

# REPORT

**TO:** Marty Spaulding, Burlington School District  
**CC:** Randy Burnett, Colin P. Lindberg Architects  
**FROM:** Mark Smith, PE  
**DATE:** April 16, 2018  
**SUBJECT:** Proposed School Site Modifications - Traffic Impact Study

---

On behalf of the Burlington School District (BSD), RSG has conducted an analysis of traffic operations and overall safety proximate to the proposed site modifications at three local schools in Burlington, Vermont:

1. Champlain Elementary
2. Edmunds Middle / Elementary
3. CP Smith Elementary

This study includes the following sections, specific to each site;

- Introduction / Existing Conditions
- Proposed Site Features
- Traffic and Safety Impact Assessment
- Summary and Conclusions

## 1.0 INTRODUCTION / EXISTING CONDITIONS

### ITEM 1: Champlain Elementary

Champlain Elementary currently has 316 students enrolled at the Pine Street location. Students arrive by Green Mt. Transit (GMT) bus, BSD bus, SSTA bus, biking and walking (for older students), or via two main vehicle drop-off locations: 1) the parking lot to the northwest, or 2) via the curb drop-off area along the eastern side of Pine Street, north or south of the bus stop (see Figure 1).

FIGURE 1. CHAMPLAIN CAMPUS - EXISTING CONDITIONS AND ENVIRONS



Drop-offs are prescribed to be between 7:45 and 8:08 am, however many occur outside these times. Younger students (~K-3) are expected to be escorted into the school, and the escort should remain until 8:08, as no formal supervision is provided until then, unless the student is participating in the school breakfast.

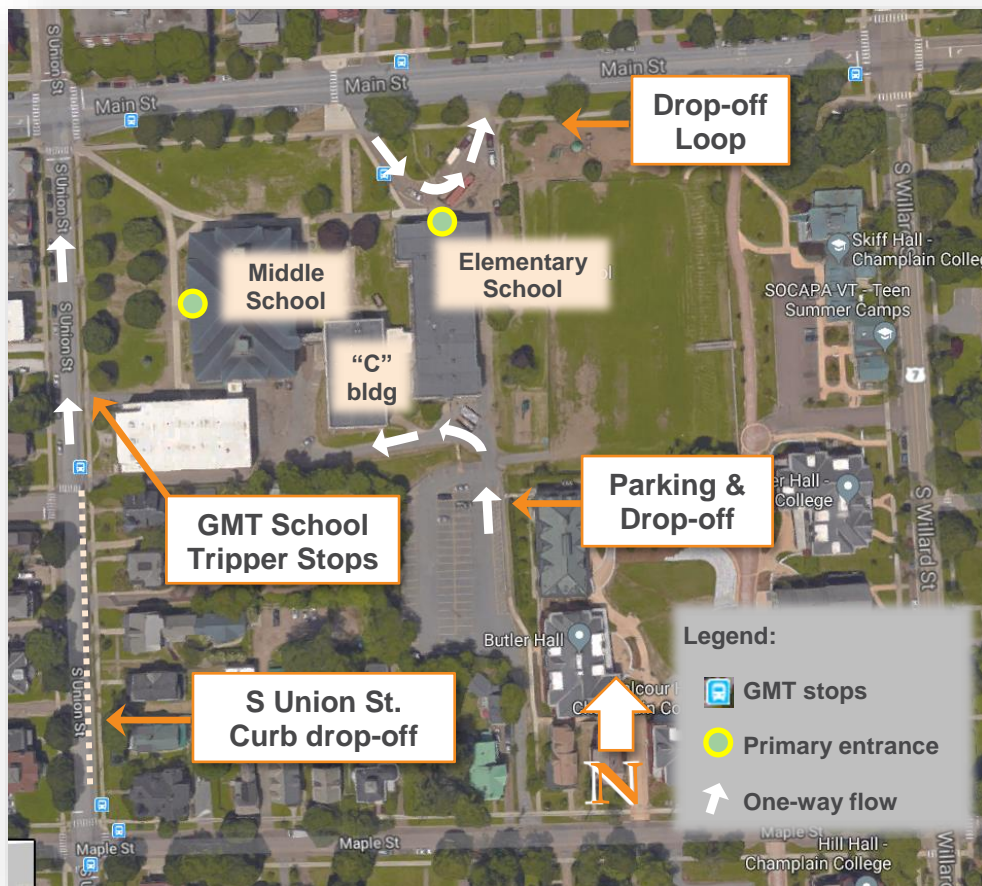
Pick-up activity at the end of the school day is less intense than drop-off activity since a significant portion of students (50-100) participate in after-school activities.

Pine Street has seen significant development in the recent past and the City is planning upgrades to bike accommodations along this route adjacent to Champlain School. This is likely to include buffered bike lanes, and where possible, bus turnouts so that busses don't block the bike lane. An easement for a bike and pedestrian path through the site is also desired by the City.<sup>1</sup>

**ITEM 2: Edmunds Middle / Elementary**

Edmunds has approximately 310 elementary and 410 middles school students enrolled at the Main Street/South Union Street location. Arrival mode is similar to Champlain: GMT bus, BSD bus, SSTA, biking and walking for older students, or via three main drop-off locations: 1) via the parking lot to the southeast, or 2) via the curb drop-off area along South Union Street, or 3) the drop-off loop (“the horseshoe”) on Main Street, near the Elementary School entrance, which is also used by the BSD bus service (see Figure 2).

**FIGURE 2. EDMUNDS CAMPUS - EXISTING CONDITIONS AND ENVIRONS**



While younger students are escorted into the school, the much higher proportion of older students (due to the middle school) means more biking, walking and simple drop-offs (without escort). There

<sup>1</sup> PlanBTV Walk Bike Master Plan 3/17/17.



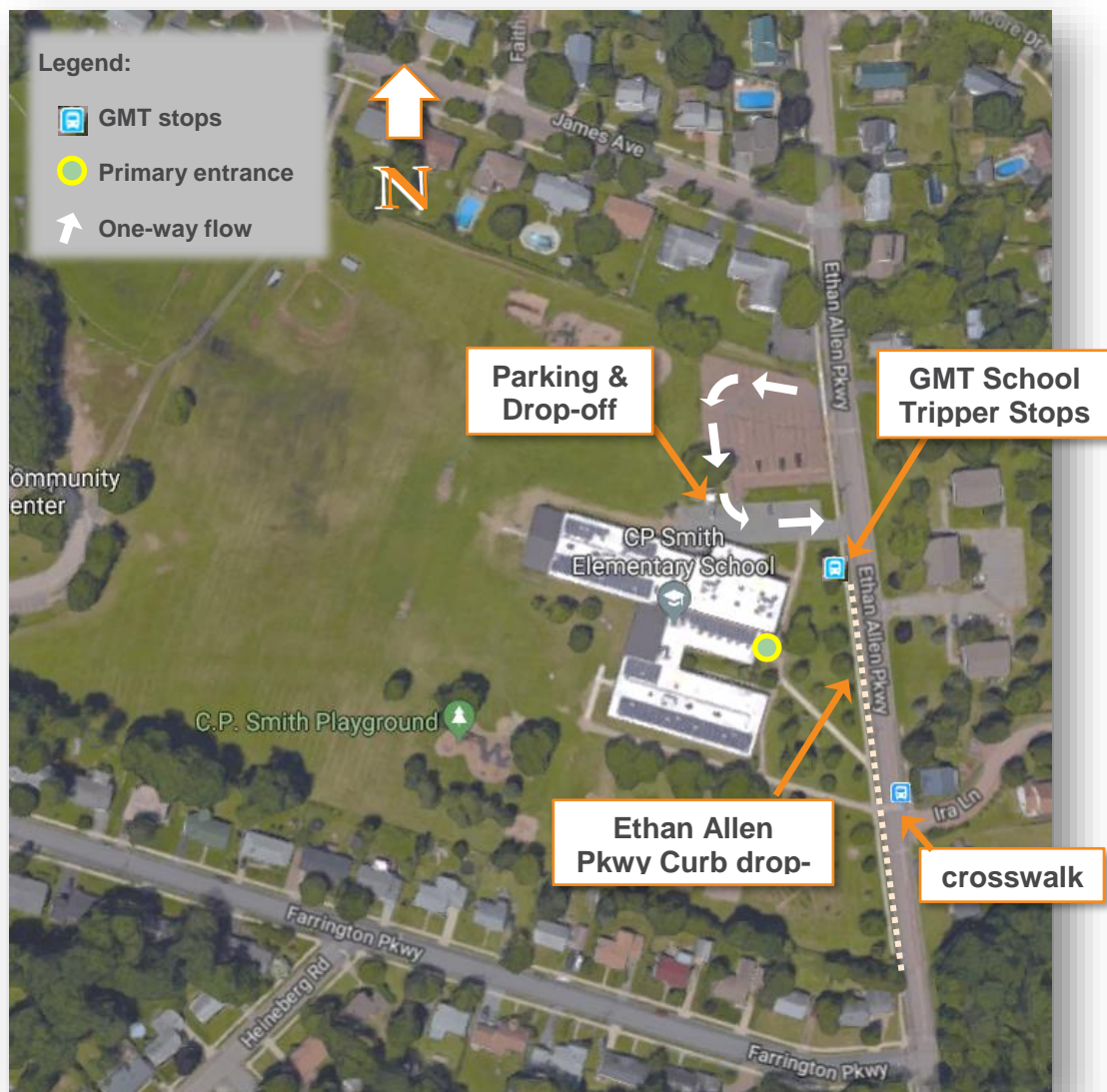
is also a volunteer most days at the Elementary drop-off loop that assist parents in escorting students in, reducing the parking dwell time for those vehicle arrivals.

Student pick-up traffic at Edmunds in the afternoon is also moderated by afterschool participation as 30-70 middle and ~50 elementary students participate in these programs.

### ITEM 3: CP Smith Elementary

CP Smith Elementary currently serves about 270 students in kindergarten through grade 5. 101 students are in afterschool programs. Pick-ups and drop-offs occur in the parking and drop-off loop to the north of the school, and along the front curb line on Ethan Allen Parkway (see Figure 3). CP Smith has excellent participation in biking and walking mode choices. The BSD buses uses the internal drop-off area near the entrance.

FIGURE 3. CP SMITH CAMPUS – EXISTING CONDITIONS AND ENVIRONS



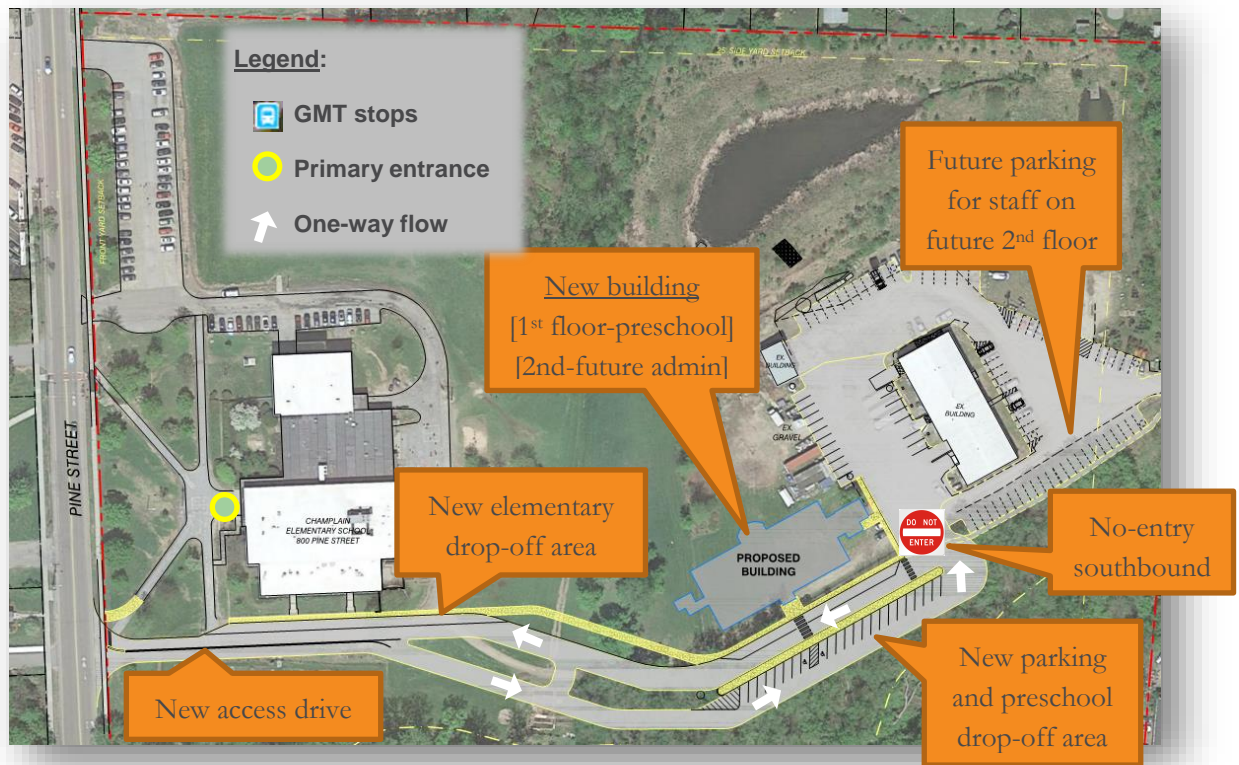
## 2.0 PROPOSED SITE FEATURES

### ITEM 1: Champlain Elementary

The improvement program for Champlain Elementary includes:

- Relocation of the preschool operation currently at the Central Office on Colchester Avenue. A new building would be constructed on site (See Figure 4) with an option to add a 2<sup>nd</sup> floor for relocating administrative staff from the Colchester Avenue Central Office. 34 parking spaces would be built to serve the first phase of the preschool facility.
- A New access driveway from Pine Street.
- A New drop-off area for preschool students and parking for staff.
- A new elementary school drop-off area.
- Future parking for administrative staff on the 2<sup>nd</sup> floor of the new building.
- In cooperation with the City’s plans to enhance bike lanes on Pine Street, the school is planning for a future pull-off for GMT busses (by others).
- Access to the new drive will not be allowed from Shelburne Street.

FIGURE 4. PROPOSED CHAMPLAIN CAMPUS FEATURES





**ITEM 2: Edmunds Middle / Elementary**

The improvement program for the Edmunds campus (Figure 5) includes:

- A New access driveway from S. Union Street to Main Street (closing the existing entrance from Main Street).
- A New drop-off area for students and a separated area for BSD busses.
- Reconfigured sidewalks and a new centralized entrance for both schools.
- Relocated GMT bus stops from S. Union to Main Street.

**FIGURE 5. PROPOSED EDMUNDS CAMPUS FEATURES**

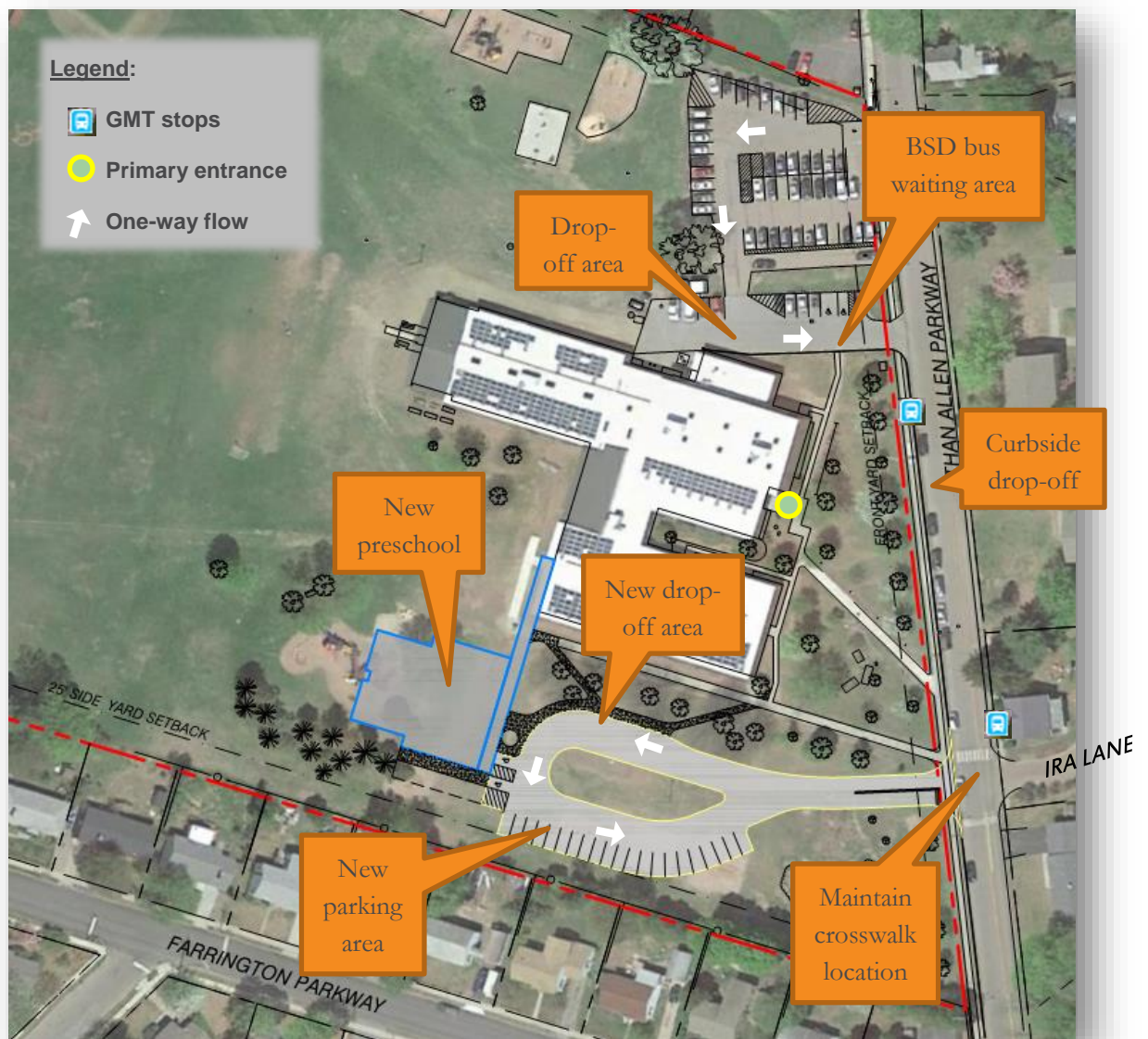


**ITEM 3: CP Smith Elementary**

The improvement program for the CP Smith campus (Figure 6) includes:

- No significant changes are proposed to the existing drop-off/pick-up operation. (The parking lot will be resurfaced and restriped in a slightly more efficient manner).
- A new preschool school building serving 75 students in 2 sessions, morning and afternoon.
- A new access drive with a drop-off area for preschool students, and new parking area for staff and visitors. Some drop-offs may also use the remaining spots in the parking area.

**FIGURE 6. PROPOSED CP SMITH CAMPUS FEATURES**



### 3.0 TRAFFIC & SAFETY

#### ITEM 1: Champlain Elementary

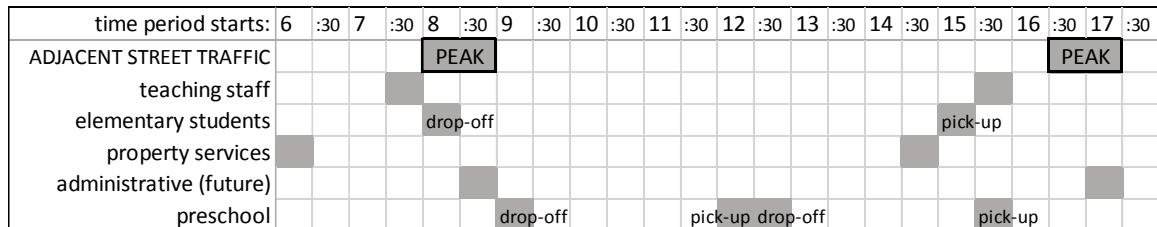
Several enhancements to traffic circulation and safety are anticipated from the proposed site improvements at Champlain School:

- Existing curb drop-offs along Pine Street will be displaced to the new area provided on the north side of the new access drive (Figure 4).
- The new curb line is a similar length to the section of Pine Street currently used and set back from the busy street traffic on Pine Street.
- Public through traffic to Shelburne Street will be prohibited.
- The enhanced safety of the exclusive drive (vs. Pine Street) should provide reassurance to parents with children who are old enough and independent enough to walk themselves to the building entrance. This will reduce dwell time for drop-offs and increase capacity of the drop-off area.
- A new path and sidewalk are proposed through the property services part of the site, from Shelburne Street to the elementary school, as envisioned by the City’s Walk-Bike Master Plan.

RSG observed traffic at the existing site<sup>2</sup> and quantified arrivals and dwell times at each drop-off and pick-up area. Results are summarized as follows:

- 50-60 vehicles arrived in the AM Peak hour (7:30-8:30 AM) at each drop-off location.
- Dwell times varied substantially, from 1-15 minutes, averaging 5 minutes. Dwell was significantly less in the parking area to the north, on average. A maximum of 22 cars were observed on Pine Street at any one time.
- PM peak arrivals (2:30-3:00 PM) were significantly less intense due to after-school participation.
- In general traffic expected from each proposed use is expected during different times of the day, most occurring off-peak from the adjacent Pine Street traffic (see Figure 7).

**FIGURE 7. TRAFFIC FROM EACH USE THROUGHOUT THE DAY**



<sup>2</sup> Friday 3/23 and Wednesday 3/28





## TRAFFIC VOLUME FROM NEW FACILITIES

The traffic expected from proposed site changes were determined using ITE<sup>3</sup> vehicle trip rates for each new use:

1. Preschool use (75 children): 58/59 trips in the AM/PM peak hour.
2. Future Office use: (37 employees): 14/15 trips in the AM/PM peak hour.

It should be noted that the BSD busses up to 50% of the preschool children, thus this portion of the estimate is likely to be quite conservative.

Traffic capacity estimates for the new access and at the property services access on Shelburne Street follow<sup>4</sup>:

## CAPACITY ESTIMATES FOR THE NEW ACCESS TO PINE STREET

The traffic entering and exiting the new access point on Pine Street was analyzed for capacity using the following assumptions:

1. Preschool drop-offs and elementary school drop-offs will be staggered by ½ hour, or more.
2. The employee related trips arrive prior (and leave after) the peak of child arrivals.
3. The drop-offs at the northern parking area will continue to serve a similar number of children as today, and this area primarily serves southbound arrivals (northbound exits), as it does today.
4. The peak occurs in the 20-minute period between 7:55 and 8:15 AM, and the new access is expected to serve approximately 76 vehicles (38 enter and 38 leave) in that time.
5. Left turns exiting the drive will be prohibited.

Accordingly, this new intersection approach is expected to be busy during the brief morning peak (~20 minutes), but well under capacity. Queues are estimated at a maximum of 3 cars. Should left turns be allowed on exit, delay would increase significantly, and the street approach would be closer to capacity<sup>5</sup>.

Delay on Pine Street at this new access will be minimal, assuming most drops-offs originating in the north use the parking lot drop-off on that side of the school, as occurs today.

The intensity of the PM school peak is much less pronounced than the morning peak and does not occur in the peak period of adjacent street traffic.

<sup>3</sup> Institute of Transportation Engineers *Trip Generation Manual* 10<sup>th</sup> Edition

<sup>4</sup> Capacity estimate methods follow VTrans Traffic Impact Study Guidelines, as well as the Highway Capacity Manual (HCM).

<sup>5</sup> Volume/capacity for that 20-minute period is estimated at 0.42 with exiting left turns prohibited, or 0.87 if allowed.



## CAPACITY ESTIMATES FOR PROPERTY SERVICES ACCESS AT SHELBURNE STREET

Two traffic scenarios were modeled at the intersection of Prospect Parkway/Shelburne Street/BSD Property Services Access Drive – the existing condition, and the potential future condition with traffic from the 2<sup>nd</sup> floor administrative space. This location operates as a 5-way intersection, with N/S operating together (and a short southbound leading left), and E/W operating together (the western leg is a Chinese restaurant driveway), and the 5<sup>th</sup> leg (the Property Services driveway) operating on its own phase. The scenarios studied were:

1. No-build 2018 PM Peak – the existing condition without any change due to school site improvements)
2. Build 2018 PM Peak – this scenario assumes the future office use is build and occupied, and the access at Shelburne Street is the main access for this use.

The AM peak analysis was ignored in this case since all traffic movements at this location are lower in the AM peak, thus the PM peak represents the worst case.

The calculations used to determine traffic volumes for the no-build and build scenarios are attached. The traffic analysis software Synchro (v9) was used, along with signal timing and phasing data supplied by the City Department of Public Works, and the results are as follows:

1. NO-BUILD scenario: Overall intersection Level of Service A<sup>6</sup>, the worst approach (the BSD driveway) was LOS D.
2. BUILD scenario: Overall intersection Level of Service A, the worst approach (the BSD driveway) was LOS D.

## ITEM 2: Edmunds Middle / Elementary

Improvements to circulation and safety expected from the proposed site modifications include:

1. The new internal drop-off arrangement has several benefits compared to the current operation, as follows:
  - a. Students are dropped-off / picked-up away from busy public street traffic.
  - b. Students are dropped-off / picked-up closer to the building, increasing the likelihood that parents are comfortable letting students walk themselves inside, reducing average dwell time.
  - c. Queuing, stopping and parking by parents on S. Union Street will be greatly reduced.
  - d. Left turns exiting the new access drive will be prohibited.
  - e. Relocating GMT busses to Main Street will further reduce congestion on the S. Union Street approach to Main Street.

---

<sup>6</sup> Level of Service represents a grading system of average vehicular delay, and ranges from A (little or no delay) to F (Severe delay)

### CAPACITY ESTIMATES FOR THE NEW EXIT ON MAIN STREET

Expected capacity and queuing was determined at the new access drive exit on Main Street. Traffic volumes were determined using available traffic counts from the CCRPC / VTrans online database, combined with site observations by RSG at the existing campus in March of 2018. Relevant findings include:

1. Morning drop-offs are the most intense period of traffic due to afterschool participation.
2. Biking and walking participation is very significant, even more than at Champlain School, presumably due to the age difference and significant population of middle schoolers.
3. Combining the number of observed drop-offs on S. Union and the “horseshoe” drop-off area off Main Street, we found that approximately 140 vehicles are expected to use the new access drive for drop-offs during the peak half hour (7:35-8:05 am).
4. Congestion at the exit will be significant during this time, with as many as 7 cars waiting to exit at the maximum. The exit is expected to be at 75% of capacity during this time.

### ITEM 3: CP Smith Elementary

No substantive changes are being made to drop-off or pick-up circulation for the existing elementary school. The proposed new separate drop-off area and parking for preschool will be available for elementary school pick-ups and drop-offs as these operations do not coincide<sup>7</sup>.

75 preschool students are expected to generate 58/59 trips in the AM/PM peaks<sup>8</sup>. The average time to drop-off a child is expected to be 10 minutes. Accordingly, it is estimate that 12 drop-off spaces will be utilized (curbside or in the parking area). A queue (entering or exiting) may form at times, however the available curb line (over 300 ft.) should easily prevent any spill back on Ethan Allen Parkway.

The existing crosswalk near Ira Lane should be maintained. As most new turning traffic here will be from and to the south, the crosswalk is in an optimal location.

As at Champlain School, the preschool hours are offset from the elementary school traffic periods (see Figure 7), as well as peak hour of adjacent street traffic. The intensity of traffic will be significantly less as well, thus no impact is expected from this new facility.

<sup>7</sup> Elementary: starts 8:10 am, ends 2:50 pm, Preschool: starts 9:15 am, ends 3:30 pm, mid-day turnover at the preschool is also staggered.

<sup>8</sup> ITE Trip Generation Manual, 10<sup>th</sup> edition.





## 4.0 SUMMARY AND CONCLUSIONS

---

### ITEM 1: Champlain Elementary

1. There are approximately 316 students enrolled, 50-100 are in after school programs at Champlain Elementary.
2. Improvements include a new preschool facility, a new access driveway, a new elementary student drop-off area, a separate preschool drop-off area, and a new parking area for staff and visitors.
3. Both new drop-off locations are away from busy Pine Street traffic.
4. Traffic on the new access drive will be exclusive to the on-site uses, which are staggered throughout the day (see item 9 below, and Figure 7). Public through traffic between Shelburne Street and Pine Street will be prohibited.
5. Left turns exiting the access drive will be prohibited.
6. The proposed preschool building will accommodate up to 75 students in two ½-day programs (morning and afternoon).
7. A proposed future 2<sup>nd</sup> floor of the new building would accommodate up to 37 administrative staff. These users would use the access at Shelburne Street, and park in a separate lot in the property services area.
8. Arrivals and departures are staggered for each use:
  - a. Elementary peak ~ 8 am and 3 pm.
  - b. Teachers and staff arrive and leave outside these times.
  - c. Preschool will peak just after 9 am, around noon, then at 12:30 for the afternoon session, and then around 3:30 pm.
  - d. Property services hours are 6:30 am - 2:30 pm.
  - e. The proposed administrative office hours are typical 9-5 with flexible hours.
9. Traffic during the morning elementary school drop-off period is greater than at pickup times in the afternoon due to afterschool participation. Both of these activities are busier than the anticipated preschool drop-off and pick-up activities.
10. Elementary drop-off activity in the morning currently amounts to 50-60 personal vehicles in the peak hour arriving at each of two drop-off locations (curbside on Pine St. and in the parking lot to the north). The most intense peak activity is about 40 vehicles arriving/departing in 20 minutes (7:55-8:15 am).
11. Up to 50% of preschool students are bussed by the BSD, substantially reducing the number of vehicle trips for this use. Vehicle trip estimates using common practices (not including any special provision for bussing) show that preschool related traffic intensity will be lower than elementary school traffic.
12. Modeling the most intense peak shows modest and manageable congestion at the proposed new access drive exit.
13. Modeling the traffic from the proposed future office on the 2<sup>nd</sup> floor of the new preschool building results in little change at the traffic signal on Shelburne St.



**ITEM 2: Edmunds Middle / Elementary**

1. There are approximately 310 elementary and 410 middle school students currently enrolled at the Edmunds schools.
2. 30-70 middle and about 50 elementary students participate in after-school programs.
3. Drop-off activity on S. Union Street occurs at three locations (curbside on S Union Street, at the “horseshoe” drop-off north of the elementary school, and behind the school to the south, entering from Maple Street, exiting onto S. Union Street).
4. A new access drive is proposed to enter from S. Union and exit on Main Street, eliminating the current horseshoe entrance on Main Street left turns on exit will be prohibited.
5. GMT busses stops will be moved to Main Street, and the BSD busses will wait at the top of the new drop-off loop, with a separated by-pass lane for other traffic.
6. The new access is expected to see about 140 personal vehicles in the morning peak period, arriving/departing in 30 minutes (7:35-8:15 am). Afternoon activity is significantly lower due to afterschool participation.
7. Modeling the most intense peak shows significant but manageable congestion at the proposed new access drive exit.

**ITEM 3: CP Smith Elementary**

1. CP Smith currently has about 270 students enrolled, with 101 in afterschool programs.
2. Most drop-offs and pickups occur on the long curb line on Ethan Allen Parkway in front of the school. Some occur at the curb line within the parking lot to the north of the school. No significant changes to these activities or accommodations are proposed.
3. A new preschool and drop-off (pick-up) area is proposed, along with a new parking area for staff and visitors.
4. The pre-school will be sized and operated in a similar fashion as the Champlain preschool (75 students in 2 sessions, hours offset from the elementary school and adjacent street peak traffic).
5. Up to 50% of preschool students are bussed by the BSD, substantially reducing the number of vehicle trips.
6. The new drop-off and drive exit will be busy during peak times (up to ½ hr.), but the drop-off and exit queuing areas are expected to accommodate these activities.
7. The existing crosswalk at Ira Lane on Ethan Allen Parkway will still be in a preferable location, given the new driveway curb cut.

END OF MEMO



## Attachments:

1. Site observation summaries:
  - Champlain School AM/PM
  - Edmunds Campus AM/PM
  
2. Traffic volume summaries:
  - Champlain School – new access exit onto Pine Street.
  - Property Services – access on Shelburne Street.
  - Edmunds Campus – new access exit on Main Street.
  
3. Traffic congestion worksheets (Synchro/HCM):
  - Champlain School – new access exit onto Pine Street.
  - Property Services – access on Shelburne Street.
    - No-Build
    - Build
  - Edmunds Campus – new access exit on Main Street.





**CHAMPLAIN CAMPUS**

Fri 3/23, Wed 2/29  
obs. by MS, CH

**Drop-off (AM)**

	<u>Pine St.-</u> <u>time park/arr.</u>	<u>Pine St. -</u> <u>leave</u>	<u>Pkd</u>	<u>Pine St.-</u> <u>bus</u>	<u>P-lot -</u> <u>arrivals</u>	<u>Parked</u>	<u>dwll</u> <u>(m)</u>
7:25				#37, #39			
7:30					2	1	2
7:35	1	1			4	0	--
7:40	1			#37 (SB)	1	0	--
7:45	3				6	0	--
7:50	7			#5 SB	1	1	22
7:55	9		8		3	3	6
8:00	14		10		5	2	8
8:05	13		17		8	5	3
8:10	4		22		6	3	5
8:15	4		17		1	1	6
8:20	1		14	#5 NB & SB			

\*bell at 8:08

**Pick-up (PM)**

	<u>Pine St.-</u> <u>time park/arr.</u>	<u>Pine St -</u> <u>leave</u>	<u>Pine St.-</u> <u>bus waits</u>	<u>P-lot -</u> <u>arrivals</u>	<u>Parked</u>
1:30				1	1
1:35			#44, 47, 48	1 SSTA	2
1:40	10	0	3	1	3
1:45	2	6	3	1	6
1:50	2	2	3	0	1
1:55	2	0	3	0	2
2:00	0	4	0	1 SSTA	0

\*bell at 1:50

**EDMUNDS CAMPUS**

Fri 3/30/2018  
obs. By MS, DG, CH

**Drop-off (AM)**

	<u>horse-</u> <u>time shoe</u>	<u>Main</u> <u>Street</u>	<u>bus</u>	<u>South</u> <u>time Union</u>	<u>bus</u>	<u>TOTAL</u>	<u>Mark Smith:</u> 30 minute demand 143
7:30				7:30	#37 bus		
7:35	7	3		7:35	#26 bus	12	143
7:40	9	1		7:40	#34 bus	18	
7:45	2	4		7:45		22	
7:50	10	6		7:50		30	
7:55	8	3		7:55		25	
8:00	8	6	BSD bus	8:00		16	
8:05	17	9	BSD bus	8:05		20	
8:10	10	3		8:10		10	

**Pick-up (PM)**

	<u>horse-</u> <u>time shoe</u>	<u>Main</u> <u>Street</u>	<u>bus</u>	<u>South</u> <u>time Union</u>	<u>bus</u>	<u>TOTAL</u>	<u>Mark Smith:</u> peak parking demand
waiting:	6	16		waiting:	0	waiting: 22	
2:35	1	0	BSD bus	2:35	0	1	
2:40	0	2		2:40	1	3	
2:45	3	5		2:45	0	8	
2:50	4	3		2:50	0	7	
2:55	2	0	SSTA bus	2:55	3	5	
3:00	1	0		3:00	10	11	
				3:05	0	#44, #45	0
				3:10	0	#47	0

**AM Peak** all existing Pine St. drop-offs will be transposed to the new drop-off area

**38** peak arrivals modeled with a PHF of 0.25 (all in 15 minutes)  
all other volumes are hourly

Other uses: Daycare (ITE) 58 staggered office (ITE) 14 arrives different time

Peak Hour Turning Movement Volumes:

		2016					Pine Street		
ATR:	AADT	DHV	D%	SB	NB				
BURL45	13,089	1,418	67%	468	950	330	6		
in front of school						↓	↘	↗ 38	
1st week of June			reported growth to 2017						
LAST DAY OF SCHOOL			0.1%			↑	↘		
June 14th									
			analysis period (hr)			656	32		
			1						
								Pine Street	
peak 15 min vol at school (8 am) / pm peak								71%	

**Access Exit**

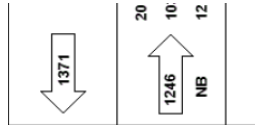
PROPERTY SERVICES/SHELBURNE ST VOLUME DEVELOPMENT  
 (derived from Flynn Ave intersection count and sideline counts from DPW)

RSG/mcs 4/6/18

Adjustment to Flynn/Shelburne count:

2011  
 AADT S of Flynn 24,100  
 %k(\*) 0.11  
 2011-2016 Urban growth(\*) 1.01

2-way peak flow:

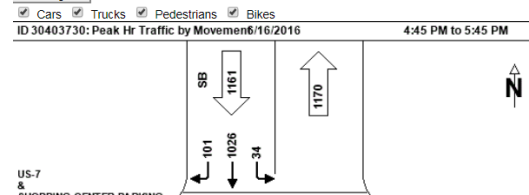
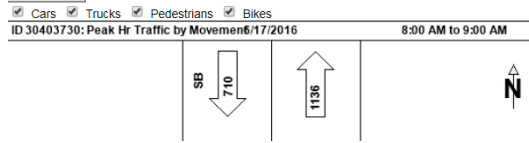


adjustment 1.023122

Flow at Prospect Parkway

	NB	SB
PM	1197	1188
AM	1162	726

@ N Approach to Flynn:



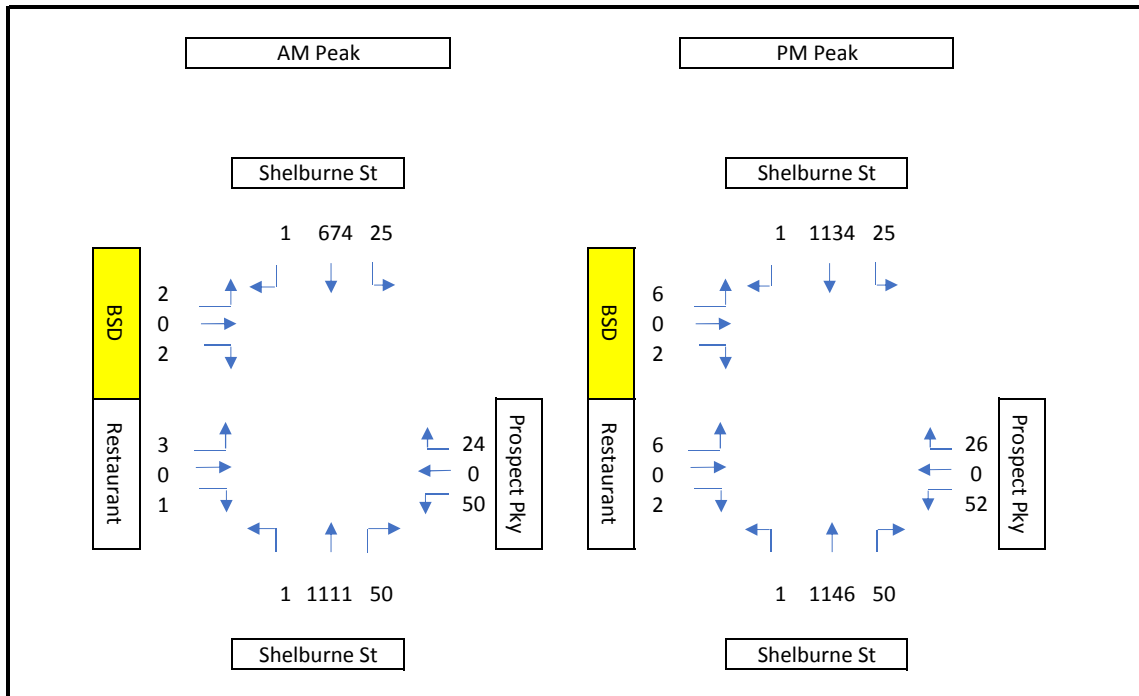
Sidelines volumes derived from weekday Peak Hour counts 3/19-3/27 provided by DGaren:

	BSD	restaurant prospect	
		EB	WB
AM PEAK	4	4	74
PM PEAK	7	8	78

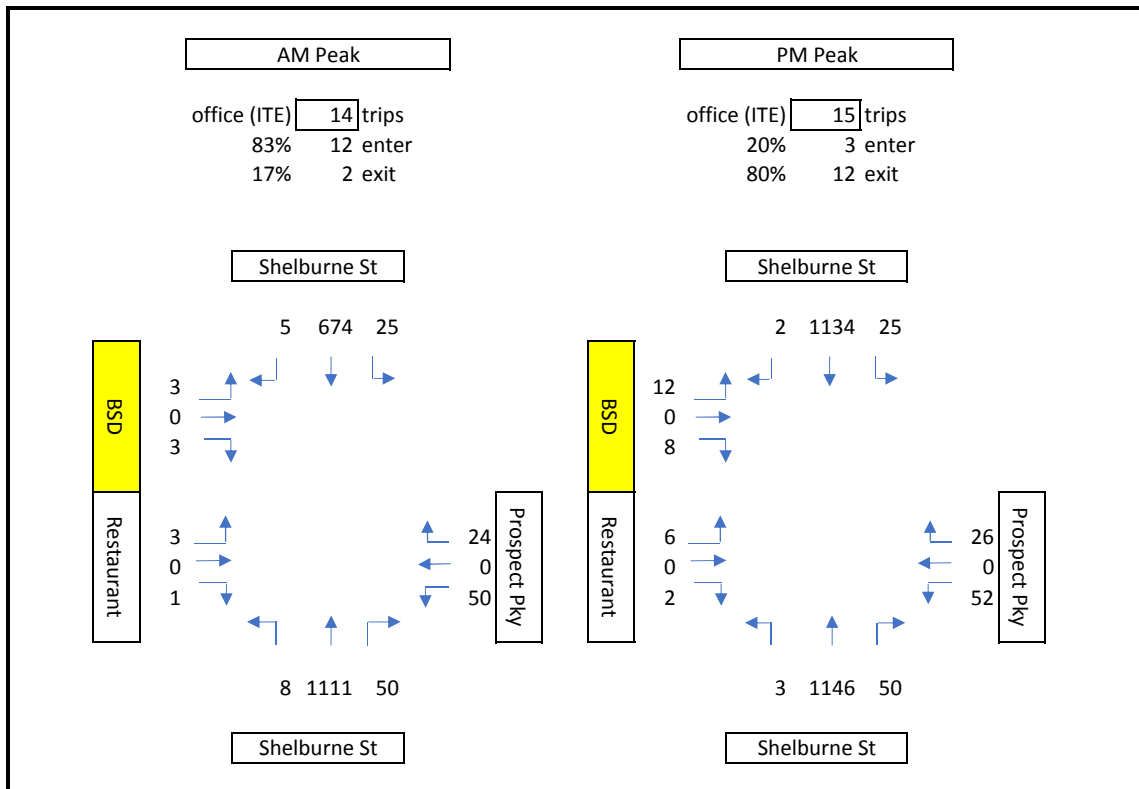
\*(2016 Redbook)



No-build



Build



EDMUNDS SITE TRAFFIC VOLUME DEVELOPMENT:

4/10/18 RSG/mcs

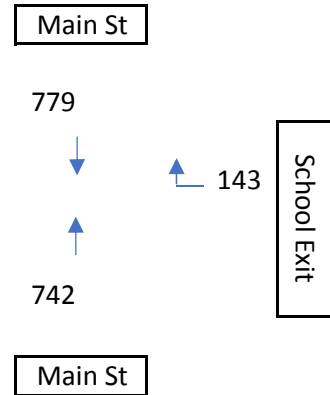
2018 AM Peak traffic at New School Exit

<u>ATR</u>	<u>Location</u>	<u>Year</u>	<u>'16-&gt;'18</u>
D161	Main St	2016	
<u>AAIT</u>	<u>DHV</u>	<u>K</u>	<u>growth</u>
13,799	1514	11%	1%

avg 15 min 2 way count on Main in Peak Hr: 311  
 2-way count on Main in AM School Peak (8-8:15): 261  
 adjustment for Main St at exit in AM School Peak: **84%**

WB vs. total proportion (from peak hr count at willard): 61%

30 minute drop off volume 143



# HCM Unsignalized Intersection Capacity Analysis

## 3: School Drive & Pine St

04/10/2018



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	38	918	32	6	462
Future Volume (Veh/h)	0	38	918	32	6	462
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.33	0.33	1.00	0.33	0.33	1.00
Hourly flow rate (vph)	0	115	918	97	18	462
Pedestrians	30		30			30
Lane Width (ft)	11.0		11.0			11.0
Walking Speed (ft/s)	3.5		3.5			3.5
Percent Blockage	3		3			3
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1524	1026			1045	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1524	1026			1045	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	58			97	
cM capacity (veh/h)	121	273			656	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	115	1015	480
Volume Left	0	0	18
Volume Right	115	97	0
cSH	273	1700	656
Volume to Capacity	0.42	0.60	0.03
Queue Length 95th (ft)	50	0	2
Control Delay (s)	27.5	0.0	0.8
Lane LOS	D		A
Approach Delay (s)	27.5	0.0	0.8
Approach LOS	D		

Intersection Summary			
Average Delay		2.2	
Intersection Capacity Utilization		67.3%	ICU Level of Service
Analysis Period (min)		15	C

# HCM Signalized Intersection Capacity Analysis

## 3: US 7 (Shelburne Street) & Restaurant/Prospect Parkway & BSD

04/06/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR2	NBL2	NBL	NBT	NBR	SBL	SBT
Lane Configurations		↕			↕				↕			↕
Traffic Volume (vph)	6	1	2	52	0	26	1	1	1146	50	25	1134
Future Volume (vph)	6	1	2	52	0	26	1	1	1146	50	25	1134
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	15	15	15	15	15	15	12	12	12	12	12	11
Total Lost time (s)		5.0			5.0				5.0			5.0
Lane Util. Factor		1.00			1.00				0.95			0.95
Frb, ped/bikes		1.00			0.99				1.00			1.00
Flpb, ped/bikes		1.00			1.00				1.00			1.00
Frt		0.97			0.95				0.99			1.00
Flt Protected		0.97			0.97				1.00			1.00
Satd. Flow (prot)		1953			1880				3548			3451
Flt Permitted		0.86			0.79				0.95			0.92
Satd. Flow (perm)		1745			1543				3384			3180
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	6	1	2	52	0	26	1	1	1146	50	25	1134
RTOR Reduction (vph)	0	2	0	0	73	0	0	0	3	0	0	0
Lane Group Flow (vph)	0	7	0	0	5	0	0	0	1195	0	0	1160
Confl. Peds. (#/hr)	2					2	15			7	7	
Heavy Vehicles (%)	0%	0%	0%	2%	2%	2%	1%	2%	1%	1%	1%	1%
Turn Type	Perm	NA		Perm	NA		Perm	Perm	NA		pm+pt	NA
Protected Phases		4			4				6		5	2
Permitted Phases	4			4			6	6			2	
Actuated Green, G (s)		4.7			4.7				40.7			53.9
Effective Green, g (s)		4.7			4.7				40.7			53.9
Actuated g/C Ratio		0.06			0.06				0.54			0.72
Clearance Time (s)		5.0			5.0				5.0			5.0
Vehicle Extension (s)		3.0			3.0				3.0			3.0
Lane Grp Cap (vph)		109			96				1831			2308
v/s Ratio Prot												c0.05
v/s Ratio Perm		c0.00			0.00				c0.35			0.31
v/c Ratio		0.07			0.05				0.65			0.50
Uniform Delay, d1		33.2			33.2				12.2			4.7
Progression Factor		1.00			1.00				1.00			1.00
Incremental Delay, d2		0.3			0.2				1.8			0.8
Delay (s)		33.4			33.4				14.1			5.5
Level of Service		C			C				B			A
Approach Delay (s)		33.4			33.4				14.1			5.5
Approach LOS		C			C				B			A

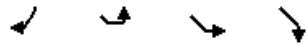
### Intersection Summary

HCM 2000 Control Delay	10.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	75.2	Sum of lost time (s)	19.0
Intersection Capacity Utilization	70.4%	ICU Level of Service	C
Analysis Period (min)	60		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 3: US 7 (Shelburne Street) & Restaurant/Prospect Parkway & BSD

04/06/2018



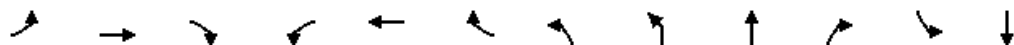
Movement	SBR	SEL2	SEL	SER
<b>Lane Configurations</b>				
Traffic Volume (vph)	1	12	0	8
Future Volume (vph)	1	12	0	8
Ideal Flow (vphpl)	1900	1900	1900	1900
Lane Width	12	12	12	12
Total Lost time (s)			5.0	
Lane Util. Factor			1.00	
Frbp, ped/bikes			1.00	
Flpb, ped/bikes			1.00	
Frt			0.95	
Flt Protected			0.97	
Satd. Flow (prot)			1711	
Flt Permitted			0.97	
Satd. Flow (perm)			1711	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1	12	0	8
RTOR Reduction (vph)	0	0	0	0
Lane Group Flow (vph)	0	0	20	0
Confl. Peds. (#/hr)	15			
Heavy Vehicles (%)	1%	2%	2%	2%
Turn Type		Prot	Prot	
Protected Phases		3	3	
Permitted Phases				
Actuated Green, G (s)			2.6	
Effective Green, g (s)			2.6	
Actuated g/C Ratio			0.03	
Clearance Time (s)			5.0	
Vehicle Extension (s)			3.0	
Lane Grp Cap (vph)			59	
v/s Ratio Prot			c0.01	
v/s Ratio Perm				
v/c Ratio			0.34	
Uniform Delay, d1			35.5	
Progression Factor			1.00	
Incremental Delay, d2			3.4	
Delay (s)			38.9	
Level of Service			D	
Approach Delay (s)			38.9	
Approach LOS			D	
<b>Intersection Summary</b>				



# HCM Signalized Intersection Capacity Analysis

## 3: US 7 (Shelburne Street) & Restaurant/Prospect Parkway & BSD

04/06/2018



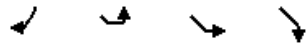
Movement	EBL	EBT	EBR	WBL	WBT	WBR2	NBL2	NBL	NBT	NBR	SBL	SBT
Lane Configurations		↕			↕				↕			↕
Traffic Volume (vph)	6	1	2	52	0	26	1	1	1146	50	25	1134
Future Volume (vph)	6	1	2	52	0	26	1	1	1146	50	25	1134
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	15	15	15	15	15	15	12	12	12	12	12	11
Total Lost time (s)		3.0			3.0				3.0			3.0
Lane Util. Factor		1.00			1.00				0.95			0.95
Frb, ped/bikes		1.00			0.99				1.00			1.00
Flpb, ped/bikes		1.00			1.00				1.00			1.00
Fr		0.97			0.95				0.99			1.00
Flt Protected		0.97			0.97				1.00			1.00
Satd. Flow (prot)		1956			1882				3548			3451
Flt Permitted		0.84			0.79				0.95			0.93
Satd. Flow (perm)		1695			1545				3384			3196
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	6	1	2	52	0	26	1	1	1146	50	25	1134
RTOR Reduction (vph)	0	2	0	0	71	0	0	0	3	0	0	0
Lane Group Flow (vph)	0	7	0	0	7	0	0	0	1195	0	0	1160
Confl. Peds. (#/hr)	2					2	15			7	7	
Heavy Vehicles (%)	0%	0%	0%	2%	2%	2%	1%	2%	1%	1%	1%	1%
Turn Type	Perm	NA		Perm	NA		Perm	Perm	NA		pm+pt	NA
Protected Phases		4			4				6		5	2
Permitted Phases	4			4			6	6			2	
Actuated Green, G (s)		4.6			4.6				40.5			53.6
Effective Green, g (s)		6.6			6.6				42.5			55.6
Actuated g/C Ratio		0.09			0.09				0.58			0.76
Clearance Time (s)		5.0			5.0				5.0			5.0
Vehicle Extension (s)		3.0			3.0				3.0			3.0
Lane Grp Cap (vph)		152			138				1959			2456
v/s Ratio Prot												c0.06
v/s Ratio Perm		0.00			c0.00				c0.35			0.29
v/c Ratio		0.05			0.05				0.61			0.47
Uniform Delay, d1		30.5			30.5				10.1			3.4
Progression Factor		1.00			1.00				1.00			1.00
Incremental Delay, d2		0.1			0.2				1.4			0.7
Delay (s)		30.7			30.7				11.5			4.0
Level of Service		C			C				B			A
Approach Delay (s)		30.7			30.7				11.5			4.0
Approach LOS		C			C				B			A

### Intersection Summary

HCM 2000 Control Delay	8.7	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	73.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	60		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis  
 3: US 7 (Shelburne Street) & Restaurant/Prospect Parkway & BSD

04/06/2018



Movement	SBR	SEL2	SEL	SER
<b>Lane Configurations</b>				
Traffic Volume (vph)	1	6	0	2
Future Volume (vph)	1	6	0	2
Ideal Flow (vphpl)	1900	1900	1900	1900
Lane Width	12	12	12	12
Total Lost time (s)			5.0	
Lane Util. Factor			1.00	
Frbp, ped/bikes			1.00	
Flpb, ped/bikes			1.00	
Frt			0.97	
Flt Protected			0.96	
Satd. Flow (prot)			1735	
Flt Permitted			0.96	
Satd. Flow (perm)			1735	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1	6	0	2
RTOR Reduction (vph)	0	0	0	0
Lane Group Flow (vph)	0	0	8	0
Confl. Peds. (#/hr)	15			
Heavy Vehicles (%)	1%	2%	2%	2%
Turn Type		Prot	Prot	
Protected Phases		3	3	
Permitted Phases				
Actuated Green, G (s)			1.2	
Effective Green, g (s)			1.2	
Actuated g/C Ratio			0.02	
Clearance Time (s)			5.0	
Vehicle Extension (s)			3.0	
Lane Grp Cap (vph)			28	
v/s Ratio Prot			c0.00	
v/s Ratio Perm				
v/c Ratio			0.29	
Uniform Delay, d1			35.7	
Progression Factor			1.00	
Incremental Delay, d2			5.6	
Delay (s)			41.3	
Level of Service			D	
Approach Delay (s)			41.3	
Approach LOS			D	
<b>Intersection Summary</b>				

# HCM Unsignalized Intersection Capacity Analysis

## 3: School Exit & Main St

04/09/2018



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑		↗
Traffic Volume (veh/h)	742	0	0	779	0	143
Future Volume (Veh/h)	742	0	0	779	0	143
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	0.50
Hourly flow rate (vph)	742	0	0	779	0	286
Pedestrians				30		
Lane Width (ft)				11.0		
Walking Speed (ft/s)				3.5		
Percent Blockage				3		
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			742		1521	772
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			742		1521	772
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	27
cM capacity (veh/h)			874		132	392
<b>Direction, Lane #</b>	<b>EB 1</b>	<b>WB 1</b>	<b>NB 1</b>			
Volume Total	742	779	286			
Volume Left	0	0	0			
Volume Right	0	0	286			
cSH	1700	1700	392			
Volume to Capacity	0.44	0.46	0.73			
Queue Length 95th (ft)	0	0	142			
Control Delay (s)	0.0	0.0	35.3			
Lane LOS				E		
Approach Delay (s)	0.0	0.0	35.3			
Approach LOS				E		
<b>Intersection Summary</b>						
Average Delay			5.6			
Intersection Capacity Utilization			58.4%	ICU Level of Service	B	
Analysis Period (min)			15			