WELLS + ASSOCIATES

MEMORANDUM

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TO: Ted Van Houten, DDOT
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FROM: Jami L. Milanovich, P.E.

COPY: Nancy Mellon, The River School
Allison Prince, Goulston & Storrs
Sherry Rutherford, Requity Real Estate
Scott Kaufman, J.M. Zell

RE: The River School (BZA Case #20472)
Comprehensive Transportation Review – Addendum #1

DATE: October 8, 2021

As a follow-up to our meeting on October 6, 2021, the following information is provided herein:

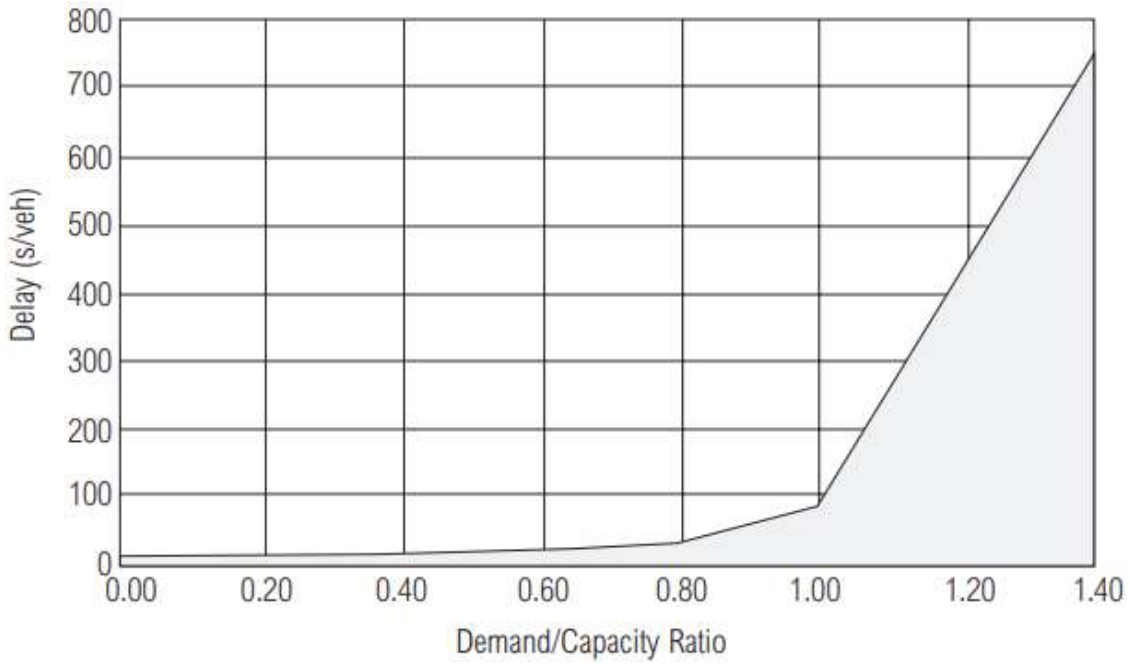
- Analysis of timing adjustments at signalized intersections for which an impact was attributed to the River School,
- A proposal for pedestrian or bicycle improvements to offset the impact at two unsignalized intersections,
- An evaluation of the proposed HAWK signal on Nebraska Avenue at Warren Street using DDOT's HAWK Scoring Matrix,
- A graphic showing the rerouting of eastbound and westbound left turns at the Nebraska Avenue/Warren Street intersection,
- Further evaluation of the Stop sign and No Left Turn sign recommended on 41st Street at its intersection with Nebraska Avenue.

Additionally, updated vehicle and bicycle parking requirements are provided.

EVALUATION OF TIMING ADJUSTMENTS

Under saturated conditions, such as the case with several intersections in the study area, the delay increases exponentially under the Highway Capacity Manual method, as shown on Exhibit 1. In other words, a proportionately small number of vehicles added to the intersection would result in disproportionate increases in delay when conditions approach saturation (i.e., a demand/capacity ratio of 1.0).

Exhibit 1
Average Delay vs. Saturation (Demand/Capacity Ratio)



Source: Highway Capacity Manual (2000)

Because of this phenomenon, traffic signal timing adjustments were evaluated to determine whether minor shifts in signal timings would offset the impact of the River School. DDOT updates traffic signal timings every five years to account for changes in traffic volumes and patterns. Therefore, any minor timing adjustments evaluated herein would be within the scope of DDOT's retiming efforts.

Timing adjustments were evaluated at the following intersections:

- Wisconsin Avenue/Van Ness Street,
- Wisconsin Avenue/Tenley Circle (south), and
- River Road/42nd Street.

Level of service and queue reports from Synchro are provided in Attachment A for all three intersections.

Wisconsin Avenue/Van Ness Street

As indicated in the CTR, the River School traffic would account for just 1.4 percent of the future traffic at the intersection. The school's impact would be limited to the westbound approach during the AM peak hour. An evaluation of signal timings at the intersection reveals that **shifting just two seconds of green time** from the Wisconsin Avenue mainline (Phase 2+6) to the Van Ness Street phase (Phase 4+8) in the AM peak would mitigate the school's impact. The results of the analysis are shown in Table 1. For comparative purposes, the background conditions and total future conditions without timing adjustment also are provided.

Table 1
AM Peak Hour Levels of Service
Wisconsin Avenue/Van Ness Street

Approach	Background	Total Future	Total Future with Timing Adjustments
EB	D	D	D
WB	E (57.3) [0.79]	E (62.3) [0.81]	D
NB	C	C	D
SB	A	A	A
Overall	**C (22.1)**	**C (24.3)**	**C (26.2)**

Wisconsin Avenue/Tenley Circle (South)

As indicated in the CTR, the River School traffic would account for just 0.8 percent of the future traffic at the intersection. The school's impact would be limited to the northbound approach during the AM peak hour. The CTR evaluated the effectiveness of removing a few parking spaces on Wisconsin Avenue to provide a northbound right turn lane at the intersection. Although the addition of the right turn lane demonstrated that it would mitigate the impact of the school, a right turn lane ultimately was not recommended because the impact was very minor, and it would require the loss of parking on Wisconsin Avenue.

An evaluation of signal timings at the intersection reveals that **shifting just one second of green time** from the eastbound, Tenley Circle approach (Phase 3) to the Wisconsin Avenue mainline (Phase 1) during the AM peak would mitigate the impact of the school. The results of the analysis are shown in Table 2. For comparative purposes, the background conditions and total future conditions without timing adjustment also are provided.

Table 2
AM Peak Hour Levels of Service
Wisconsin Avenue/Tenley Circle (South)

Approach	Background	Total Future	Total Future with Timing Adjustments
NB	D	E (57.2) [0.98]	D
SB	B	B	A
NEB	C	C	C (23.8)
Overall	**C (25.6)**	**C (27.1)**	**C (26.6)**

River Road/42nd Street

As indicated in the CTR, the River School traffic would account for just 1.6 percent of the future traffic at the intersection. The school's impact would be limited to the northbound approach during the PM commuter peak hour. Given the proximity of the Brandywine Street intersection to the south of River Road, any improvements on the northbound approach of the River Road/42nd Street intersection are not feasible. Therefore, the CTR evaluated other approaches to determine whether turn pockets would mitigate the impact. Creation of a southeast-bound right turn lane on River Road was determined to mitigate the impact. However, due to the very minor impact and the loss of RPP parking required to accommodate the turn lane, the improvement ultimately was not recommended.

An evaluation of signal timings at the intersection reveals that **shifting just one second of green time** from the eastbound/westbound, River Road phase (Phase 2) to the northbound/ southbound 42nd Street phase (Phase 4) during the PM Commuter peak would mitigate the impact of the school. The results of the analysis are shown in Table 3. For comparative purposes, the background conditions and total future conditions without timing adjustment also are provided.

Table 3
PM Commuter Peak Hour Levels of Service
River Road/42nd Street

Approach	Background	Total Future	Total Future with Timing Adjustments
SEB	A	A	B
NWB	B	B	B
NB	D	E (55.2) [0.82]	D
SB	D	D	D
Overall	**C (25.1)**	**C (27.1)**	**C (25.7)**

UNMITIGATED UNSIGNALIZED INTERSECTIONS

Only two intersections, both unsignalized, remain unmitigated within the study area. At the Van Ness Street/42nd Street intersection, the impact of the school is limited to the southbound approach during the PM school peak hour. The southbound approach is projected to operate at a LOS E under background conditions (without the River School) and would continue to operate at a LOS E with the additional of River School traffic. The average delay for the southbound approach would increase by just 6.9 seconds/vehicle. Physical improvements at the Van Ness Street/42nd Street intersection are not feasible because of the curb extensions in place at the intersection. The width of Van Ness Street is not wide enough to accommodate any additional turn lanes.

At the Yuma Street/Tenley Circle intersection, the impact of the school is limited to the eastbound approach during the PM school peak hour. The eastbound approach is projected to operate at a LOS F during the PM school peak hour under background conditions and would continue to operate at a LOS F under future conditions with the school, with an increased delay. Due to physical constraints at the intersection, no roadway improvements are feasible at this location.

To offset the school's impact at these two intersections and to further supplement the mitigation strategies for the three signalized intersections discussed above, the River School proposes to fund the installation of a new Capital Bikeshare station in the neighborhood and fund the first year's operating cost. DDOT has identified a planned station location just west of the River School near the Van Ness Street/45th Street intersection.

HAWK Scoring Matrix

At DDOT's request, an evaluation of the proposed HAWK signal on Nebraska Avenue at Warren Street was performed using DDOT's HAWK Scoring Matrix. The HAWK Scoring Matrix is provided as Table 4.

Table 4
DDOT HAWK Matrix Summary

Criteria	Max Points Possible	Points Awarded	Points and Considerations	Notes
Pedestrian and Bicycle Crashes at intersection	20	5	Crashes over a recent 3-year period: 5 pts per crash	1
Vehicular crashes at intersection	10	14	Crashes over a recent 3-year period: 2 point per crash	2
Street Traffic Volume (ADT)	30	30	< 12,000=0 pts 12,000-15,000 w/median=10 pts >15,000-w/median=20 pts >15,000-w/o median=30 pts	3
Number of lanes at peak hour	30	0	2 lanes in each direction=10 pts Each additional lane=5 pts If one-way, 1 lane=5 pts Each additional lane=5 pts	4
Elderly/disabled population density (65+)	10	0	Preference to areas with elderly/disabled populations	
Proximity to school (pre-K-HS)	15	23	5 pts per school w/i ¼ mi 2 pts per school w/i ½ mi	5
Connection to parks, rec center, libraries, commercial zone, or other large ped generator	15	10	5 pts per facility or zone within ¼ mi; 2 pts per facility or zone within ½ mi	6
Metro Station/Bus Stop presence and use (each stop)	20	20	<50 daily boardings=5 pts 50-150 daily boardings=10 pts >150 daily boardings or Metro Station w/in 2 blocks=20 pts	7
Posted speed limit	15	15	25 mph= 5 pts, 30 mph= 10 pts, >30 mph= 15 pts	8
Distance to nearest signalized intersection	30	20	<300 ft=0 pts 300-500 ft=20 pts >500 ft=30 pts	9
Crossing part of designated bike route	5	0	Yes=5 pts	
TOTAL LOCATION SCORE:	**200**	**137**		

Table 4 (continue)
DDOT HAWK Matrix Summary

Notes:

1. Crash data was taken from the American University 2021 Campus Plan CTR. One crash involving a pedestrian or bicycle occurred between 2016 and 2019.
2. Crash data in the AU CTR revealed that 10 crashes occurred over a 4-year period. Assuming an even distribution of crashes over the period, the pro-rated estimated number of crashes over a 3-year period is 7.
3. The 2018 ADT on Nebraska Avenue was 16,000 vpd.
4. During the AM and PM peak periods, three travel lanes operate on Nebraska Avenue.
5. Within ¼ mile: The River School, National Presbyterian School, and St. Alban's Early Childhood Center. Within ½ mile: Janney Elementary, Woodrow Wilson HS, Sidwell Friends School, Georgetown Day School.
6. Within ½ mile: Friendship Rec Center, Turtle Park, Tenley Friendship Neighborhood Library, City Ridge/Upton Place (Commercial), 4500 Wisconsin Avenue (Commercial).
7. There are 11 bus stops within 2 blocks. The Wisconsin Avenue/Tenley Circle stops alone have more than 150 daily boardings (based on Fall 2019 data provided by WMATA).
8. The speed limit on Nebraska Avenue is 30 mph.
9. The distance to the nearest traffic signal at Tenley Circle is 350'.

As requested, in addition to the HAWK Scoring Matrix, DDOT's Crossing Treatment Selection criteria was reviewed, as requested. The criteria are summarized in Table 5.

Nebraska Avenue operates with three travel lanes during the AM peak period (7:00 – 9:30 AM) and PM peak period (4:00 – 6:00 PM) and with four travel lanes the remainder of the day. The ADT on Nebraska Avenue is 16,000 vehicles per day (vpd). Using three lanes, an Activated Pedestrian Device, such a Rapid Flashing Beacon would be warranted. Using four lanes, a HAWK signal would be warranted.

The River School will defer to DDOT's judgement as to whether the HAWK signal or Rapid Flashing Beacon is most appropriate.

Table 5
Crossing Selection Criteria
(*Source: DDOT Design and Engineering Manual, Table 31-36*)

Roadway Configuration	1500–9000 vpd	9000–12,000 vpd	12,000–15,000 vpd	>15,000 vpd
2 Lanes [1]	A	A	A or B	B or C
2 Lanes with Channelized Turn Lanes [1]	A	A	B	B or C
2 Lanes One Way	B	B	C	C
4 Lanes w/Raised Median [2]	B	B	C	C
3 Lanes No Median [3]	B	B	C	C
5 Lanes w/Raised Median [3]	B	B	C	C
6 Lanes w/Raised Median [4]	B	B	C	D
4 Lanes No Median [4]	B	B or C	C	D
5 Lanes No Median [3]	B	B or C	D	D
6 Lanes No Median [4]	B	B or C	D	D

Notes:
1. This assumes a two-way road with 1 lane in each direction at the crossing location
2. The road may be one-way or two-way with unbalanced lanes at the crossing location
3. The road may be one-way or two-way at the crossing location
4. The relationship of traffic volume, number of lanes, and speed for "C" treatments require additional evaluation to determine their effectiveness, as these features are relatively new devices
5. Lane configurations should be determined at peak hour vehicular volume conditions

Crossing Treatment Types:
Treatment A – High-Visibility Crosswalk and Side of Street Pedestrian Law Sign
Treatment B – In-Street Stop for Pedestrians Sign and/or Traffic Calming (See **Chapter 40**). Advance Stop Sign should be used for all Multi-Lane Crossings.
Treatment C – Activated Pedestrian Device (Rapid Flash Beacon, Flashing Beacon, In-Roadway Lights)
Treatment D – Signal (Pedestrian Hybrid, Full Signal) or Grade Separation

Rerouting of Eastbound and Westbound Left Turns at Warren Street/Nebraska Avenue

The CTR recommended left turn restrictions at the Nebraska Avenue/Warren Street intersection as a means to reduce delay and also reduce cut through traffic on Warren Street (a concern voiced by some members of the community). As requested, the rerouted left turn assignment is shown on Figure 1.

Nebraska Avenue/41st Street Improvements

The CTR recommended the replacement of the YIELD sign on 41st at its intersection with Nebraska Avenue with a STOP sign and No Left Turn sign. According to the MUTCD, "vehicles controlled by a YIELD sign need to slow down to a speed that is reasonable for the existing conditions or stop when necessary to avoid interfering with conflicting traffic." The MUTCD further states, "YIELD signs may be installed . . . on the approaches to a through street or highway where conditions are such that a full stop is not always required." Given the volume of traffic on Nebraska Avenue and the sharp left turn required based on the acute intersecting angle, a STOP sign and a NO LEFT TURN sign were recommended in place of the YIELD sign.

The Design and Engineering Manual further states that "YIELD signs should be used for minor intersections only" (§44.13.2). Although 41st Street is a local street, Nebraska Avenue is classified as a Principal Arterial. As such, YIELD control is not appropriate at the intersection.

As requested by DDOT, a sight distance evaluation was undertaken. W+A personnel noted that sight distance varied depending on whether vehicles were parked on the east side of Nebraska Avenue (Nebraska Avenue currently has peak period parking restrictions). The sight distance for vehicles on 41st Street are summarized in Table 6.

Table 6
Sight Distance Summary

Direction	Measured		Required
	With parked vehicles	No parked vehicles	
Looking to the Left	98'	263'	390'
Looking to the right	No cars were parked during observation period	250'	335'

The obstruction looking to the left under the "no parked vehicles" condition was noted as large trees along the east side of Nebraska Avenue. Looking to the right, the obstruction was noted as the northbound queue stemming from the traffic signal at Tenley Circle.

Based on the sight distance evaluation, we believe that it is appropriate to restrict the left turn from 41st Street onto Nebraska Avenue.

Finally, as requested by DDOT, the crosswalk treatment for 41st Street was evaluated. The ADT on 41st Street was estimated to be 850 vpd (based on PM peak hour traffic volumes and a k factor of 10 percent). According to the Design and Engineering Manual, a parallel crosswalk, as is present today, is the most appropriate treatment for crossings with an ADT less than 1,500 vpd.

UPDATED VEHICULAR AND BICYCLE PARKING REQUIREMENTS

The vehicular and bicycle parking requirements have been updated since the submission of the CTR and are summarized in Tables 7 and 8, respectively. The vehicle parking required calculated in the CTR incorrectly used the private education use for the entire school. Since part of the school will be a child development center, the parking requirements must be calculated based on both the private school use and the daytime care use. As shown in Table 7, The resulting vehicular parking requirement is 52 spaces (compared to 60 spaces cited in the CTR).

Table 7

Vehicle Parking Summary

Required (per §701.5)†	DDOT Preferred Vehicle Parking	Proposed
Education, private (Elementary and Middle Schools) 2 per 3 teachers and other employees 2(63/3) = 42 spaces	"Other Uses" ≤ 90% of §701.5 0.9(42) ≤ 38 spaces	55 garage spaces‡ 10 surface spaces
Daytime Care (Child development Center) 0.5 spaces per 1,000 SF 0.5*(20,058/2) = 10 spaces	"Other Uses" ≤ 90% of §701.5 0.9(10) ≤ 9 spaces	
Total = 52 spaces	47 spaces	

† Although the site is within ½ mile of Metro, since the site is in an R zone, it is not eligible for the 50% parking reduction per §702.1.

‡ Includes 12 tandem spaces.

The bicycle parking requirements in the CTR were inadvertently calculated without the square footage of the existing mansion. As shown in Table 8, nine long-term spaces would be required (compared to six cited in the CTR) and 33 short-term spaces would be required (compared to 24 cited in the CTR). The proposed project will provide at least the minimum required bicycle parking.

Table 8

Bicycle Parking Summary

Long-Term Parking		Short-Term Parking	
Required	**Proposed**	**Required**	**Proposed**
Education, private school 1 per 7,500 SF of GFA 66,691[†]/7,500 = 9	9	Education, private school 1 per 2,000 SF of GFA 66,691/2,000 = 33	34

[†] GFA calculated in accordance with §803.2

SUMMARY

The River School has prepared a multi-pronged approach to its transportation mitigation package that fully mitigates any adverse impacts created by the school. This multi-pronged approach provides improvements for vehicles, pedestrians, and bicycles and commits to implementing one of the most, if not the most, aggressive transportation management plans of any school in the District.

The following summarizes the school's proposed transportation package as outlined in the CTR and this addendum:

1. Improvements at the Nebraska Avenue/Van Ness Street intersection, including the following:
    - Modification of the traffic signal to include a westbound left turn phase;
    - Removal of approximately four RPP parking spaces on the north side of Van Ness Street between Nebraska Avenue and 41st Street to improve access to the westbound left turn lane at the intersection;
    - Removal of parking on both sides of Nebraska Avenue from 7:00 AM to 7:00 PM from approximately 500 feet south of Van Ness Street to Warren Street to improve the capacity of the intersection;
2. Installation of a pedestrian hybrid signal or rapid flashing beacon on Nebraska Avenue south of Warren Street to facilitate pedestrian crossings across Nebraska Avenue;
3. Installation of a STOP sign and a NO LEFT TURN sign in place of the YIELD sign on 41st Street at its intersection with Nebraska Avenue;
4. Funding of a Capital Bikeshare Station and first year's operating cost near the site;
5. Construction of approximately 400 feet of missing sidewalk along the school's 42nd Street frontage; and

6. Commitment to evaluate the Yuma Street/Tenley Circle (west) and 42nd Street/Van Ness Street intersections during the first school year that the school reaches its maximum enrollment of 350 students and, in the event that conditions warrant improvements, a commitment to fund signing, pavement marking, or flex post delineator improvements up to $30,000.
7. Implementation of a comprehensive TMP, which includes the following components:
    - A Transportation Demand Management Plan that establishes trip caps equivalent to a 45 percent reduction during the AM peak hour and a 15 percent reduction during both the PM school and PM commuter peak hours;
    - An Operations Management Plan that outlines protocols for promoting safe and efficient traffic flow on site, including provisions for the pick-up/drop-off operations and loading management; and
    - An aggressive Monitoring Plan that requires four monitoring studies in the first year of operation followed by at least one annual study thereafter (with gradual phase out after continued compliance) and provides specific strategies that will be implemented should monitoring requirements not be met.

Please do not hesitate to contact me at jlmilanovich@wellsandassociate.com or 202.556.1113 should you have any questions.

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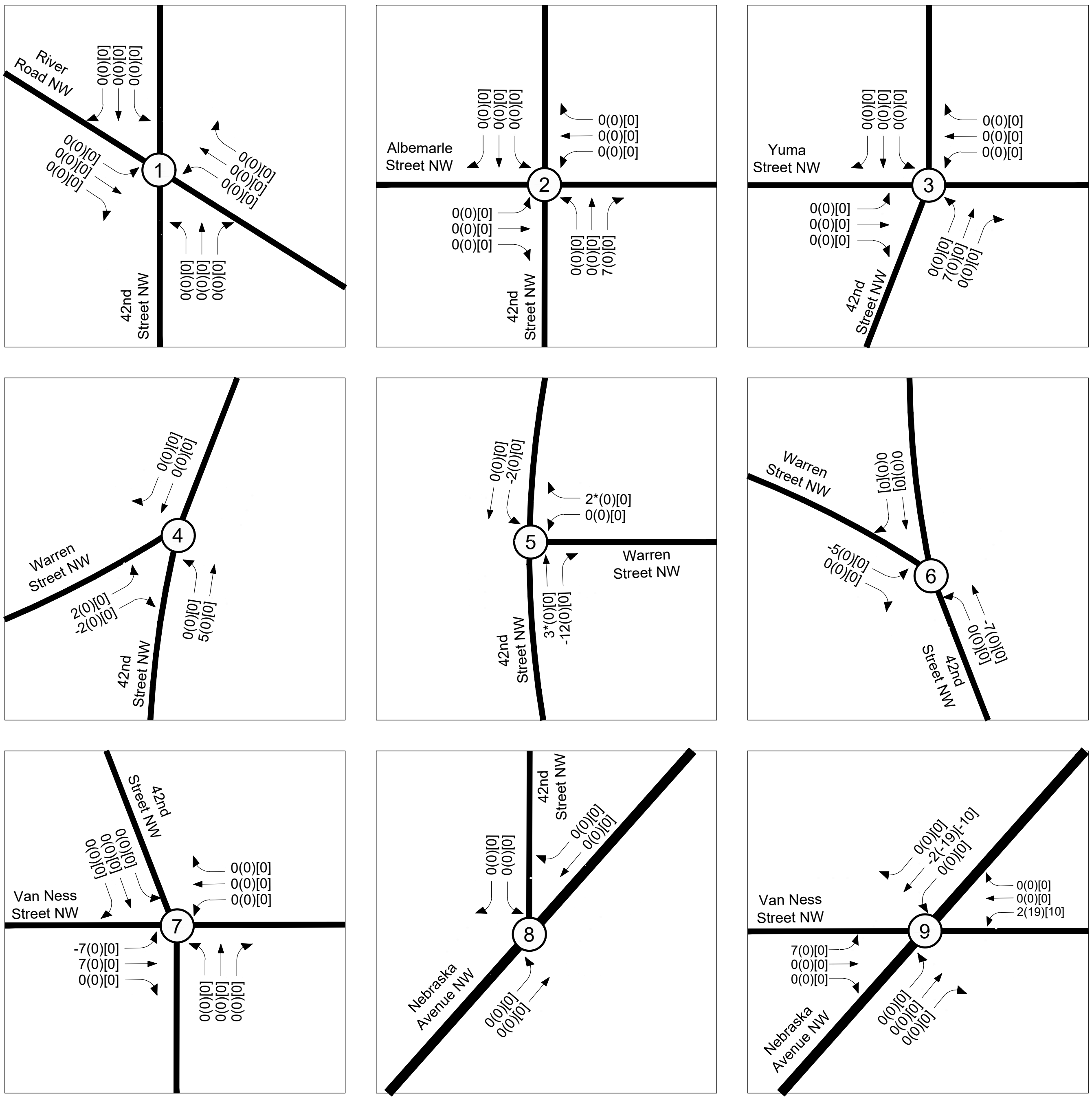


*Localized Traffic Originating on Warren and 42nd Streets

Figure 1

Rerouted Left Turns Associated with "No Left Turn" Restriction at Nebraska Avenue and Warren Street

AM PEAK HOUR
SCHOOL PEAK HOUR
PM PEAK HOUR
000 (000) [000]

NORTH

River School
Washington, DC

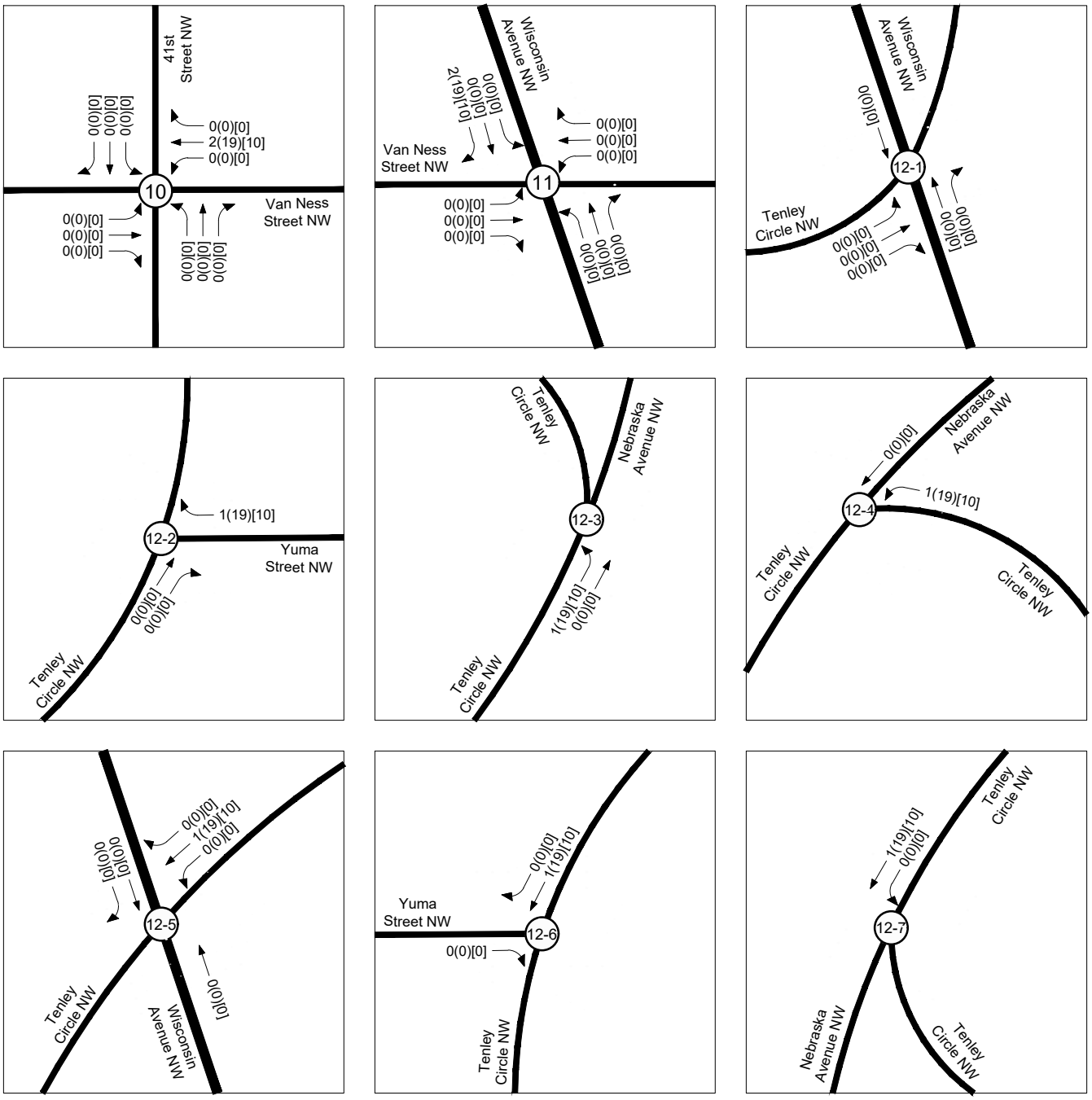


Figure 1-Cont
Rerouted Left Turns Associated with "No Left Turn" Restriction at Nebraska Avenue and Warren Street

AM PEAK HOUR
SCHOOL PEAK HOUR
PM PEAK HOUR
000 (000) [000]

NORTH
River School
Washington, DC

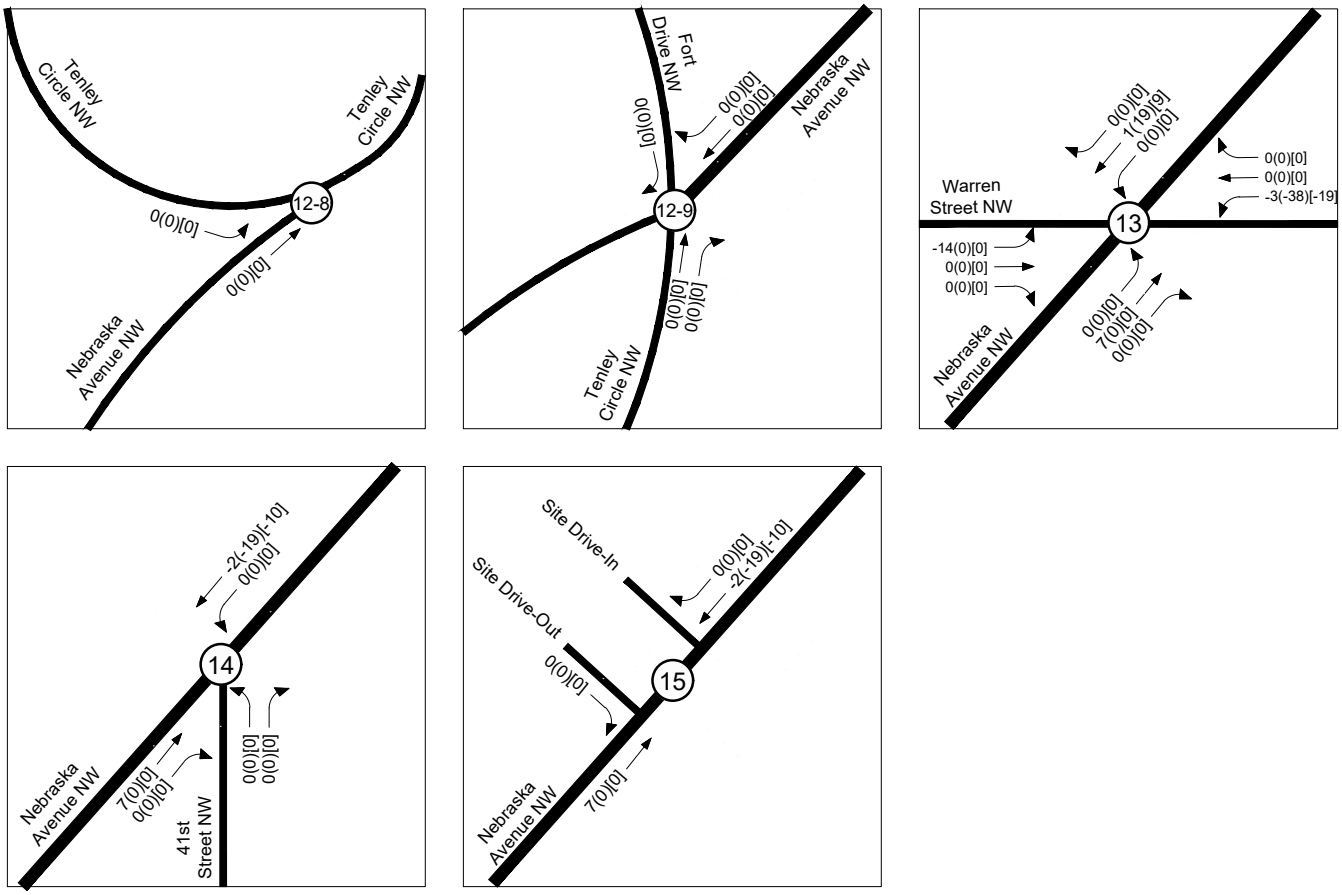


Figure 1-Cont
Rerouted Left Turns Associated with "No Left Turn" Restriction at Nebraska Avenue and Warren Street

AM PEAK HOUR
SCHOOL PEAK HOUR
PM PEAK HOUR
000 (000) [000]

NORTH
River School
Washington, DC

ATTACHMENT A
SYNCHRO REPORTS
TOTAL FUTURE WITH TIMING ADJUSTMENTS

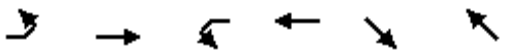
Lane Group	NBT	SBT	SET	NWT
Lane Group Flow (vph)	243	204	164	390
v/c Ratio	0.78	0.55	0.23	0.42
Control Delay	51.5	36.8	10.3	12.5
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	51.5	36.8	10.3	12.5
Queue Length 50th (ft)	142	110	45	123
Queue Length 95th (ft)	#232	167	72	168
Internal Link Dist (ft)	689	132	177	285
Turn Bay Length (ft)				
Base Capacity (vph)	312	369	708	925
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.78	0.55	0.23	0.42

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Traffic Volume (vph)	89	112	1	10	156	3	8	64	64	34	260	30
Future Volume (vph)	89	112	1	10	156	3	8	64	64	34	260	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-4%			5%			7%			-7%	
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frpb, ped/bikes		1.00			1.00			0.99			1.00	
Flpb, ped/bikes		0.97			1.00			1.00			1.00	
Frt		1.00			1.00			0.94			0.99	
Flt Protected		0.98			1.00			1.00			0.99	
Satd. Flow (prot)		1538			1301			1207			1604	
Flt Permitted		0.69			0.98			0.98			0.96	
Satd. Flow (perm)		1080			1274			1180			1543	
Peak-hour factor, PHF	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Adj. Flow (vph)	107	135	1	12	188	4	10	77	77	41	313	36
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	243	0	0	204	0	0	164	0	0	390	0
Confl. Peds. (#/hr)	58		42	42		58	20		8	8		20
Heavy Vehicles (%)	0%	0%	0%	9%	0%	0%	0%	0%	0%	0%	1%	0%
Parking (#/hr)				10	10	10	10	10	10			
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)		27.0			27.0			58.0			58.0	
Effective Green, g (s)		29.0			29.0			60.0			60.0	
Actuated g/C Ratio		0.29			0.29			0.60			0.60	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Lane Grp Cap (vph)		313			369			708			925	
v/s Ratio Prot												
v/s Ratio Perm		c0.23			0.16			0.14			c0.25	
v/c Ratio		0.78			0.55			0.23			0.42	
Uniform Delay, d1		32.5			30.0			9.3			10.7	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		17.1			5.9			0.8			1.4	
Delay (s)		49.6			35.9			10.1			12.1	
Level of Service		D			D			B			B	
Approach Delay (s)		49.6			35.9			10.1			12.1	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM 2000 Control Delay	25.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	78.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Lane Group	EBL	EBT	WBL	WBT	SET	NWT
Lane Group Flow (vph)	70	392	63	329	1867	1247
v/c Ratio	0.51	0.92	0.64	0.77	0.77	0.94
Control Delay	40.0	56.5	68.0	52.2	5.9	38.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	40.0	56.5	68.0	52.2	5.9	38.9
Queue Length 50th (ft)	40	311	43	233	54	449
Queue Length 95th (ft)	m48	m#400	#116	#367	63	#630
Internal Link Dist (ft)		849		339	239	287
Turn Bay Length (ft)	70		110			
Base Capacity (vph)	137	424	99	430	2439	1333
Starvation Cap Reductn	0	0	0	0	19	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.51	0.92	0.64	0.77	0.77	0.94

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

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

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Traffic Volume (vph)	64	279	77	57	246	54	2	1625	72	3	1077	55
Future Volume (vph)	64	279	77	57	246	54	2	1625	72	3	1077	55
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		5%			3%			1%			-1%	
Total Lost time (s)	4.0	4.0		4.0	4.0			3.5			3.5	
Lane Util. Factor	1.00	1.00		1.00	1.00			0.91			0.95	
Frpb, ped/bikes	1.00	1.00		1.00	0.99			0.98			0.99	
Flpb, ped/bikes	0.97	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.97			0.99			0.99	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1439	1477		1460	1496			3966			2532	
Flt Permitted	0.32	1.00		0.23	1.00			0.94			0.95	
Satd. Flow (perm)	478	1477		347	1496			3726			2404	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	70	307	85	63	270	59	2	1786	79	3	1184	60
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	70	392	0	63	329	0	0	1867	0	0	1247	0
Confl. Peds. (#/hr)	38		6	6		38	36		76	76		36
Confl. Bikes (#/hr)						2			5			5
Heavy Vehicles (%)	0%	1%	3%	2%	1%	0%	50%	4%	2%	0%	7%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	20	20	0	0	0
Parking (#/hr)											20	20
Turn Type	Perm	NA		Perm	NA		pm+pt	NA		Perm	NA	
Protected Phases		8			4		1	6			2	
Permitted Phases	8			4			6			2		
Actuated Green, G (s)	32.5	32.5		32.5	32.5			76.0			64.5	
Effective Green, g (s)	34.5	34.5		34.5	34.5			78.0			66.5	
Actuated g/C Ratio	0.29	0.29		0.29	0.29			0.65			0.55	
Clearance Time (s)	6.0	6.0		6.0	6.0			5.5			5.5	
Lane Grp Cap (vph)	137	424		99	430			2437			1332	
v/s Ratio Prot		c0.27			0.22			c0.05				
v/s Ratio Perm	0.15			0.18				0.45			c0.52	
v/c Ratio	0.51	0.92		0.64	0.77			0.77			0.94	
Uniform Delay, d1	35.7	41.5		37.3	39.0			14.6			24.8	
Progression Factor	0.86	0.89		1.00	1.00			0.25			1.00	
Incremental Delay, d2	7.3	18.4		27.3	12.2			2.2			13.5	
Delay (s)	38.0	55.3		64.6	51.3			5.9			38.3	
Level of Service	D	E		E	D			A			D	
Approach Delay (s)		52.7			53.4			5.9			38.3	
Approach LOS		D			D			A			D	

Intersection Summary			
HCM 2000 Control Delay	26.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	75.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	NBT	SBT	NET
Lane Group Flow (vph)	1248	1919	924
v/c Ratio	0.87	0.79	1.04
Control Delay	36.5	6.3	63.5
Queue Delay	0.5	2.0	22.4
Total Delay	37.0	8.3	85.9
Queue Length 50th (ft)	503	87	~389
Queue Length 95th (ft)	576	m90	#524
Internal Link Dist (ft)	297	110	29
Turn Bay Length (ft)			
Base Capacity (vph)	1441	2424	885
Starvation Cap Reductn	28	343	143
Spillback Cap Reductn	34	0	0
Storage Cap Reductn	0	0	0
Reduced v/c Ratio	0.89	0.92	1.25

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

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

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	0	991	169	0	1785	0	242	545	73	0	0	0
Future Volume (vph)	0	991	169	0	1785	0	242	545	73	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	10	10	10	12	12	12	12	12	12
Grade (%)		1%			-1%			-3%			1%	
Total Lost time (s)		2.0			2.0			7.0				
Lane Util. Factor		0.95			0.91			0.95				
Frpb, ped/bikes		0.99			1.00			1.00				
Flpb, ped/bikes		1.00			1.00			1.00				
Frt		0.98			1.00			0.99				
Flt Protected		1.00			1.00			0.99				
Satd. Flow (prot)		2620			4098			3039				
Flt Permitted		1.00			1.00			0.99				
Satd. Flow (perm)		2620			4098			3039				
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	0	1066	182	0	1919	0	260	586	78	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	1248	0	0	1919	0	0	924	0	0	0	0
Confl. Peds. (#/hr)	61		68	68		61	5		23	23		5
Confl. Bikes (#/hr)			4			4			2			
Heavy Vehicles (%)	0%	5%	13%	0%	4%	0%	4%	6%	4%	0%	0%	0%
Bus Blockages (#/hr)	0	0	0	0	20	0	0	0	0	0	0	0
Parking (#/hr)		0	0									
Turn Type		NA			NA		Perm	NA				
Protected Phases		15 6 1			15 6 1 2			3 4				
Permitted Phases							3 4					
Actuated Green, G (s)		61.0			69.0			43.0				
Effective Green, g (s)		59.0			62.0			45.0				
Actuated g/C Ratio		0.49			0.52			0.38				
Clearance Time (s)												
Lane Grp Cap (vph)		1288			2117			1139				
v/s Ratio Prot		c0.48			c0.47							
v/s Ratio Perm								0.30				
v/c Ratio		0.97			0.91			0.81				
Uniform Delay, d1		29.6			26.4			33.7				
Progression Factor		1.24			0.27			0.50				
Incremental Delay, d2		18.0			3.0			5.4				
Delay (s)		54.9			10.2			22.3				
Level of Service		D			B			C				
Approach Delay (s)		54.9			10.2			22.3			0.0	
Approach LOS		D			B			C			A	

Intersection Summary			
HCM 2000 Control Delay	26.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	26.0
Intersection Capacity Utilization	84.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group