American University

Transportation Analysis of the SIS Parking Facility

Future Conditions Assessment

HNTB

Revised October 2005

ZONING COMMISSION
District of Columbia
CASE NO.05-27
EXHIBIT NO.17C

Executive Summary

HNTB Corporation (HNTB) conducted a study for American University (AU) to analyze future traffic and parking for the future School of International Service (SIS) parking facility. Although existing queuing of traffic on Nebraska Avenue is expected to continue into the future, the SIS will produce no significant change on surrounding traffic operations.

HNTB studied existing traffic operations on streets surrounding AU and parking behavior at AU lots. The parking characteristics of the proposed SIS parking facility will be similar to those of other parking facilities on the AU campus. Two scenarios were examined as a basis for estimating future parking activity. The first scenario assumed that all trips to the proposed SIS parking facility are new auto trips to AU, and represents a "worst case" scenario. The second scenario assumed that the total number of auto trips to AU would remain constant and that these trips would be redistributed from existing parking facilities on the main campus to the proposed SIS parking facility. HNTB also examined several alternative configurations and operations for the SIS entrance, including adding dedicated left turn lanes on Nebraska Avenue at New Mexico Avenue.

This study reached the following conclusions:

- Nebraska Avenue is congested during peak periods due to traffic volumes exceeding capacity at Ward Circle and, to a lesser extent, the Foxhall Road intersection. The signalized intersections at Newark Street/Rockwood Parkway and New Mexico Avenue play a minor role in congestion within this corridor. Absent the impacts of the problems at Ward Circle and Foxhall Road, these other intersections would operate at a good level of service.
- The proposed SIS parking garage would generate a small volume of new traffic on Nebraska Avenue, and thus result in no significant traffic impacts on this street. The computed change in delay due to this small volume change would go unnoticed by most motorists. Delays associated with Ward Circle congestion are expected to continue, and it is this congestion that governs travel time in the corridor.
- Anticipated changes in traffic volumes are very small compared to the total volume of traffic on the roadways. The estimated increase in traffic volumes is on the order of the normal variation in traffic volumes from day to day.
- The alternative lane configurations and operating schemes examined for the proposed SIS driveway show little variation in average intersection delay and would go unnoticed by most motorists. Congestion due to Ward Circle would mask the reduction in delay that an alternative configuration or operation would bring about.

- The level of service analysis in itself does not justify widening Nebraska Avenue to five lanes with exclusive left turn lanes at New Mexico Avenue. While such a widening would improve the calculated intersection level of service, the improvements would not result in noticeable travel time differences along Nebraska Avenue during peak periods because the true capacity constraints in the corridor would remain unaddressed.
- As the number of University parking spaces will increase, no increase in pressure on off-campus parking is anticipated.
- With proper site design, the SIS Building and its parking facilities will not interfere with pedestrians crossing Nebraska Avenue.

Introduction

American University has asked HNTB to conduct an analysis of traffic and parking for the future School of International Service (SIS) parking facility. American University's main campus is located in northwest Washington, DC, at the intersection of Massachusetts and Nebraska Avenues NW. The University proposes to construct a new SIS Building on the site of the current Bender Library parking lot. The building would have a below grade parking facility under the building. The parking facility would have a single vehicular access point on Nebraska Avenue that could be located opposite New Mexico Avenue. See Figure 1 depicting the project site.

The proposed SIS Building is included in the University's approved campus plan. However, constructing the building will require approval from the District of Columbia Zoning Commission. The proposed facility may have potential impacts on the local street network — such as increased traffic congestion or parking. These impacts need to be understood as part of the zoning approval process.

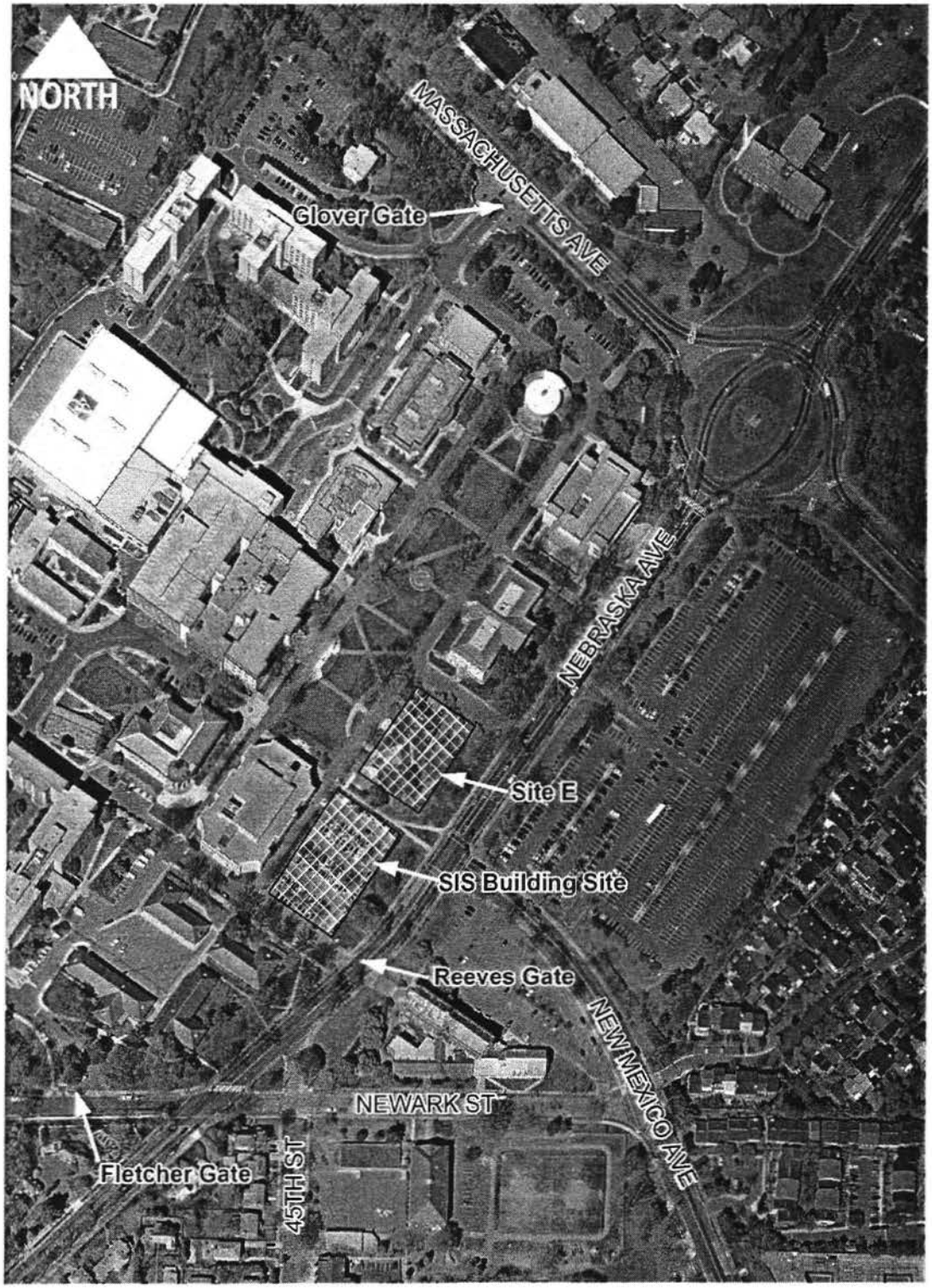
The purpose of this study is to analyze potential traffic impacts of the proposed facility on the existing street system. This analysis will be used by the SIS Building design team and the legal team in presenting the zoning case to the District of Columbia Zoning Commission.

This report documents the analysis of future conditions to assess potential impacts to traffic and parking. Based on the operations of the existing parking facilities, the operation of the SIS parking facility is postulated. Peak period trip generation at the proposed parking facility is estimated and superimposed on the background traffic. Potential redistribution of parking activity at the University is assessed. Future condition traffic impacts on Nebraska Avenue are estimated and potential mitigating measures are examined.

The following assumptions were made about future conditions at the opening of the new SIS Building:

- No increase in background traffic over current conditions
- The peaks in background traffic continue to occur at the same times
- The Katzen Arts Center constitutes the only other new development within the study area
- No changes to the transportation system, such as the creation or elimination of streets or transit lines
- No policy or scheduling changes, to include class schedule, transit schedules, and parking regulations.

Figure 1: Project site



Methodology

This section outlines the assumptions and basis of the subsequent analysis.

The new SIS parking garage will be located on the site of the existing Bender Library lot. At the time of this study the programmed number of parking spaces in this facility is 350, a conservative figure as the final design will likely have fewer spaces. The analysis also looks at the case of 520 parking spaces, the maximum contemplated in the campus plan for this site and neighboring Site E. The building will displace the approximately 90 parking spaces currently on the site, including 77 spaces in the Bender Lot. The new garage will allow parking by permit and will likely have metered parking as well. Access to the garage will be from Nebraska Avenue immediately across from the intersection with New Mexico Avenue.

The new garage will have a maximum occupancy of 90 percent of spaces. This can be ensured by setting a low initial oversell ratio of parking permits and slowly raising the oversell ratio until the desired maximum occupancy is achieved. Of the permit-only lots examined in the existing conditions analysis part of this study, a maximum occupancy of 72 to 75 percent was observed. Including the Nebraska lot, the aggregate maximum occupancy observed was 89 percent.

The arrival and departure rate at the new SIS garage will be the same as the aggregate arrival and departure rate at the observed parking facilities. This means the new garage will take on operational characteristics of each of the observed facilities.

In terms of traffic impacts, two scenarios are examined:

Scenario 1: Parkers at the new SIS garage represent new auto trips to the University. That is, everyone who currently drives to the University will continue to do so, and those who will park in the SIS garage currently do not drive to the University. Scenario 1 is the most problematic in terms of traffic impacts.

Scenario 2: Parkers at the new SIS garage currently drive to the University and park elsewhere. They will be diverted from their former parking facility to the SIS garage. Parkers will be diverted only from parking facilities on the main campus. These exclude:

- *Tenley Campus.* This campus is assumed independent of the main campus.
- *Nebraska lot.* Current policies at this lot have created a demand exceeding supply, so this lot will continue to fill.

- *Nebraska Hall lot.* This lot is too far from the campus core and too small to make a difference.
- *Handicapped parking near Woods Gate.* This lot caters to a segment of population with specific requirements.
- *Katzen Arts Center.* This new facility itself will divert parkers from other main campus parking facilities.

One hundred percent of parking in the current Bender lot will be diverted to the SIS garage, as the Bender lot is being replaced by the garage. Diversion from the remaining parking facilities will be proportional to the number of spaces in each facility. A portion of traffic therefore will be diverted from Glover Gate, Reeves Gate, and Fletcher Gate to the new garage entrance near New Mexico Avenue.

Scenario 2 is expected to result in reduced traffic impacts as compared to Scenario 1. Scenario 2 could be viewed as a sensitivity analysis.

Analysis

The analysis begins with an aggregation of parking data collected on November 1, 2004. A generalized parking facility occupancy profile is created. Then generalized arrival and departure rates are computed to arrive at an auto trip generation for the proposed SIS garage.

Next, the generated trips are distributed through the study area roadway network following the two scenarios described in the Methodology section:

- all new trips scenario
- diverted trips scenario.

Finally, the new trip distribution is superimposed on the existing background traffic so that traffic impacts can be assessed. Assessment will be measured using intersection level of service.

Trip Generation

The occupancy of the studied on-campus parking facilities was determined in the existing conditions phase of this study. The combined occupancy and the total capacity of these lots are shown in Figure 2. The total occupancy is then plotted in Figure 3 in terms of the percentage of capacity.

It can be seen that the aggregate parking facility occupancy peaks at about 90 percent of capacity. The proposed SIS garage is therefore assumed also to peak at 90 percent of capacity. This is consistent with the notion of effective capacity: at some point, the few remaining spaces are so difficult to find, parkers will stop looking and try to park elsewhere.

Figure 2: Aggregate lot occupancy –by number of spaces

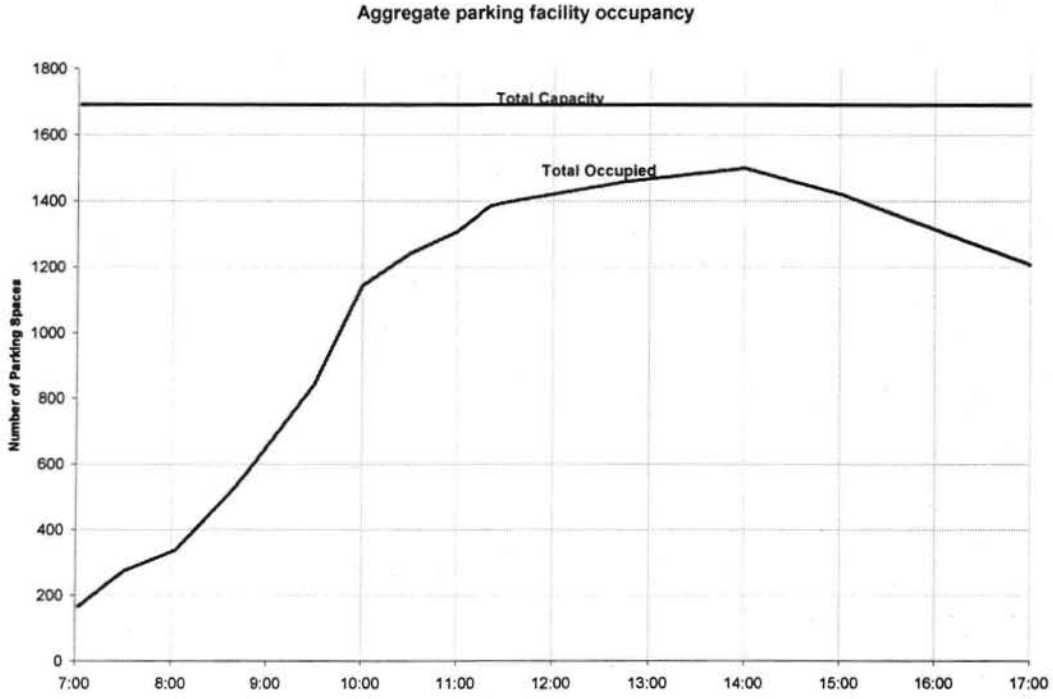
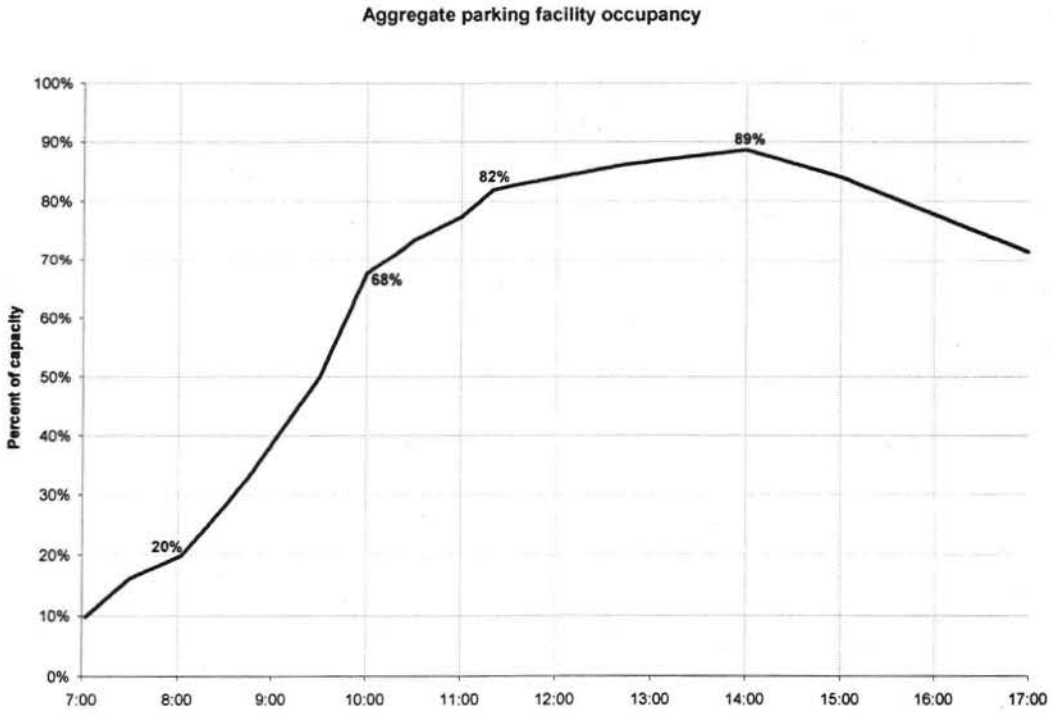


Figure 3: Aggregate lot occupancy – by percent of capacity



The vehicle arrival and departure rates at the observed parking facilities was similarly aggregated. The vehicle flow rates into and out of the combined facilities is expressed in terms of the percentage of capacity in Figure 4. The arrival and departure rates in Figure 4 are therefore based on a generalized parking facility that fills to about 90 percent occupancy. Using Figure 4, an estimated trip generation rate can be calculated by time of day for the proposed 350-space SIS garage that fills to 90 percent occupancy, as shown in Figure 5. Similarly, an estimated trip generation rate for a maximum of 520 parking spaces filling to 90 percent capacity (for the SIS Building plus Site E) in shown in Figure 6.

Figure 4: Aggregate arrival and departure rate

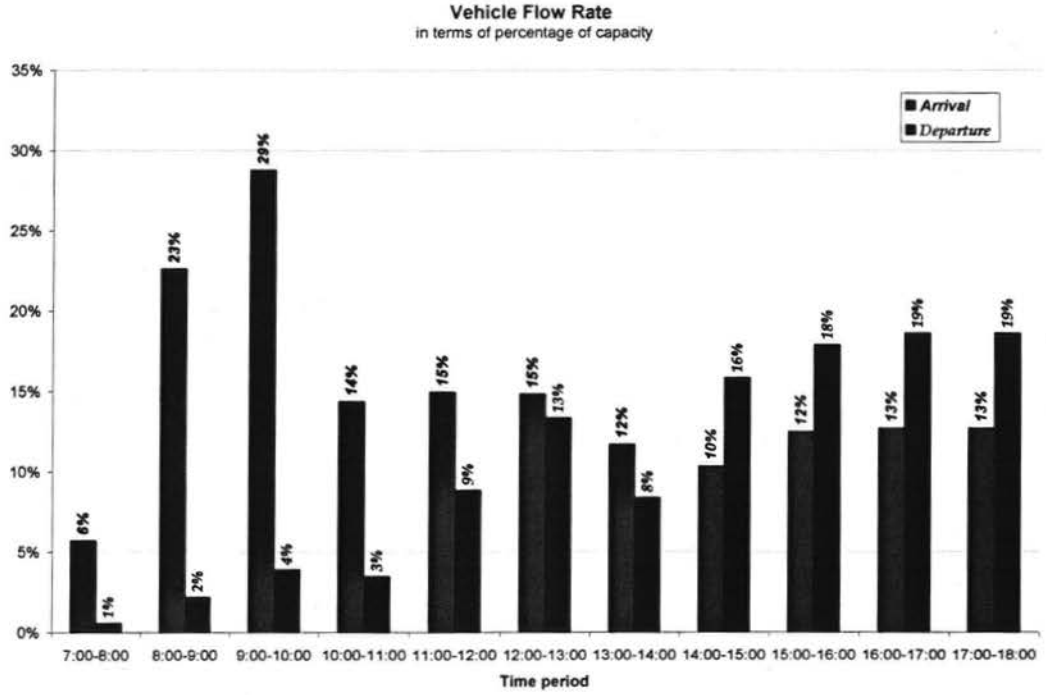


Figure 5: Trip generation at proposed 350-space SIS garage

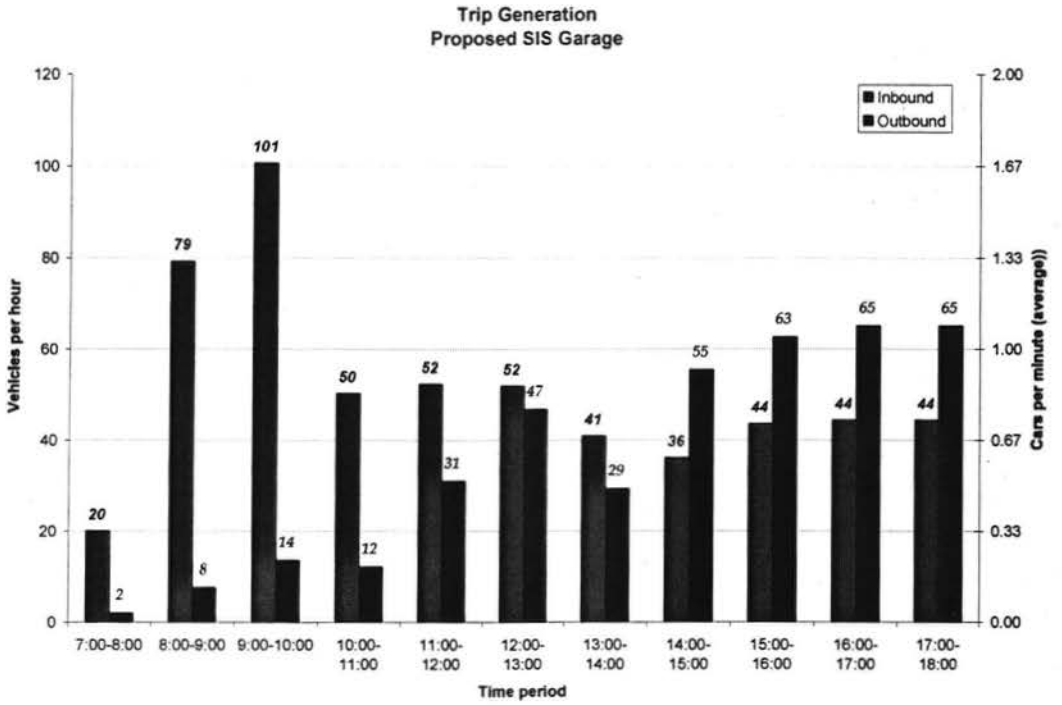
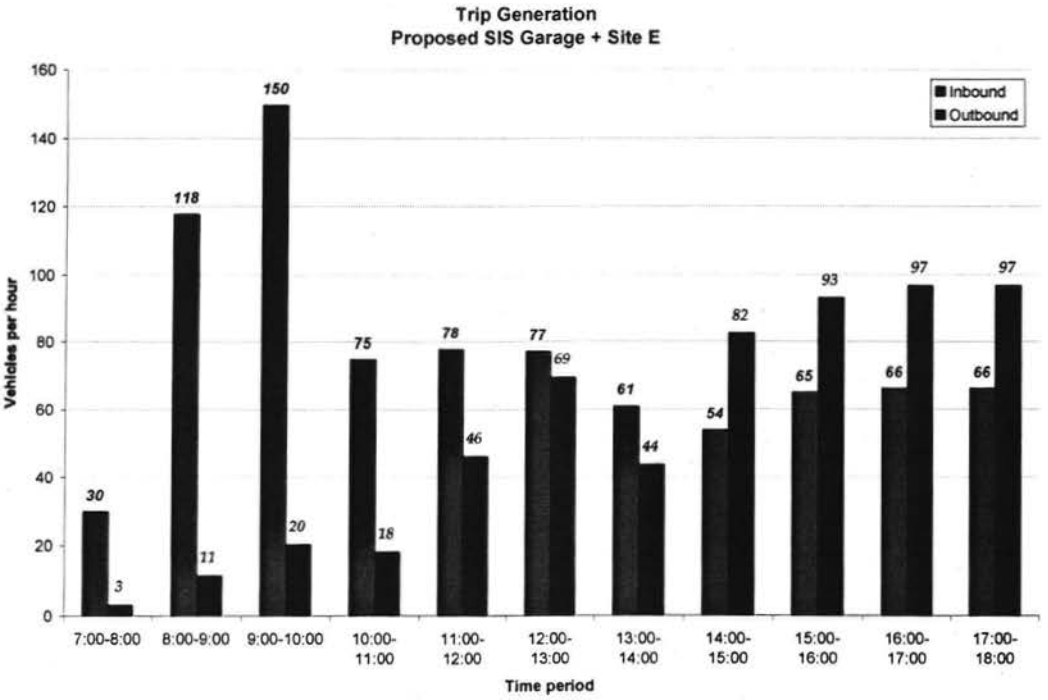


Figure 6: Trip generation for 520 spaces at SIS and Site E



Parking data collection began at 7:00 a.m. and stopped at 5:00 p.m. Based on observations of various University parking facilities and an understanding of current class schedules and staff working hours, it is a conservative assumption that activity in the 5:00 p.m. hour is similar to activity in the 4:00 p.m. hour. Therefore, for the purpose of this study, the trip generation in the 5:00 p.m. hour is considered the same as the 4:00 p.m. hour.

Trip generation at the proposed SIS garage and for the maximum number of spaces for four "peak" hours is summarized in Table 1. The roadway peak hours measured during this study are 8:00 – 9:00 a.m. and 5:00 – 6:00 p.m. The University-generated traffic peaks at 9:00 – 10:00 a.m. and 4:00 – 5:00 p.m. based on observations during this study.

Table 1: Summary of trip generation

	SIS Building		SIS Building + Site E	
Hour	Inbound trips	Outbound trips	Inbound trips	Outbound trips
8:00 - 9:00 a.m.	79	8	118	11
9:00 - 10:00 a.m.	101	14	150	20
4:00 - 5:00 p.m.	44	65	66	97
5:00 - 6:00 p.m.	44	65	66	97

Trip Distribution

Two scenarios are examined for trip distribution:

- all generated trips are totally new trips to the University
- all generated trips are redistributed from other University parking facilities.

Trips to and from the proposed SIS garage are distributed to the cordon of the study area in proportion to existing traffic volumes at each portal. This is a common method for estimating trip distribution and is valid if:

- the study area is small enough that all of the generated outbound auto trips terminate outside the study area and all of the generated inbound auto trips originate outside the study area
- the number of new trips generated is small compared to the traffic volumes at the portals.

The proportion of traffic volumes at the study area cordon is shown for the a.m. peak period in Figure 7 and for the p.m. peak period in Figure 8.

Figure 7: Distribution of trips at portals – a.m. peak period

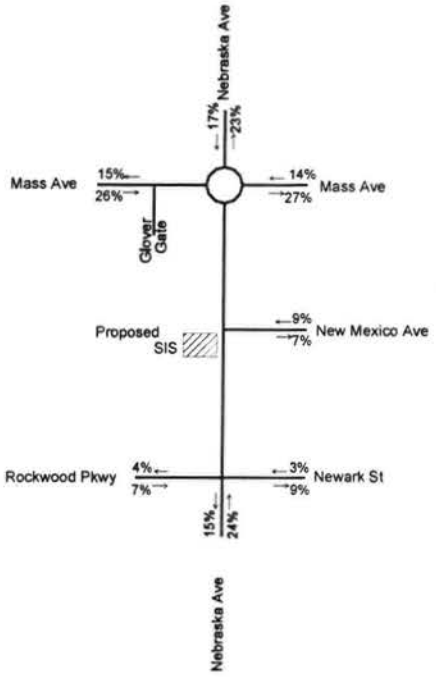
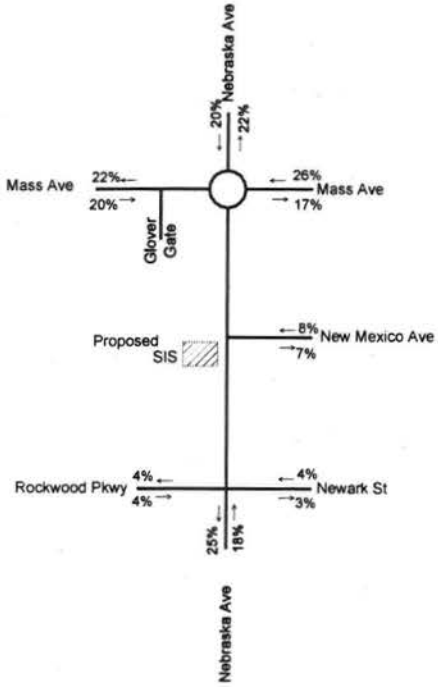


Figure 8: Distribution of trips at portals – p.m. peak period



Scenario 1

In the first scenario, all generated trips to the proposed SIS garage are new auto trips to the University, representing a "worst case" scenario.

The new trips to and from the proposed SIS garage create a slight increase in the intersection turning movement volumes within the study area. These volume increases and the resulting new volumes are shown in Appendix A.

Scenario 2

In the second scenario, the total number of auto trips to the University remains constant. Those who park in the proposed SIS garage formerly parked elsewhere on campus. Trips are redistributed from existing parking facilities on the main campus to the proposed SIS garage in proportion to the number of spaces accessible from each of three gates: Glover Gate, Reeves Gate, and Fletcher Gate. The estimated percentage of trips to the SIS that are diverted from each of these gates is shown in Table 2.

Table 2: SIS trips diverted from other gates

Diverted from Glover Gate	49%
Diverted from Reeves Gate	37%
Diverted from Fletcher Gate	14%
TOTAL	100%

From Glover Gate, 49 percent of on-campus parking spaces are served, therefore 49 percent of diverted trips are taken away from Glover Gate. The same process holds for Reeves Gate and Fletcher Gate.

Trips to and from the proposed SIS garage slightly increase the intersection turning movement volumes within the study area. However, there is a simultaneous decrease in turning movement volumes for trips no longer going to other parking facilities. The turning volume changes and the resulting new volumes are shown in **Appendix B.**

Impacts

Level of Service Impacts

Traffic impacts due to the proposed SIS garage are measured using level of service at the affected intersections along Nebraska Avenue. Level of service (LOS) is defined in the Transportation Research Board's *Highway Capacity Manual* for signalized and unsignalized intersections based on control delay in seconds per vehicle. Level of service is rated using the letters A through F, with A being very good level of service (low delay) and F being poor level of service (high delay). Generally, lower levels of service are tolerated during peak periods in urban environments such as this study area. The District of Columbia has defined LOS D as acceptable. For more information on the definition of level of service, see Appendix C.

The following three tables give the calculated level of service for the roadway peak hours analyzed for the existing condition, the Scenario 1 condition, and the Scenario 2 condition. Table 3 is for the intersection of Nebraska Avenue and New Mexico Avenue, Table 4 is for Nebraska Avenue at Newark Street, and Table 5 is for Massachusetts Avenue at Glover Gate.

It should be noted that queues northbound from Ward Circle and, to a lesser extent, southbound from Foxhall Road at times extend to the studied intersections, as discussed below. This congestion can result in lower turning movement counts. Also, delay attributable to Ward Circle congestion is not reflected in the level of service calculations. Nevertheless, comparing the change in delay at the studied intersections gives an indication of the traffic impacts of the proposed SIS building.

Table 3: Level of service and delay (sec/veh)
Nebraska Avenue at New Mexico Avenue

	SIS Building		SIS Building + Site E	
Scenario	8 - 9 a.m.	5 - 6 p.m.	8 - 9 a.m.	5 - 6 p.m.
Existing condition	B (18.1)	B (18.8)		
Scenario 1	C (20.1)	C (21.8)	C (21.4)	C (23.8)
Scenario 2	B (19.8)	C (20.1)	C (20.3)	C (21.3)

Table 4: Level of service and delay (sec/veh)
Nebraska Avenue at Newark Street

	SIS Building		SIS Building + Site E	
Scenario	8 - 9 a.m.	5 - 6 p.m.	8 - 9 a.m.	5 - 6 p.m.
Existing condition	B (16.9)	B (15.4)		
Scenario 1	B (17.4)	B (16.1)	B (17.7)	B (16.9)
Scenario 2	B (16.9)	B (15.3)	B (16.9)	B (15.2)

Table 5: Level of service and delay (sec/veh)
Massachusetts Avenue at Glover Gate

	SIS Building		SIS Building + Site E	
Scenario	8 - 9 a.m.	5 - 6 p.m.	8 - 9 a.m.	5 - 6 p.m.
Existing condition	A (8.6)	B (11.9)		
Scenario 1	A (8.7)	B (12.0)	A (8.8)	B (12.0)
Scenario 2	A (8.1)	B (11.3)	A (8.2)	B (11.3)

From Tables 3 through 5, it is clear that in Scenario 1 intersection delays increase slightly at Nebraska Avenue and New Mexico Avenue and are virtually unchanged elsewhere. For the 5:00 – 6:00 p.m. hour, the level of service at Nebraska and New Mexico drops to C; however, mitigation does not appear to be in order. In Scenario 2, again the level of service at Nebraska and New Mexico drops to C. The changes in intersection delay from existing conditions are too small to be noticed by most motorists.

Queuing

Currently, northbound Nebraska Avenue traffic backs up from Ward Circle, interfering with operations at the New Mexico Avenue intersection. **Figures 9 – 11** give the estimated average and maximum queue lengths for northbound Nebraska Avenue approaching Ward Circle in the existing, Scenario 1, and Scenario 2 conditions.

Figure 9: Existing condition computed queue lengths –
northbound Nebraska Avenue at Ward Circle



Figure 10: Scenario 1 computed queue lengths – northbound Nebraska Avenue at Ward Circle

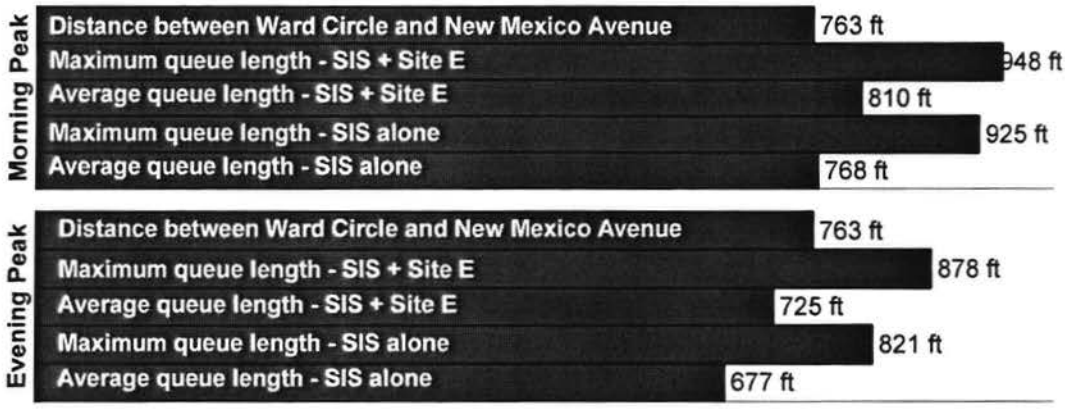
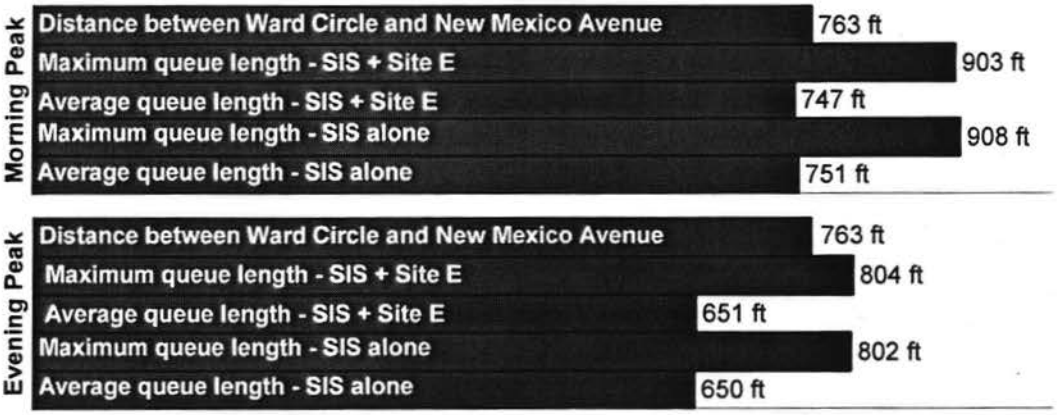


Figure 11: Scenario 2 computed queue lengths – northbound Nebraska Avenue at Ward Circle



In Scenario 1, queues are slightly longer than existing, and in Scenario 2, queues are slightly shorter. The difference in queue length between the SIS-alone case and the SIS + Site E case is more pronounced in Scenario 1 when trips are assumed to be added. In Scenario 2 when trips are assumed to be redistributed the difference between the SIS-alone case and the SIS + Site E case is non-existent. In all cases, however, maximum queues still interfere with operations at the intersection of Nebraska Avenue and New Mexico Avenue. Southbound queues backing up from Foxhall Road are similarly expected to continue into the future.

Parking Impacts

Parking impacts resulting from the construction of the SIS Building are expected to be minimal.

During the interim condition while the building is being constructed, 80 spaces at the Bender lot will be eliminated. At the same time, approximately 500 new spaces are now open at Katzen Arts Center. Demand at the Nebraska lot will remain high. Former Bender lot parkers will need to be accommodated in metered parking at the Nebraska lot or in permit parking elsewhere. While Katzen construction workers will no longer be using the Nebraska lot, SIS construction workers are likely to park there.

At the end of SIS Building construction, there will be a gain of 350 spaces, along with the recent gain of 500 spaces at Katzen Arts Center. Former Bender lot parkers could be accommodated in new SIS garage with pay-by-the-hour or permit parking. No changes in on-street parking policies are anticipated. Therefore, as the number of University parking spaces will increase, no increase in pressure on off-campus parking is anticipated.

Pedestrian Impacts

The number of pedestrians crossing Nebraska Avenue at New Mexico Avenue, adjacent to the Nebraska lot, is expected to remain high. Left turning vehicles exiting the proposed SIS garage would conflict with this pedestrian crossing. However, compared to the number of right turns from New Mexico Avenue that also conflict with this pedestrian crossing, the number of left turns is small—on average one vehicle per signal cycle in the peak hour. Therefore, the presence of the SIS Building and garage is not expected to add to interference with pedestrians crossing Nebraska Avenue.

Presently, heavily used walkways from the Nebraska / New Mexico intersection abut the existing Bender lot. The proposed SIS Building and its driveway likely would require realigning these walkways. Attention to site design is important to mitigate potential conflicts.

Should the decision be made to add a fifth lane to Nebraska Avenue to accommodate exclusive left turn lanes, a change in signal timing should be considered to increase the time allowed for pedestrians to cross the widened Nebraska Avenue. An increase of 3 seconds to the east-west (New Mexico Avenue approach) phase, complemented by a decrease in 3 seconds to the north-south (Nebraska Avenue approaches) phase, is suggested.

Transit Impacts

The SIS Building is expected to have minor impacts on transit operations. Currently a bus stop is located on Nebraska Avenue in front of the Bender lot and near the New Mexico Avenue intersection. It may be necessary to relocate this bus stop slightly to the south to accommodate the new driveway, but this would not change transit operations.

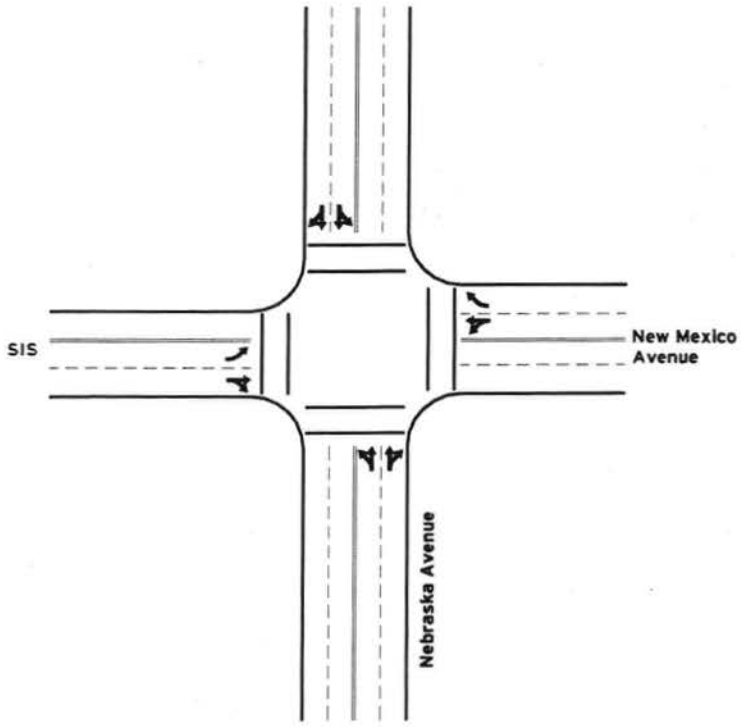
Suggested Intersection Layout

Figure 12 shows a suggested layout of the intersection of Nebraska Avenue and New Mexico Avenue including the driveway to the proposed SIS Building garage. Based on the level of service analysis, no widening or additional turn lanes on Nebraska Avenue appear warranted.

The driveway should consist of three lanes at the intersection, one inbound and two outbound. The left outbound lane should be for left turns, and the right outbound lane should be for right turns and through movements. The number of outbound left turns is expected to exceed the number of outbound right turns and through movements. Furthermore, outbound left turns conflict with three movements (all westbound movements from New Mexico Avenue) while outbound right turns and through movements only conflict with westbound left turns from New Mexico Avenue.

The two outbound lanes could be aligned with the two eastbound lanes of New Mexico Avenue, as shown in Figure 12 below. In this configuration, eastbound and westbound through movements align with their receiving lanes.

Figure 12: Suggested intersection layout



Alternative configurations and operations of this intersection have been considered. These are summarized in Table 6.

Table 6: Additional configurations considered

Alteration Case	Impacts on Nebraska & New Mexico	Other Impacts
Repositioning the parking garage entry to the existing Reeves Gate driveway and keeping the Reeves Gate driveway and Nebraska Avenue as an unsignalized intersection.	Moving the garage entrance to Reeves Gate would result in a delay reduction at Nebraska and New Mexico by an amount that would go unnoticed by most motorists.	Delay reduction at Nebraska and New Mexico would be offset by an increase in delay at the new Reeves Gate intersection.
Repositioning the parking garage entry to the existing Reeves Gate driveway and upgrading the Reeves Gate driveway and Nebraska Avenue to a signalized intersection.	Moving the garage entrance to Reeves Gate would result in a delay reduction at Nebraska and New Mexico by an amount that would go unnoticed by most motorists.	Delay reduction at Nebraska and New Mexico would be offset by an increase in delay at the new Reeves Gate intersection. Decreasing the spacing between signalized intersections also would increase the likelihood of spillback problems.
Keeping the parking garage entry as proposed by adding the fourth leg to the intersection of Nebraska Avenue and New Mexico Avenue and optimizing the signal timing to provide a northbound protected left into the garage from Nebraska Avenue.	Providing a protected northbound left turn phase at Nebraska and New Mexico would result in modest delay reductions but would waste green time given the infrequency of northbound left turns. Assigning the left lanes on the northbound and southbound approaches exclusively for left turns would reduce substantially the through capacity, resulting in highly noticeable increases in delay. Adding a protected northbound left turn would not change the green time on the New Mexico Avenue approach. Therefore, it would not change operations for those vehicles or for pedestrians crossing Nebraska Avenue.	

Alteration Case	Impacts on Nebraska & New Mexico	Other Impacts
Keeping the parking garage entry as proposed by adding the fourth leg to the intersection of Nebraska Avenue and New Mexico Avenue and prohibiting the northbound left turn from Nebraska Avenue.	Banning northbound left turns into the SIS parking garage would result in an unnoticeable decrease in intersection delay.	Banning northbound left turns would divert a small number of additional vehicles (about 30 in the peak hour) onto Newark Street and New Mexico Avenue.
Keeping the parking garage entry as proposed by adding the fourth leg to the intersection of Nebraska Avenue and New Mexico Avenue and splitting the phase for Nebraska Avenue so that southbound and northbound movements each occur in their own phase.	Splitting the northbound and southbound phases at Nebraska and New Mexico (which would allow protected left turns) would also substantially increase delay.	
Keeping the parking garage entry as proposed by adding the fourth leg to the intersection of Nebraska Avenue and New Mexico Avenue and adding a dedicated left turn lane southbound and northbound on Nebraska Avenue.	Widening Nebraska Avenue to provide dedicated left turn lanes would result in an unnoticeable change in intersection delay in the morning peak, and a slightly greater reduction in delay in the evening peak. A protected northbound left turn phase would result in higher intersection delay than merely a permitted northbound left turn, because it would necessarily reduce green time for the heavy southbound through movement.	Adding a dedicated left turn lanes would entail widening Nebraska Avenue from the current 40 feet to at least 50 feet (five 10-foot lanes) or 55 feet (five 11-foot lanes). The increased pedestrian crossing distance could require extending the green time on the New Mexico Avenue approach by 3 seconds while decreasing the green time for Nebraska Avenue the same amount. The widening would extend north from the New Mexico Avenue intersection approximately half way to Ward Circle, causing the relocation of sidewalks, bus shelters, and landscaping.

Conclusions

Nebraska Avenue near American University is congested during peak periods due to traffic volumes exceeding capacity at Ward Circle and, to a lesser extent, the Foxhall Road intersection. The signalized intersections at Newark Street/Rockwood Parkway and New Mexico Avenue play a minor role in congestion within this corridor. Absent the impacts of the problems at Ward Circle and Foxhall Road, these other intersections would operate at a good level of service.

The proposed SIS building and parking garage would generate a small volume of new traffic on Nebraska Avenue, and thus result in no significant traffic impacts on Nebraska Avenue. Level of service calculations show a minor increase in intersection delay at Nebraska Avenue and New Mexico Avenue due to these small anticipated changes in traffic volumes. The change in delay would go unnoticed by most motorists. Delays associated with Ward Circle congestion are expected to continue, and it is this congestion that governs travel time in the corridor.

Anticipated changes in traffic volumes at Nebraska Avenue and New Mexico Avenue are very small compared to the total volume of traffic on these streets. The estimated worst-case increase in traffic volumes turning at Nebraska Avenue and New Mexico Avenue is on the order of the normal variation in traffic volumes from day to day.

The alternative lane configurations and operating schemes examined for the proposed SIS driveway show little variation in average intersection delay and would go unnoticed by most motorists. Congestion due to Ward Circle would mask the reduction in delay that an alternative configuration or operation would bring about.

The level of service analysis in itself does not justify widening Nebraska Avenue to five lanes with exclusive left turn lanes at New Mexico Avenue. While such a widening would improve the *calculated* intersection level of service, the improvements would not result in noticeable travel time differences along Nebraska Avenue during peak periods because the true capacity constraints in the corridor would remain unaddressed.

Appendix A: Turning Movement Volumes – Scenario 1

Figure A-1: Turning movement volumes, Scenario 1, SIS only, 8 - 9 a.m.

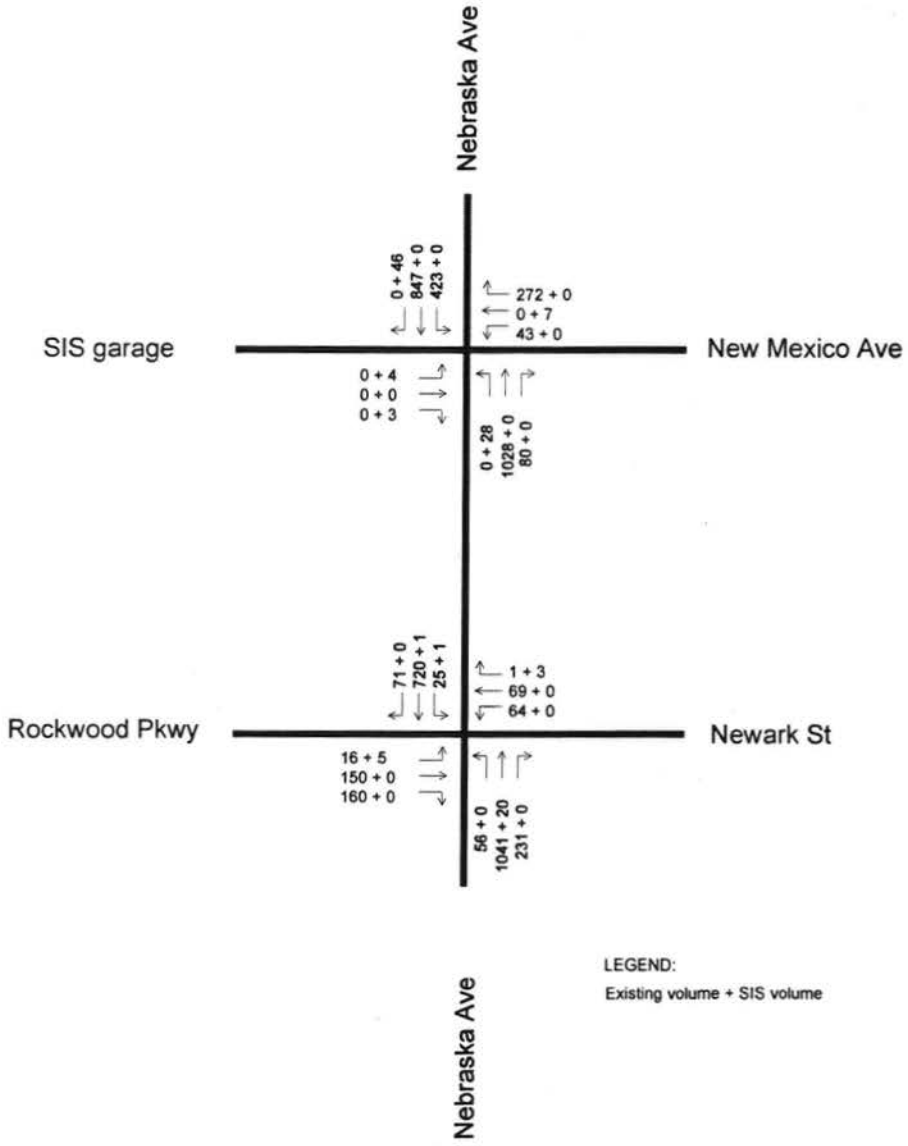


Figure A-2: Turning movement volumes, Scenario 1, SIS only, 5 - 6 p.m.



Figure A-3: Turning movement volumes, Scenario 1, SIS + Site E, 8 – 9 a.m.

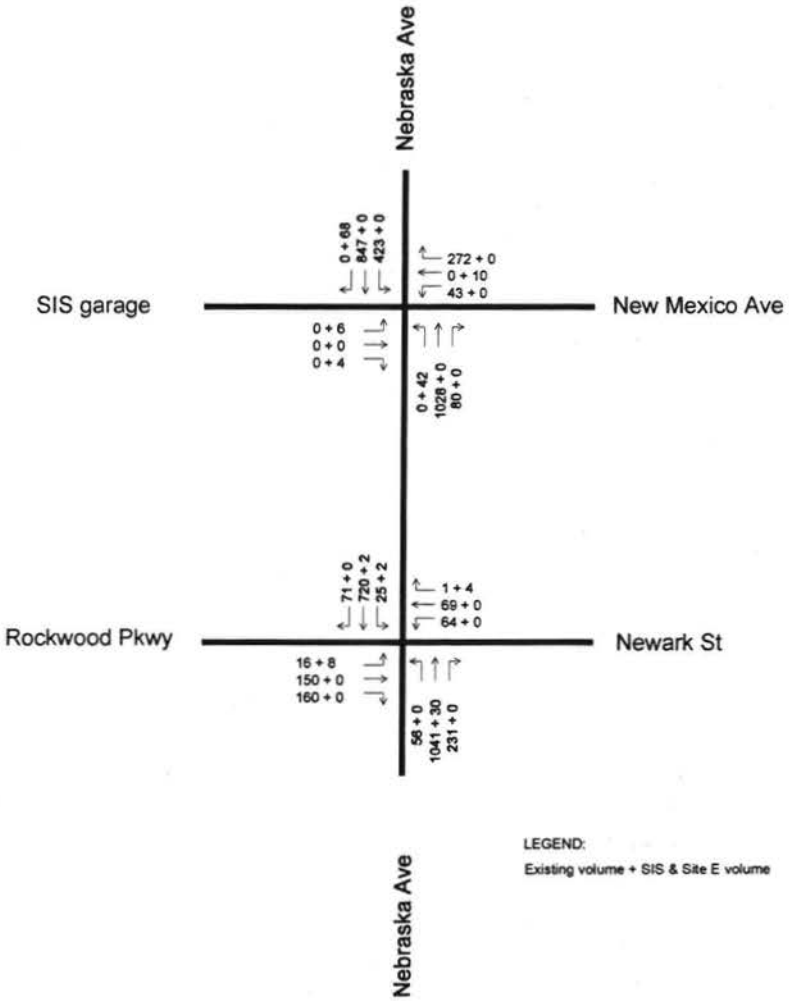
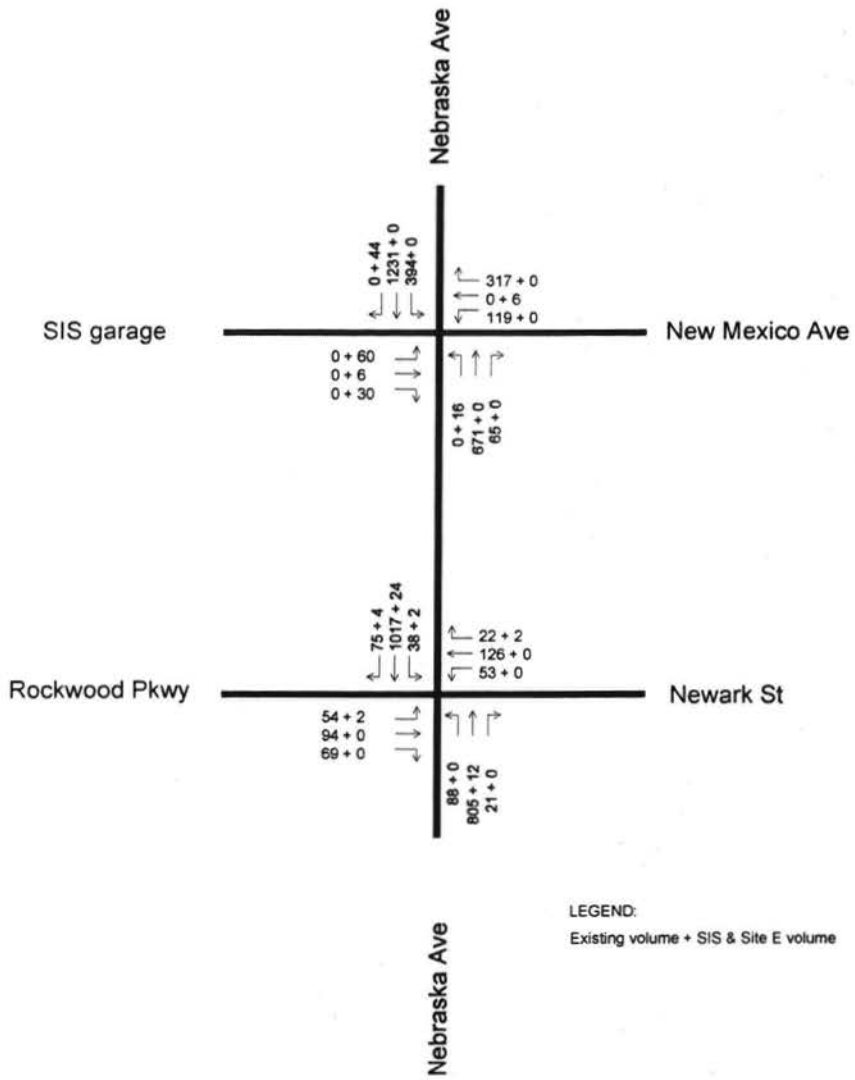


Figure A-4: Turning movement volumes, Scenario 1, SIS + Site E, 5 – 6 p.m.



Appendix B: Turning Movement Volumes – Scenario 2

Figure B-1: Turning movement volumes, Scenario 2, SIS only, 8 - 9 a.m.

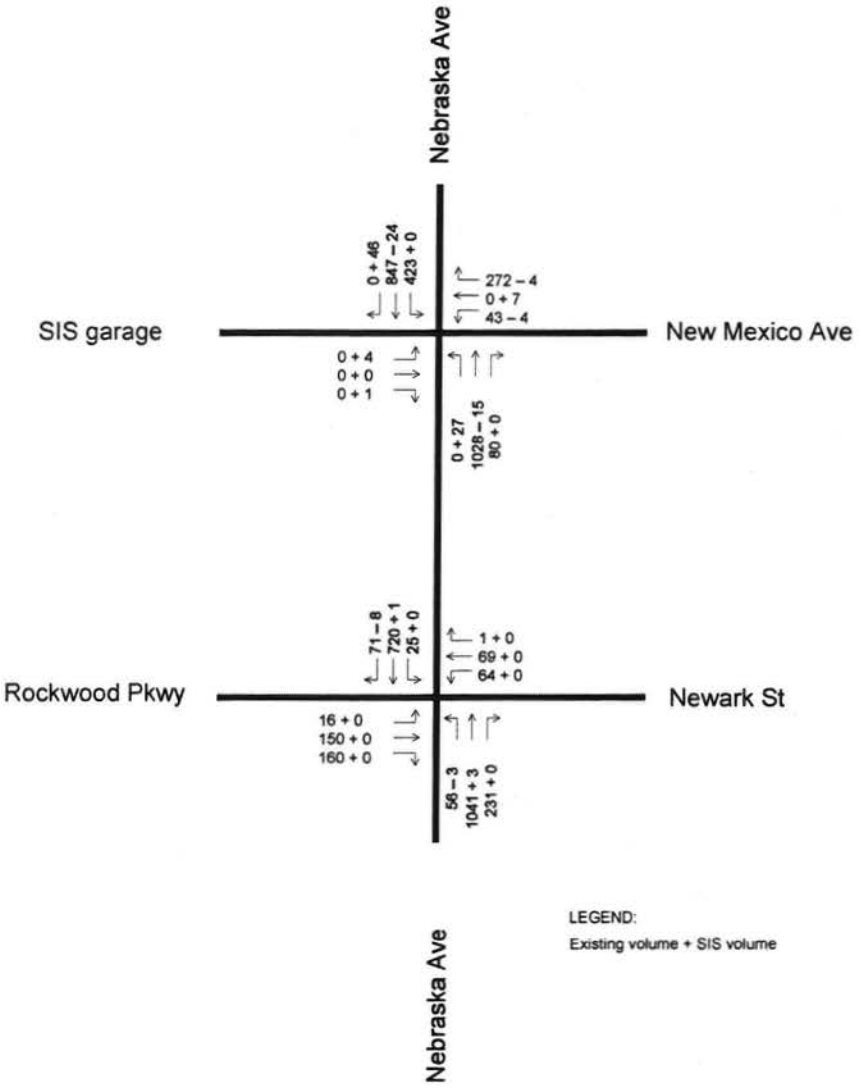


Figure B-2 Turning movement volumes, Scenario 2, SIS only, 5 - 6 p.m.

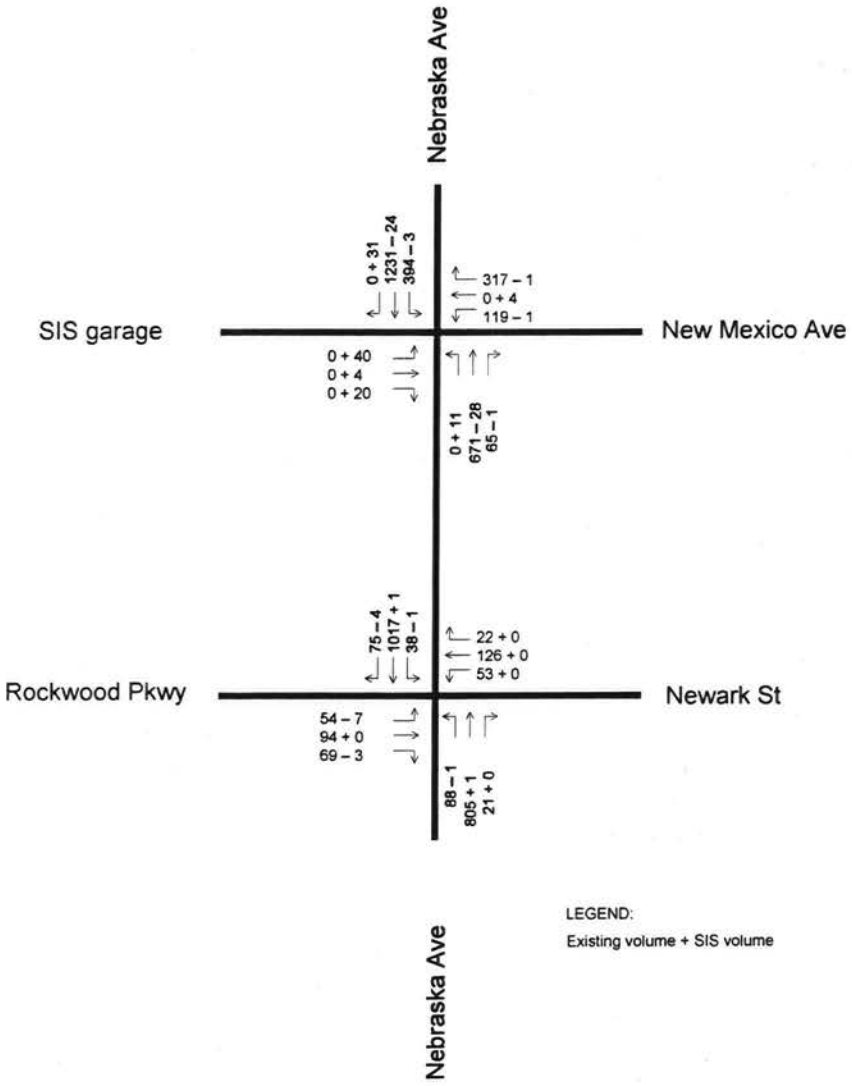


Figure B-3: Turning movement volumes, Scenario 2, SIS + Site E, 8 – 9 a.m.

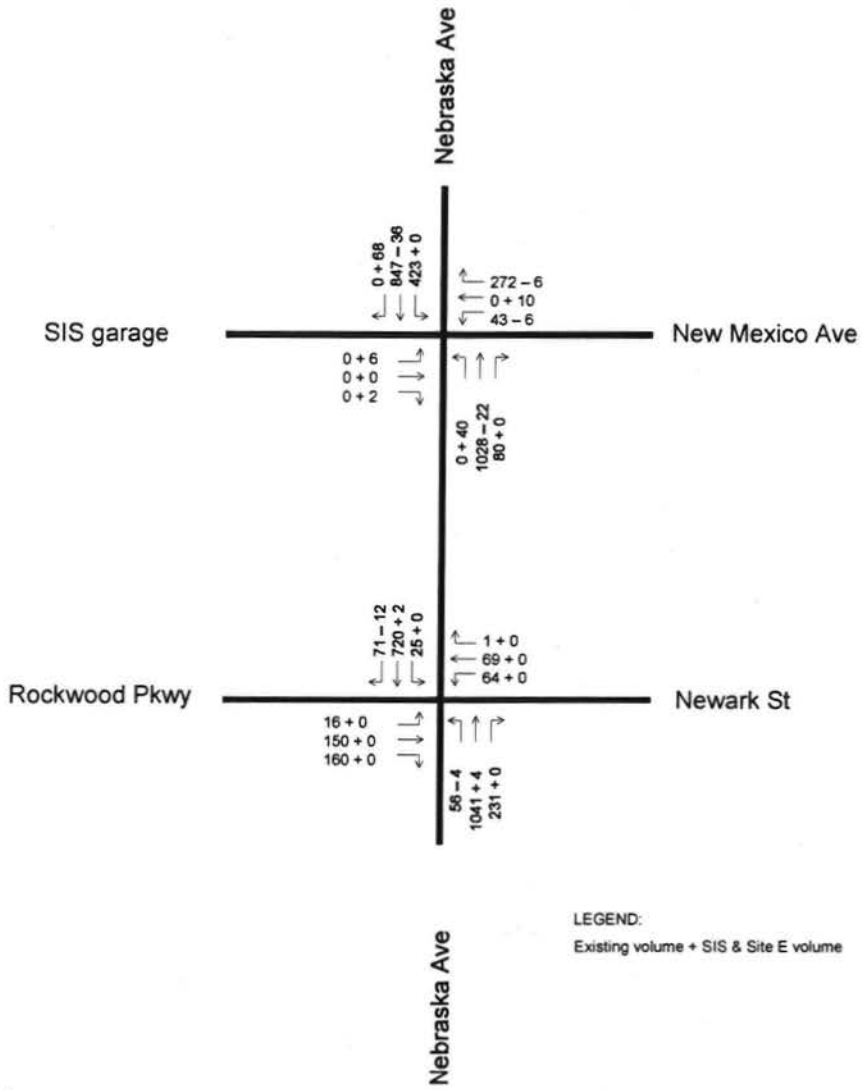
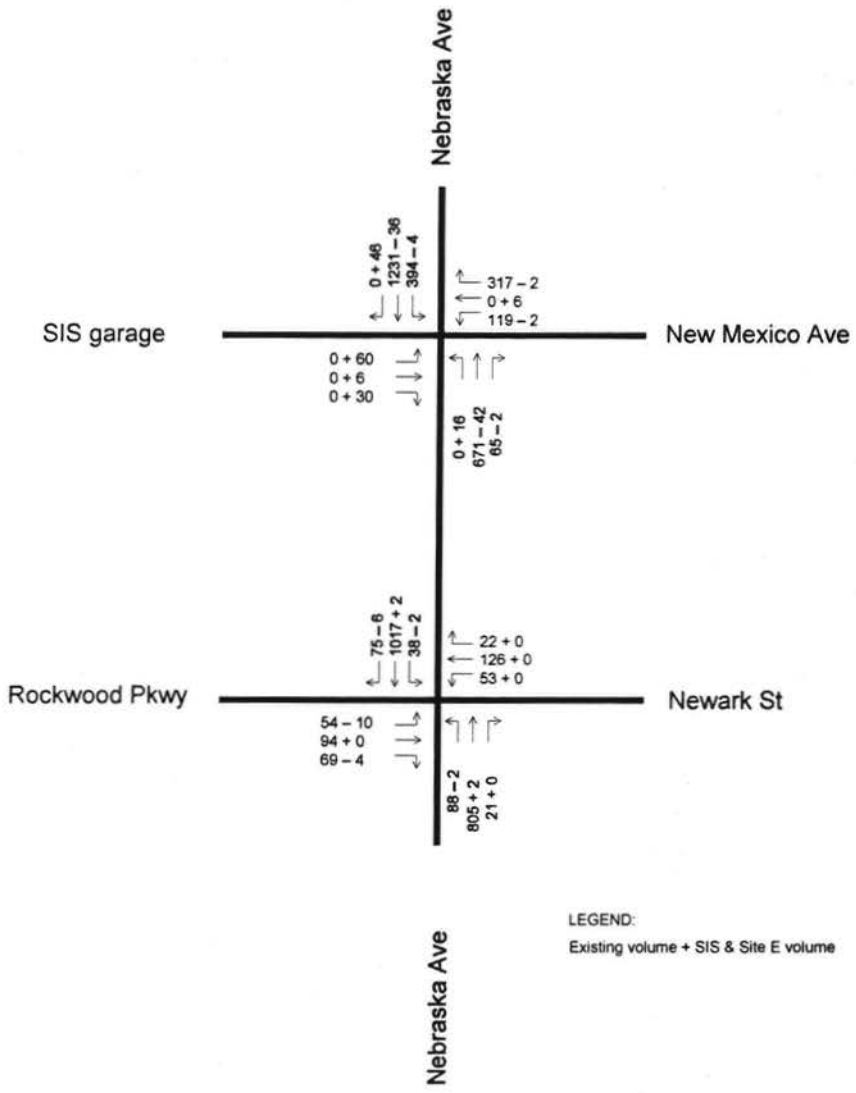


Figure B-4: Turning movement volumes, Scenario 2, SIS + Site E, 5 – 6 p.m.



Appendix C: Definition of Level of Service

For signalized and unsignalized intersections, the *Highway Capacity Manual* defines level of service (LOS) in terms of control delay. The average control delay per vehicle (time stopped due to the traffic signal or stop sign) is estimated for each approach to the intersection. This delay is then aggregated for the intersection as a whole, using an average weighted for approach volume. The LOS criteria for signalized and unsignalized intersections are given in Table C-1.

Table C-1: LOS criteria for intersections

LOS	Control Delay per Vehicle (seconds/vehicle)	
	Signalized	Unsignalized
A	0 - 10	0 - 10
B	10 - 20	10 - 15
C	20 - 35	15 - 25
D	35 - 55	25 - 35
E	55 - 80	35 - 50
F	> 80	> 50