results of the analysis for the **Bartlett Street/Existing Shared Driveway** intersection are summarized on Table 10, and demonstrate that all applicable movements will operate below capacity during the 2030 peak hour periods with the site in full operation; subject to the occasional restrictions due to vehicle queuing on Bartlett Street. Nevertheless, long delays (LOS F) and vehicle queues of up to six vehicles are expected on the minor approach during the weekday PM peak hour in 2030. 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.

Table 10

STOP-Controlled Intersection Capacity Analysis
Bartlett Street / Shared Access Road

	Weekday PM Peak Hour				Saturday Peak Hour			
	Delay [1]	V/C [2]	LOS [3]	Queue [4]	Delay [1]	V/C [2]	LOS [3]	Queue [4]
Shared Access Road - WB Left & Right-Turn Departures								
2018 Existing	22.2	0.36	C	2	17.3	0.18	C	1
2020 No-Build	44.3	0.63	E	4	24.2	0.35	C	2
2020 Build	58.1	0.71	F	5	22.3	0.32	C	1
2030 No-Build	62.3	0.74	F	5	28.3	0.39	D	2
2030 Build	91.6	0.86	F	6	26.2	0.37	D	2
Bartlett Street - SB Left-Turn Arrivals								
2018 Existing	8.8	0.03	A	<1	8.3	0.02	A	<1
2020 No-Build	9.4	0.05	A	<1	8.7	0.04	A	<1
2020 Build	9.0	0.02	A	<1	8.4	0.01	A	<1
2030 No-Build	9.7	0.05	A	<1	8.8	0.04	A	<1
2030 Build	9.2	0.02	A	<1	8.5	0.01	A	<1

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



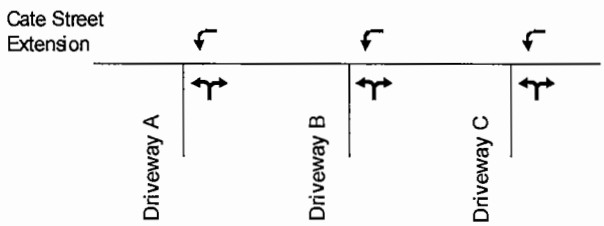
Analysis of the three **Cate Street Extension/Proposed Site Driveway** intersections are summarized on Table 11, and demonstrate that all applicable movements will operate well below capacity and at LOS B (or higher) through 2030 and beyond with the site in full operation. Vehicle queuing on the minor approaches will be minimal.

Table 11

STOP-Controlled Intersection Capacity Analysis
Cate Street Extension / Site Driveways A, B & C

	Weekday PM Peak Hour				Saturday Peak Hour			
	Delay [1]	V/C [2]	LOS [3]	Queue [4]	Delay [1]	V/C [2]	LOS [3]	Queue [4]
Cate Street Extension / Site Driveway A								
Site Driveway A - NB Left & Right-Turn Departures								
2020 Build	13.1	0.21	B	1	13.9	0.31	B	1
2030 Build	13.1	0.21	B	1	13.9	0.31	B	1
Cate Street Extension - WB Left-Turn Arrivals								
2020 Build	7.7	0.01	A	<1	7.8	0.01	A	<1
2030 Build	7.7	0.01	A	<1	7.8	0.01	A	<1
Cate Street Extension / Site Driveway B								
Site Driveway B - NB Left & Right-Turn Departures								
2020 Build	10.8	0.06	B	<1	10.5	0.06	B	<1
2030 Build	10.8	0.06	B	<1	10.5	0.06	B	<1
Cate Street Extension - WB Left-Turn Arrivals								
2020 Build	7.5	0.00	A	<1	7.5	0.00	A	<1
2030 Build	7.5	0.00	A	<1	7.5	0.00	A	<1
Cate Street Extension / Site Driveway C								
Site Driveway C - NB Left & Right-Turn Departures								
2020 Build	10.3	0.01	B	<1	10.0	0.01	B	<1
2030 Build	10.3	0.01	B	<1	10.0	0.01	B	<1
Cate Street Extension - WB Left-Turn Arrivals								
2020 Build	7.4	0.00	A	<1	7.4	0.00	A	<1
2030 Build	7.4	0.00	A	<1	7.4	0.00	A	<1

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



STUDY FINDINGS AND CONCLUSIONS

Based on the existing conditions data collected along US1 Bypass, Bartlett Street, Islington Street, Cate Street and at the six existing study area intersections, the anticipated traffic increases from the proposed residential/commercial development, the anticipated traffic diversion that will result from the extension of Cate Street to the US1 Bypass, and the analysis of future traffic operations in the study area, Pernaw & Company, Inc. concludes that:

1. The May 2018 traffic counts revealed that the Weekday PM peak hour traffic volumes are generally higher than those observed during the Saturday Midday peak hour period. During the PM peak hour (4:30 to 5:30 PM) the US1 Bypass carried over 2,200 vehicles (total both directions, north of cottage Street), Islington Street and Bartlett Street carried over 1,100 vehicles, Cottage Street (east of the Bypass) carried 500 vehicles, and Cate Street (west of Bartlett Street) carried approximately 150 vehicles. See Figure 2A.

2. The proposed residences and commercial uses are expected to generate a total of 379 vehicle-trips (215 arrivals, 164 departures) during the weekday PM peak hour period, and 471 vehicle-trips (243 arrivals, to 228 departures) during the Saturday Midday peak hour period. Approximately 22-27% of these trips will be "pass-by" trips that will turn into the site from the existing traffic stream on the Bypass. See Table 1A and 1B.

3. The realignment and extension of Cate Street to the US1 Bypass (at Borthwick Avenue) and the closure of the Cate Street bridge to through traffic (for pedestrian use only) is expected to alter local travel patterns as the new Cate Street Extension to the Bypass will become an attractive travel route for many drivers (depending upon their trip origin/destination). During the PM peak hour trip reductions of -200 vehicle-trips are expected on Bartlett Street (north of the study area) and -80 vehicle-trips on Cottage Street (east of the Bypass) as drivers utilize Cate Street Extension for easier and more convenient access to the US1 Bypass.

4. The intersection capacity and Level of Service analyses for the three signalized study area intersections indicates that long-range capacity deficiencies will occur by 2030 as a result of site traffic and diverted traffic. With implementation of the traffic mitigation measures contained herein, these intersections are capable of operating with an overall 2030 volume-capacity ratio of close to or below 1.00. (Bypass/Cottage = 1.01, Borthwick/Cate Street Extension = 0.95, and Islington/Bartlett = 0.98). See Table 6.

5. Analysis of the three existing unsignalized study area intersections revealed that peak period capacity deficiencies will occur at the Bartlett Street/Cate Street intersection in 2020 as a result of site traffic and diverted traffic (weekday PM peak hour). Three mitigation scenarios were evaluated, with varying results. Configuration A, which maintains Cate Street as the minor leg of the intersection, appears to operate more efficiently than reconfiguring Bartlett Street such that the north leg functions as the minor approach (Configuration B and C) See Table 9A and 9B.

6. Analysis of the three proposed site driveway intersections on Cate Street Extension confirm that each intersection will operate well below capacity with single approach lanes on each leg of each intersection. These intersections will operate at LOS B (or higher) through 2030 with the site fully occupied. Vehicle queuing will be minimal. See Table 11.

In conclusion, the subject site will generate significant traffic volumes during the peak hour periods (379 PM trips, 471 Saturday Midday trips) and the extension of Cate Street to US1 Bypass has the potential to divert approximately 200 vehicle-trips from several existing travel routes to the new roadway alignment. The impact of both site traffic and diverted traffic can be mitigated reasonably well by implementing mitigation measures contained herein. Both NHDOT and City approval of this traffic study as well as the selected traffic mitigation measures are a prerequisite for development of the subject site as proposed.

STAMP