Transportation Assessment

Williamsburg MS & New ES

Arlington County, Virginia

DRAFT

August 3, 2012

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Arlington Public Schools

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EXECUTIVE SUMMARY

This report presents the findings of a transportation assessment for Williamsburg Middle School in Arlington County, Virginia. The purpose of this assessment is to:

1. Review the existing transportation conditions at Williamsburg Middle School; and
2. Assess the impacts of expanding Williamsburg Middle School and placing a new elementary school on the same site.

This report was assembled early in the process of planning of the existing schools' expansion and new elementary school construction. It purposely contains information for the design team to incorporate into the designs. Typically, traffic analyses occur after a site has been designed and are reactionary in nature. APS' desire was to perform analyses early in the process to help inform how to minimize traffic and parking impacts can be minimized.

Existing Conditions - Williamsburg Middle School

The report reviews existing school access, including traffic and parking demand, pick-up/drop-off activity, bus loading and unloading, and pedestrian and bicycling facilities. Details are included in the report, with findings of note from the traffic and parking counts including:

- Williamsburg Middle School generates a significant amount of trips during their morning peak arrival time. The morning traffic generation is much higher than national averages, and is likely due to a high amount of pick-up/drop-off activity.
- The school's afternoon traffic generation, during the highest concentration of departures, occurs hours before the commuter peak of traffic, and is significantly smaller than the traffic generated during the morning. This is likely due to how the departures of students are spread-out by after school activities, and how students are more likely to carpool in the afternoon compared to the morning.
- Parking demand was mostly accommodated on site, based on parking counts, observations and conversations with school staff. Some cars were parked on-street adjacent to the school.

A review of student and employees access to school noted several concerns, which are detailed in the report, and which includes a list of potential solutions:

- Passenger Car Pick-up/Drop-off Layout and Congestion - Potential solutions include additional signs and markings, switching the lot circulation, and reconstructing the pick-up/drop-off facility in conjunction with the proposed new construction.
- Pedestrian Facilities (lack of crosswalks and sidewalks) - Potential solutions include working with the County to evaluate and possibly install missing facilities.
- Speeding (on nearby residential streets) - Potential solutions include working with the County to study these issues more, and develop potential traffic calming designs along significant student walking routes.
- Parking (employee and visitor lots on site reach capacity) - The report recommends expanding the current lots as overspill parking occurs on neighboring streets. Although this does not appear to generate issues it would be beneficial to increase existing parking to account for the expected growth. As part of new construction on site for the new elementary school, opportunities exist to provide more supply.

Potential Impacts from Existing School Growth and New Elementary School

The growth of Williamsburg MS and the new elementary school have the potential to generate traffic impacts internal to the school sites and external on the surrounding roadways. The goal of this report is to determine how to minimize these potential impacts. Based on the existing conditions analysis, the most impact to surrounding roadways would be generated by the additional traffic generated during the morning peak of school arrivals. A significant amount of new pick-up/drop-off activity is projected for the schools. The impact in the afternoon peak time of school departures does not have the same potential impact because it occurs much earlier than the commuter traffic peak, and because student departures are more spread out in the afternoon, with a much lower concentration of vehicles.

In addition to external impacts, negative impacts on the school sites could occur from the additional pick-up/drop-offs and bus traffic generated. Also, the new trips have the potential to generate significant congestion at school driveways.

The following report also collected traffic and parking data in order to analyze current conditions. Traffic data was collected to analyze intersection capacity to identify issues and serve as a baseline for evaluating the decision to place a new elementary school adjacent to Williamsburg Middle School. The parking data was collected in order to determine how well the current lots serve school demand, if school generated parking overflowed to surrounding on-street parking, and if so to what amount. Details on the parking information and findings are contained in the report.

Findings from Impact Analysis

Impact analyses were performed in order to develop recommendations on how the new school's site design should be configured to minimize transportation impacts. The impact analyses were performed for several scenarios, which incorporated the strategies of: (1) staggering and altering school start times, and (2) changing access patterns and creating new driveways.

Conclusions reached after completing the impact analyses included the following:

- Staggering start times leads to a much greater reduction in impacts to external roadway traffic than the various access schemes that explored new driveway locations.
  - Successfully minimizing impacts of the schools is dependent on staggering start times.
  - For a significant reduction in impacts, the new elementary school start time should be 20 to 30 minutes earlier or later than Williamsburg Middle School.
  - An even greater reduction in impacts occurs when start times are shifted earlier, to avoid the commuter traffic peak. The least amount of congestion in all scenarios evaluated in the report was one where the start time of the Middle School was moved 30 minutes earlier than it is now. Starting class this early in the morning may not be practical though.
- Analyses of the different access schemes, where new driveway locations were tested, showed that changing school access could have a positive benefit to internal school traffic. Different access schemes for the schools did not show significant benefits to commuter traffic on external roadways.
  - Access alternatives with separate driveways for the two schools showed less congestion at school driveways.
  - Some access schemes evaluated provide opportunities to improve access for the existing schools.

With the evaluation completed, the following recommendations were made for the site design of the campus containing the existing schools and the new elementary school:

- School start times should be staggered; the elementary school start times should be 20 to 30 minutes earlier or later than Williamsburg Middle School.
- If possible, the direction of traffic should be switched in the east lot. This will create a safer environment for students being picked up and dropped off. An exclusive pick-up/drop-off facility separate from the parking lot is also suggested to further improve the safety as well as allow vehicles parking to be unobstructed by pick-up/drop-off activity. The switch in traffic flow may not be possible depending on other changes to site access.
- Access to the new ES parking and pick-up/drop-off facilities should occur as a separate driveway. This allows for less possibility of congestion at a shared access.
- Access schemes with separate and shared bus facilities were both found to be acceptable. Both will accommodate the new bus traffic for the middle school and the elementary school.
- The recommended future parking supply of 273 spaces is 159 spaces more than the current parking supply (total for both schools). This report recommends that the two schools share as much parking supply as possible. Quality walking paths should be provided and walking distances kept to a minimum between the schools. This shared resource could help accommodate parking during events at either school. This would require coordination between the schools so events do not occur at the same time. Such an arrangement is already in place between Carlin Springs ES and Kenmore MS, which are adjacent to each other.
- A factor in deciding how many spaces to construct is the presence of ample on-street parking. The existing parking counts show over 100 spaces available on weekdays adjacent to the school property (not counting the other side of the street). These spaces could be used to keep the amount of new construction to a minimum, reducing the amount of new spaces to construct from 159 to 59. The design should balance the zoning and practical parking needs, while also keeping the amount of new parking constructed at a minimum to preserve as many playing fields on site as possible.
- A Transportation Demand Management (TDM) plan should be developed in conjunction with the County's DES to help reduce overall trip generation at the existing schools and new ES.

Next Steps

The following list contains the next steps to be taken to move forward on this project.

- Improving access to Williamsburg Middle School
  - Perform a travel survey of students and parents to learn more about school transportation use and concerns;
  - Examine crash data at nearby intersections to help provide more information on pedestrian and vehicular safety; and
  - Discuss potential solutions with school staff, community and Arlington County Department of Environmental Services staff:
- Planning and designing a new elementary school on the site

- Scope and complete a full Transportation Impact Study in coordination with Arlington County Department of Environmental Services staff;
- Work with design team to implement recommendations contained within this report; and
- Design the access and circulation of the new school in a manner that best fits with the characteristics of the surrounding transportation network.

INTRODUCTION

This report presents the findings of a transportation assessment for Williamsburg Middle School in Arlington County, Virginia. The purpose of this assessment is to:

1. Review the existing transportation conditions at Williamsburg Middle School; and
2. Assess the impacts of expanding Williamsburg Middle School and placing a new elementary school on the same site.

With this in mind, the report is split into several sections; the first evaluates existing conditions at Williamsburg Middle School, including student/employee access, capacity of nearby intersections, and parking demand. It ends with a summary of existing concerns and potential solutions. The second section of this report reviews potential impacts of a new elementary school, including traffic and parking demands. Then, the report includes a section examining potential concepts at the site and ends with recommendations on how the school should be designed in order to minimize potential transportation issues and concerns.

This report was assembled early in the process of planning of the existing schools' expansion and new elementary school construction. It purposely contains information for the design team to incorporate into the designs. Typically, traffic analyses occur after a site has been designed and are reactionary in nature. APS' desire was to perform analyses early in the process to help inform how to minimize traffic and parking impacts can be minimized.

Williamsburg Middle School, located at 3600 North Harrison Street, was built in 1954 and served as a junior high school for grades seven, eight, and nine. From September 1978 until June 1990, Williamsburg was an intermediate school with seventh and eighth grades only. Currently, Williamsburg Middle School is composed of sixth, seventh and eighth grade students. In November 2011, the school had 903 students enrolled. The school is currently approved to expand its enrollment to as many as 1,300 students, with approximately 1,135 expected by 2015.

The proposed new elementary school is planned to open around 2015. It will serve the surrounding neighborhood, with an enrollment of 600 students.

Figure 1 shows the location of Williamsburg Middle School and the existing school boundaries.

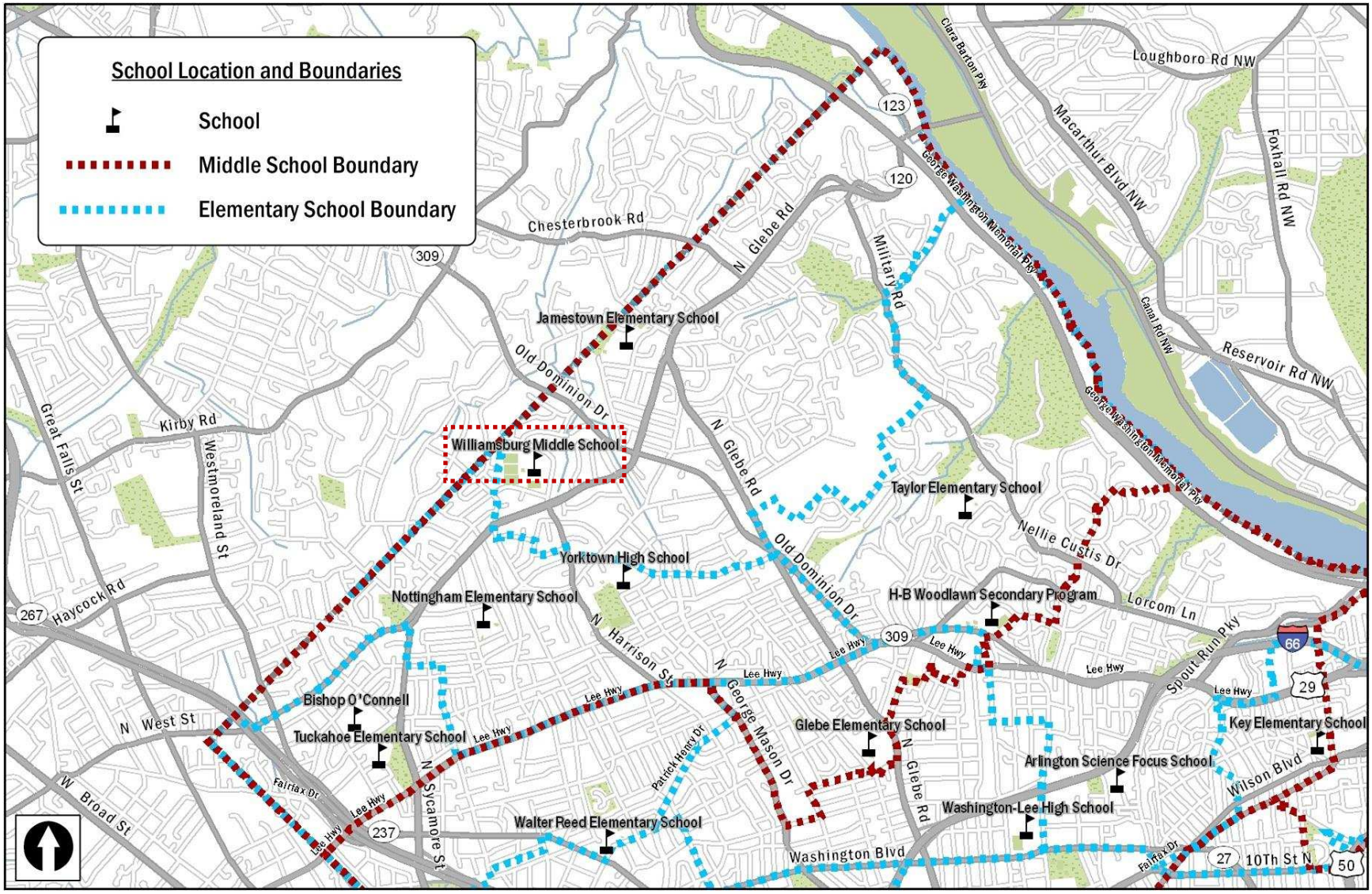

Figure 1: School Location and Boundaries

EXISTING CONDITIONS AT WILLIAMSBURG MIDDLE SCHOOL

This section of the report reviews how students, parents, and employees access Williamsburg Middle School; examines capacity at nearby intersections; summarizes concerns resulting from the review; and presents potential conclusions.

The review of existing conditions is based on the following:

- Interviews with school staff, during a meeting on April 25, 2012;
- Data collected during May 2012, including traffic data at nearby intersections, school driveways, and counts of parking demand on- and off-street; and
- Site visits and observations in May and June 2012, including a field review of transportation conditions (attached to this report).

This evaluation used the Safe Routes to School (SRTS) program for guidance, notably in its review of pedestrian conditions during the field review. SRTS programs are sustained efforts by parents, schools, community leaders and local, state, and federal governments to improve the health and well-being of children by enabling and encouraging them to walk and bicycle to school[1]. SRTS programs can also provide a transportation benefit via the reduction in vehicular demand generated by a school.

SRTS programs use a variety of education, engineering, and enforcement strategies that help make routes safer for children to walk and bicycle to school and encouragement strategies to entice more children to walk and bike. They have grown popular in recent years in response to problems created by a growing reliance on motor vehicles for student transportation, an expanding built environment, as well as the development and availability of federal and state funding for SRTS programs. SRTS principles guide the decisions that local professionals and members of the school community make as they begin to address issues that will improve the built environment for children to safely walk and bicycle to school.

Student Access

Students travel to and from school in three major ways: (1) school bus, (2) passenger car pick-up/drop-off, and (3) walking. Homeroom begins at 7:50 am, and students start arriving around 7:30 am. The last bell of the day is at 2:24 pm, with school buses departing at 2:35pm. Many students do not leave at this time and stay for after school programs and activities. Another significant departure of students occurs around 4:10 pm, around the time when the late bus leaves. Thus, the concentration of arrivals is greater in the morning than in the afternoon. The following sections describe how students get to and from school via bus, pick-up/drop-off, walking and cycling.

School Bus

School buses use a dedicated lane and loading/unloading zone located on the north side of the school, shown in Figure 2. Around eight to nine buses are used, and they currently can all fit within the facility. The path from the loading/unloading zone to the school is direct and does not require students to cross traffic.

Passenger Car Pick-up/Drop-off

Passenger car pick-up and drop-off occurs in two areas: a primary location is provided within the eastern parking lot, and a secondary location is provided in the northern parking lot. Each pick-up/drop-off area is depicted on Figure 2. The primary drop-off area has some issues, including cars that pull up on the left, which means that students are often exiting cars into

[1] http://www.saferoutesinfo.org

the travel lane instead of onto the curb. In addition, traffic can back up unless all vehicles pull up to the designated drop-off zone, and drivers often ignore the rules and attempt to drop-off students in the southern end of the lot. This can generate queuing problems onto North Harrison Street.

Illegal movements in the parking lot are worse in the afternoon because picking up students occurs differently from the order of passenger car arrivals. Because the designated pick-up/drop-off area restricts vehicles from passing, drivers who pick-up students before those drivers that arrive earlier need to either wait, disobey this rule, or make a turn in the lot and exit through the entrance driveway.

The secondary pick-up/drop-off location is located in the northern parking lot. This pick-up/drop-off area generally operates well, although the path that students take to the school crosses the bus access lane. It is not an ideal location, because the pick-up/drop-off area is also a parking lot drive aisle. Ideally, the two would be separated to provide fewer conflicts between drivers needing to pick-up/drop-off and those entering or leaving the parking lot.

Walking & Cycling

During the field visits a significant amount of students were observed walking to and from school. No students were observed bicycling to or from school; based on discussions with school staff, bicycling is not common. Although the County has installed bicycle facilities near the school, shown on Figure 5, topography and vehicular speeds likely create undesirable conditions for bicycling.

The pedestrian facilities surrounding Williamsburg Middle School are generally of high quality, although some concerns were noted during the field review. A summary of pedestrian facilities and conditions is contained in Figure 4. A detailed field review of conditions is attached to this report, which consisted of walking pedestrian routes within a 0.25 mile radius from the school. Within this area, the majority of streets have sidewalks on both sides. A few blocks only have sidewalks on one side of the street; a list is provided in the field review. Most of the walking paths to and from school are located along residential streets, with low traffic volumes and generally favorable conditions for pedestrians. The closest arterial street is Williamsburg Boulevard, which has sidewalks on both sides and a landscaped pedestrian buffer. Pedestrians are even further separated from moving traffic on Williamsburg Boulevard due to the presence of an on-street parking lane and bicycle lane. Students can cross Williamsburg Boulevard to reach the neighborhood to the south at its intersection with North Harrison Street, which has crosswalks with pedestrian signal heads and countdown timers. A crossing guard is also stationed at this intersection during peak arrival and departure times.

Although conditions are generally favorable, several concerns were noted during the field review. First, the speeds of vehicles on the residential streets appeared to be high and intimidating for pedestrians, especially when crossing the road. The natural grade of the roads leads to many cars speeding up going downhill. Although on-street parking is permitted on both sides of the residential streets, most homes have driveways, and a lot of the parking stays empty. This leads to very wide travel lanes for cars, which can in turn lead to increased speeds from drivers. At the majority of intersections in residential neighborhoods, crosswalks are not marked.

Several speed humps already exist on North Harrison Street, adjacent to the school, indicating that speeding has been an issue in the past. The placement of the speed humps does not cover all of the major walking routes to school; they are mostly located close to the school itself, sometimes where students would have already left the roadway to walk on a path to/from the school.

Further concerns include the lack of direct access routes for walking to and from residential neighborhoods close to the school, due to the layout of the roadways. The streets were likely not connected when constructed due to the natural hills

and topography and to discourage commuter cut-through traffic in the neighborhood. Additionally, although students can cross Williamsburg Boulevard at North Harrison Street, crosswalks are not provided at other intersections within a quarter-mile radius. Walking routes to and from the school need to take this into account and funnel students towards this intersection if they need to cross Williamsburg Boulevard.

Employee Access

The majority of employees drive and park in school parking lots. Figure 3 identifies the parking facilities at the school. Some school employees park on North Harrison Street, mostly for convenience (the on-street parking space is closer to where they want to go), but sometimes the parking lots get fully occupied and parking spills over to North Harrison Street.

Some employees take advantage of transit service in the area. ART 53 travels along Williamsburg Boulevard and stops close by the school. Additionally, Metrobus route 23A/C runs along Old Dominion Drive, a further walk away from the school but still accessible. Figure 6 shows the existing transit service near the school.

Employees that walk or bike to work encounter the same quality facilities and concerns that students do, as described above. School staff noted that the amount of employees walking or biking to work is currently minimal.

Transportation Demand

Traffic

As part of this assessment, traffic counts were conducted at the school driveways to determine the peak traffic generated by the school in amount, concentration, and time. These counts were conducted on Thursday, May 12, 2012 between the hours of 7:00 to 9:30 am and 2:00 to 4:30 pm; these times were chosen because they correspond to the first and last bell times of the school.

The data collected provided the following information:

- The peak hour of morning traffic generated by the school was 7:00 to 8:00 am, with school traffic highly concentrated in the half hour between 7:30 and 8:00 am. The total amount of vehicles entering and exiting the school from 7:00 to 8:00 am was 794, with 560 of those between 7:30 and 8:00 am.
- The peak hour of afternoon traffic generated by the school was 2:15 to 3:15 pm, with school traffic highly concentrated in the half hour between 2:15 and 2:45 pm. The total amount of vehicles entering and exiting the school from 2:15 to 3:15 pm was 204, with 148 of those between 2:15 and 2:45 pm.
- Morning traffic generated by the school is much greater and more concentrated than traffic generated in the evening. This is likely because afternoon programs and activities at the school spread out student departures.

The count data was used to assemble the charts contained in Figure 7 and Figure 8. The purpose of these charts is to graphically show the concentration of school traffic and to compare the school traffic in relation to network traffic. In these charts, network traffic is represented by the number of vehicles that enter and exit the study area at the same time the school counts were conducted. The charts demonstrate how much higher the morning school traffic peak is compared to the afternoon school traffic peak, and how the afternoon departures are much more spread out. In addition, it shows how the morning school peak coincides with the network traffic, while the afternoon school peak occurs before network traffic has entered its peak period.

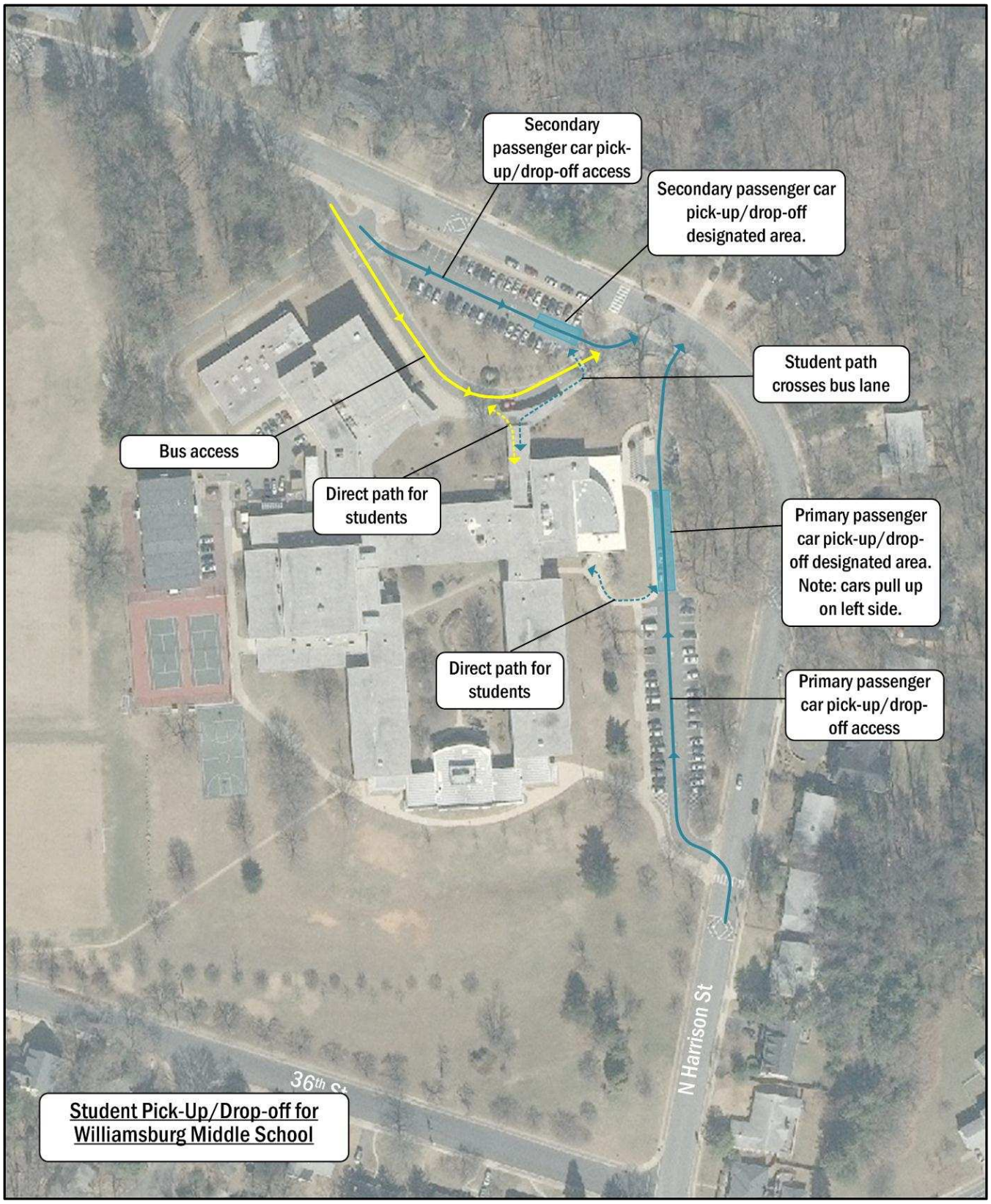

Figure 2: Student Pick-up/Drop-off Locations

Figure 3: Parking

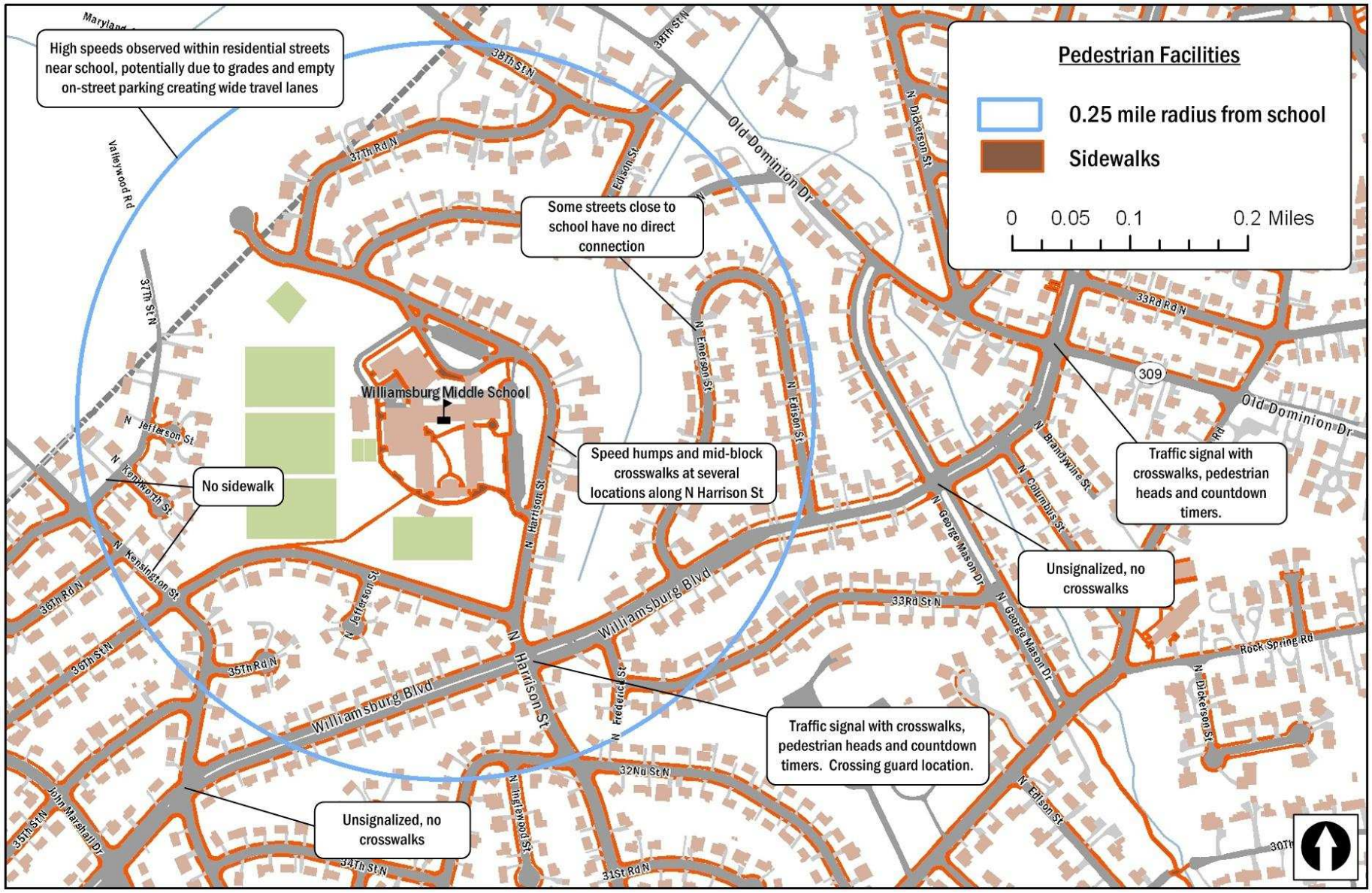

Figure 4: Pedestrian Facilities near Williamsburg MS

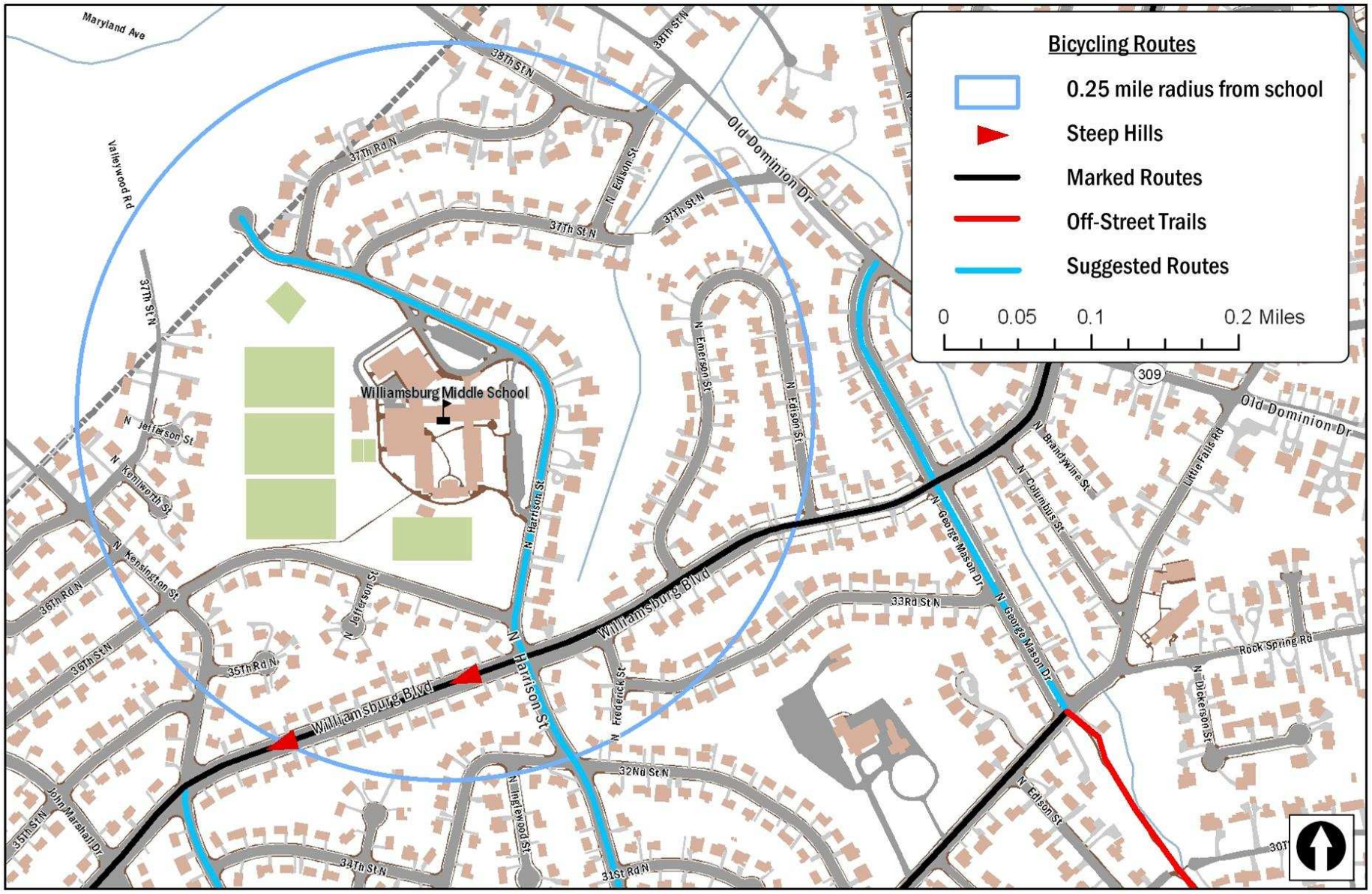

Figure 5: Bicycling Facilities near Williamsburg MS

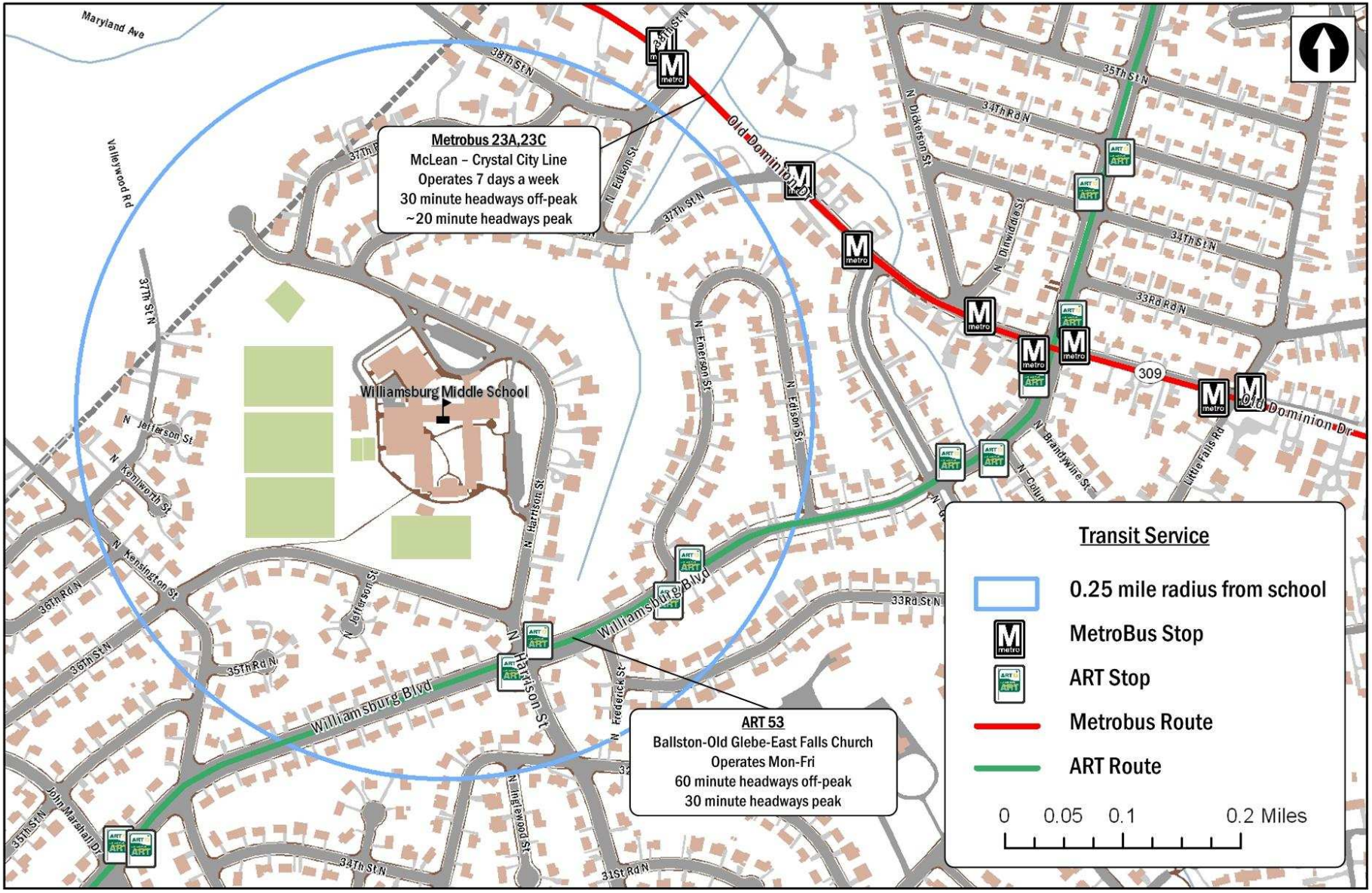

Figure 6: Transit Service near Williamsburg MS

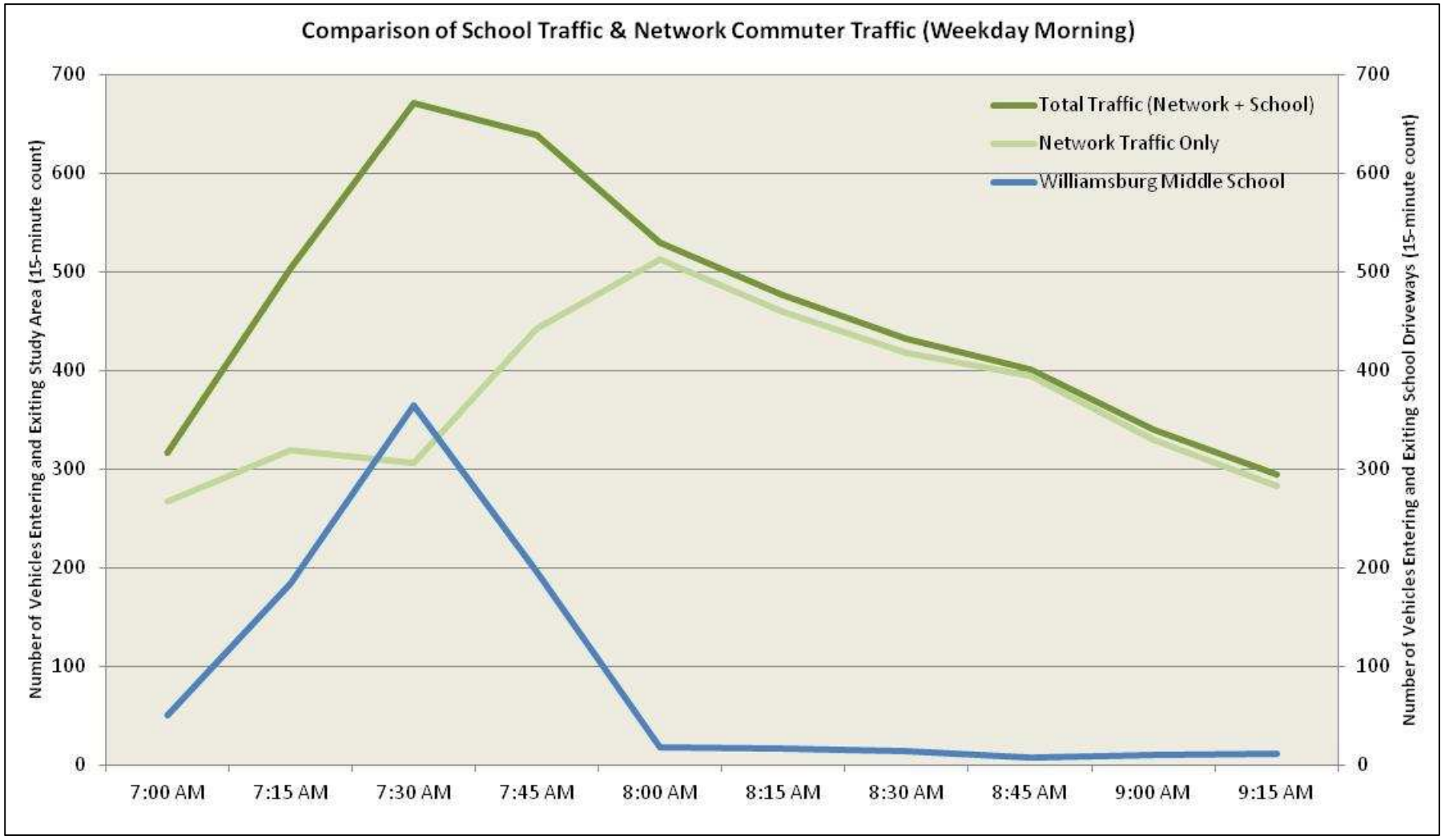

Figure 7: Comparison of School Generated and Commuter Traffic (Weekday Morning)

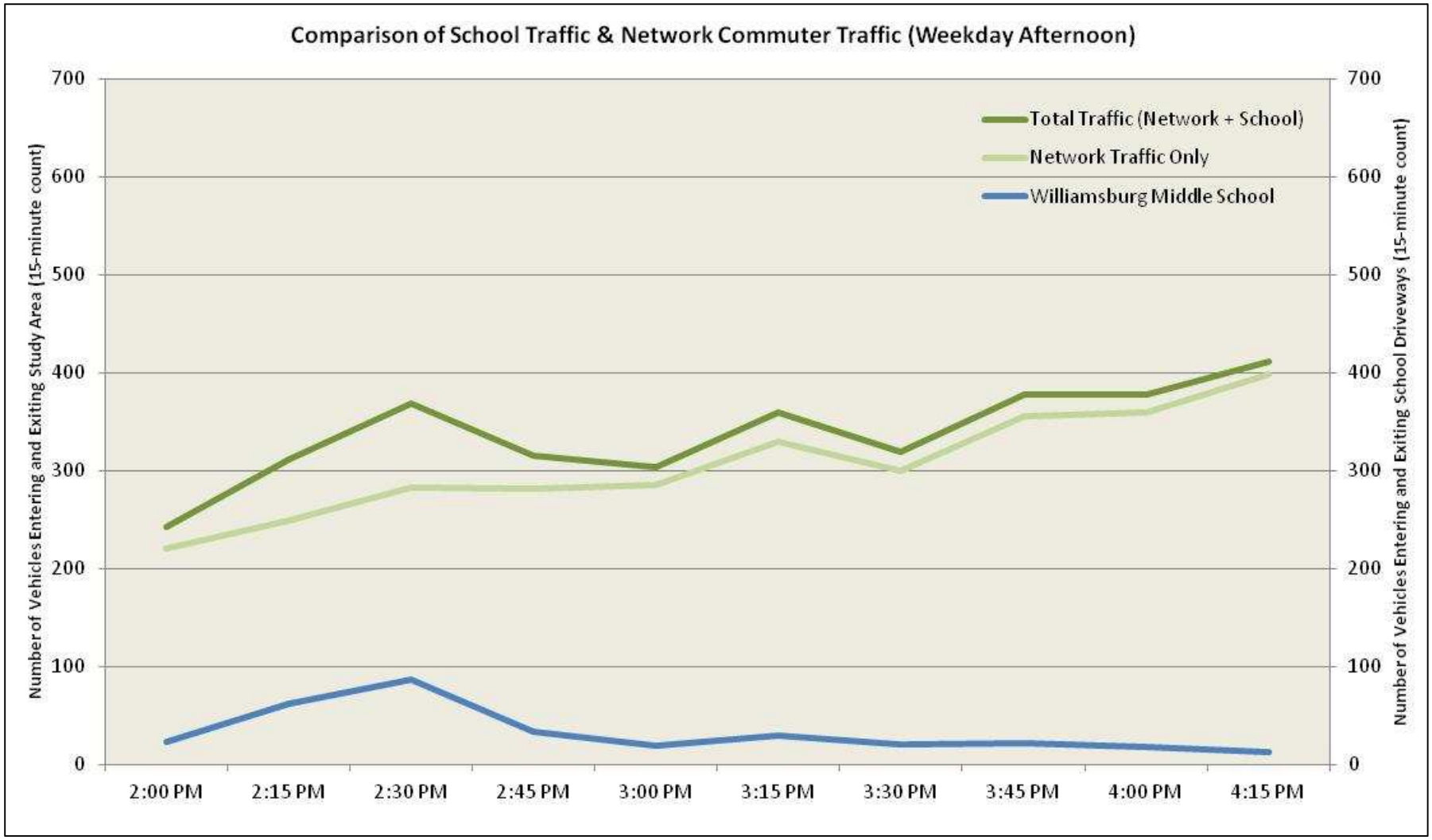

Figure 8: Comparison of School Generated and Commuter Traffic (Weekday Afternoon)

ITE Trip Generation

This report also compared the measured trip generation of the existing school with industry standards for middle school trip generation. Transportation Planners traditionally use the Institute of Transportation Engineers' (ITE) *Trip Generation*, 8th Edition to calculate projected traffic demand for a new development or project. The manual is used to estimate the number of trips entering and exiting a site at a given time (frequently the morning and afternoon peak hours and a typical weekday). ITE rates are typically functions based on the type of development and square footage, number of dwelling units, or other standard measurable size variable. The rates do not consider the location of the development, the cost of transportation, and many other important factors; they are often estimated based on observations of existing development.

Trip Generation defines Middle schools/junior high schools as those that serve students who have completed elementary school and have not yet entered high school. The weekday morning peak hour of the schools typically coincide with the peak hour of the adjacent street traffic; the weekday afternoon peak hour of the schools varies between 2:00 and 4:00 PM.

Table 1: Trip Generation Comparison

School	Size (Students)	Existing Trips		ITE Trip Generation	
		AM Peak	*PM Peak*	*AM Peak*	*PM Peak*
Williamsburg Middle School	903	794	204	488	280

As shown in ITE Trip Generation

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Table 1, the trip generation comparison shows:

- ITE *Trip Generation* shows a higher trip generation during the morning peak period than the afternoon peak period. This is also reflected in the existing trips counted for the middle school.
- The middle school generates a higher number of existing morning peak hour trips than predicted by *Trip Generation*. This is likely due to the high volume of drop-off activity at the school.
- The middle school generates slightly less number of trips predicted by *Trip Generation* in the afternoon peak hour. This is likely due to a higher number of students participating in after school activities.

Parking

This assessment also conducted counts of parking demand at the school. Williamsburg Middle School has approximately 115 spaces on its property. (An exact count is not possible because some spaces are unmarked). School staff noted that, generally, all vehicles that want to park can find a space, but occasionally the lots become full. In addition, some staff members prefer to park on-street for convenience reasons, since sometimes their destination is closer to the street than the parking lots. On the days of the counts, school employees were asked to place a sign on the dashboards identifying them, so they could be incorporated into the counts.

The recreation fields adjacent to Williamsburg Middle School are in partnership with Arlington County Parks and Recreation. Thus, the parking demand counts at on-site facilities include both demand for the school and parking demand for the recreation fields. Demand for parking on the school lots (and on-street) is generated by non-school sources when the fields are used for non-school use. Parking counts were conducted on two days, Thursday May 10, 2012 and Saturday, May 12, 2012, from 11 AM to 8:00 PM. In addition to traditional school activities, a band concert took place on May 10th. One of the recreation fields was reserved by Arlington Soccer Association (ASA) practice from 5:00 to 8:00 PM and another by YHS soccer practice from 3:30 to 5:30 PM. On May 12th, ASA had reserved two fields for games, one from 8:30 AM to 5:15 PM and the other from 8:30 AM to 2:45 PM. Figure 9 summarizes the parking counts on school grounds, including identified school cars parked on-street.

The weekday parking data matches discussions with school staff, showing that the parking on grounds can get full and that excess demand sometimes uses the on-street parking for additional supply. During site visits, it was noted that up to eight vehicles would park in unmarked spaces, including the pick-up/drop-off areas and the bus lane. During the evening of the Thursday counts, the demand peaked again, likely due to the band concert, but the lots on school grounds did not reach capacity.

The Saturday data shows that all demand was easily accommodated on site. Some demand was generated during the day, likely from use of the recreation fields. Additional demand occurred in the evening, likely generated by school activities taking place.

According to the Arlington County Zoning Ordinance (AZCO), junior high (middle) schools must provide one parking space per twenty (20) students of design capacity[2]. This equates to an existing minimum parking supply of 45 spaces for Williamsburg Middle School. Based on the criteria for student design capacity, Williamsburg Middle School provides a parking supply greater than what is required by the AZCO.

Additionally, the AZCO requires that one parking space must be provided for each ten (10) seats in an auditorium or other facility for public assembly. If no fixed seating arrangement is specified, the requirement is one parking space per fifty (50) square feet of floor area. This equates to a minimum parking supply of 148 spaces at Williamsburg Middle School. Therefore the school has a parking shortage of approximately 33 spaces.

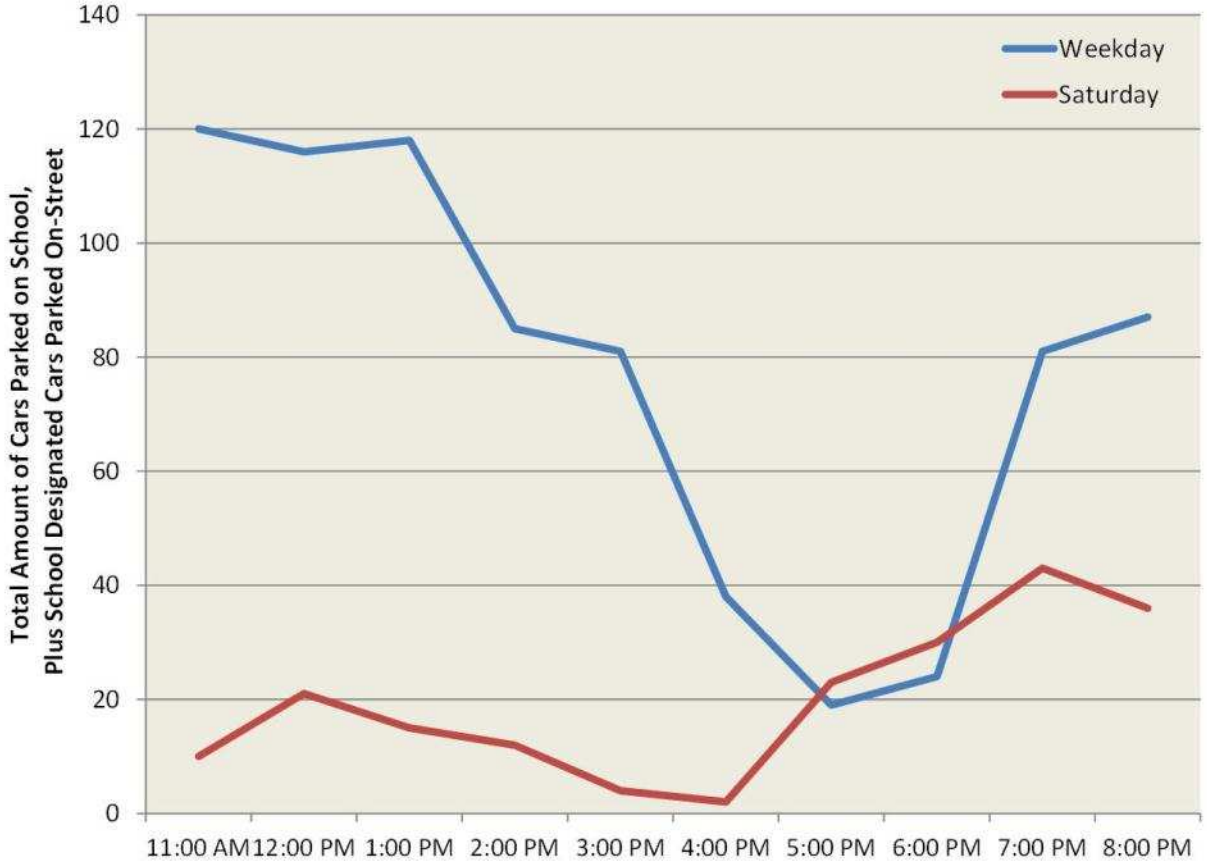
In addition to the counts of the parking demand of school lots, a count of on-street parking inventory was performed. For this count, data was collected at the same times, between 11:00 AM and 8:00 PM on a Thursday and a Saturday (the same days at the off-street counts). The extent of the counts was selected to represent a reasonable walking distance to both the school and the recreation fields. School staff noted that the parking generated by the recreation fields often fills up streets on the southern edges of the school, so the extents of the on-street parking counts were adjusted in an attempt to count both this activity and any overspill from the school. The Thursday count was performed on the day where Williamsburg

[2] Arlington County Zoning Ordinance, *Section 33: Automobile Parking, Standing and Loading Space*, page 8 of 11; April 27, 2010

Middle School had a band concert and generated evening parking demand. Figure 10 and Figure 11 contain the results of these counts.

The weekday on-street counts showed a minimal amount of on-street parking during the day. All of the blocks counted where less than half occupied. In the evening, blocks near the northern side of the school were relatively full, likely from people parking for the band concert. This occurred even though spaces were available on the school grounds, likely because people were not aware or do not prefer the parking on the back (western) side of the school. On the southern side of the school, the blocks closest to the recreation fields had some parked cars, but not enough to fill up all of the on-street spaces. It appears that the event from the school generated more demand than recreation fields, which makes sense because the fields do not have lights.

The Saturday counts showed that blocks near the school had very low occupancy. Blocks on the southern side of the school did have parked cars regularly throughout the day. In the early evening, most blocks near the recreation fields were full. Thus, the Saturday parking demand using on-street spaces appears to be mostly generated by the recreation fields.



Thursday, May 10, 2012

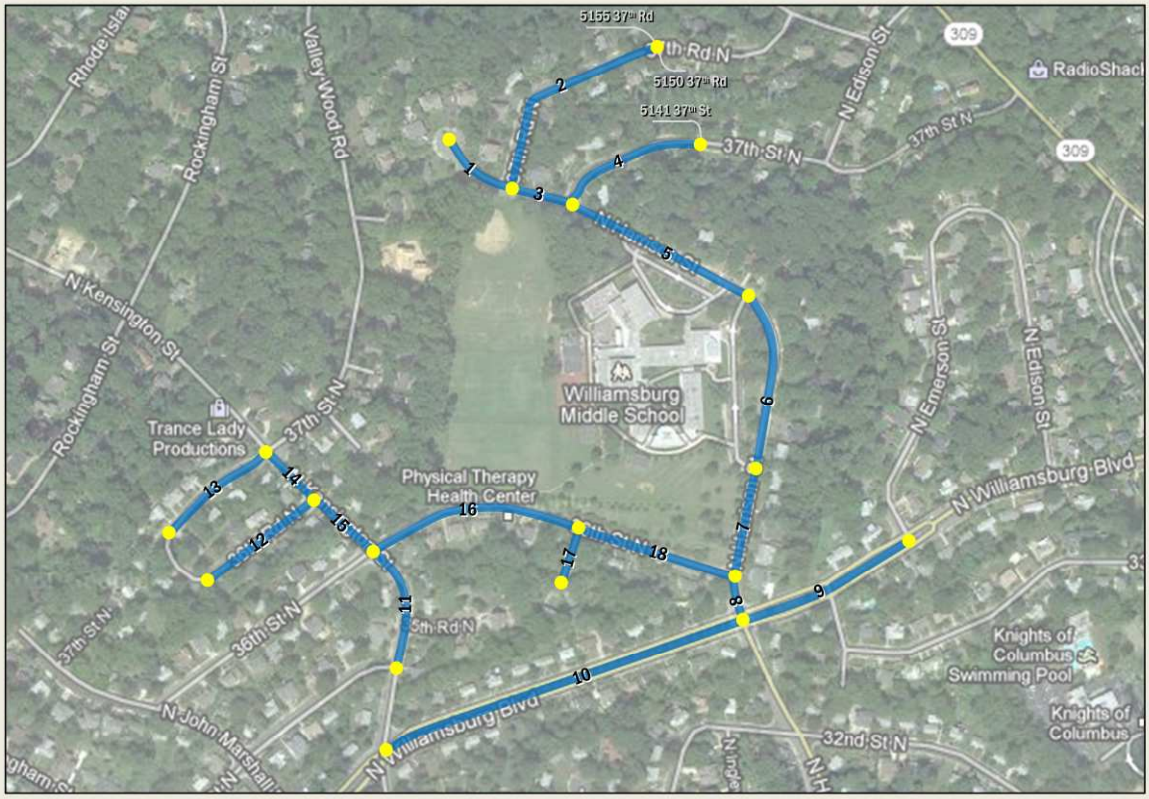
Time	Off-Street	On-Street*	Total	Percent
11:00 AM	112	8	120	104%
12:00 PM	109	7	116	101%
1:00 PM	109	9	118	103%
2:00 PM	76	9	85	74%
3:00 PM	75	6	81	70%
4:00 PM	36	2	38	33%
5:00 PM	18	1	19	17%
6:00 PM	24	0	24	21%
7:00 PM	81	0	81	70%
8:00 PM	87	0	87	76%

Saturday, May 12, 2012

Time	Off-Street	On-Street*	Total	Percent
11:00 AM	10	0	10	9%
12:00 PM	21	0	21	18%
1:00 PM	15	0	15	13%
2:00 PM	12	0	12	10%
3:00 PM	4	0	4	3%
4:00 PM	2	0	2	2%
5:00 PM	23	0	23	20%
6:00 PM	30	0	30	26%
7:00 PM	43	0	43	37%
8:00 PM	36	0	36	31%

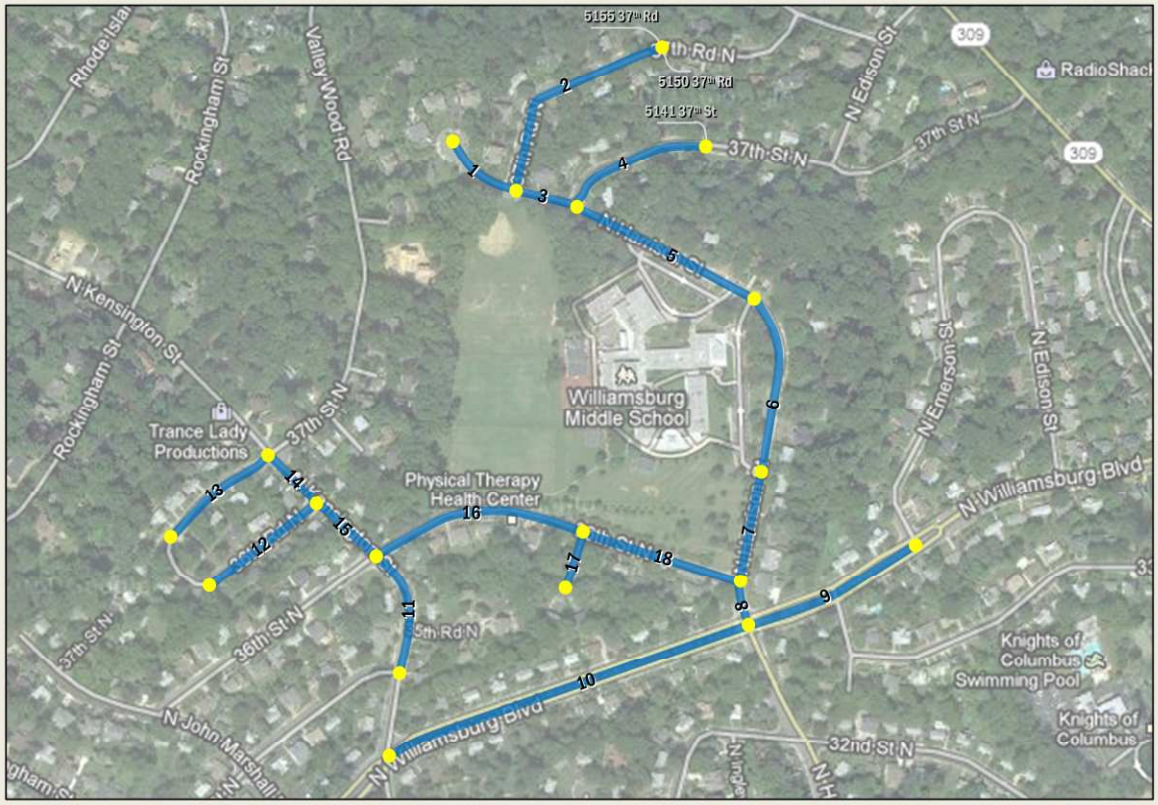
** - School employees were requested to place notes on their dashboard identifying them*

Figure 9: Summary of School Parking Data



Segment	Street	From	To	No. of Spaces	Occupancy										Segment
					11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	
1	Harrison St	Cul-de-sac	37th Rd	24	1	1	1	1	0	1	2	2	1	2	1
2	37th Rd	N Harrison St	5155/5150 Drwy	50	5	3	4	5	6	5	6	7	8	11	2
3	Harrison St	37th Rd	37th St	10	2	1	1	1	1	1	1	1	9	8	3
4	37th St	N Harrison St	5141 Drwy	36	3	2	3	4	1	2	3	2	8	12	4
5	Harrison St	37th St	West Lot Exit	45	11	11	12	16	13	8	4	2	39	41	5
6	Harrison St	West Lot Exit	West Lot Entrance	45	8	5	9	8	10	8	6	4	27	33	6
7	Harrison St	West Lot Entrance	36th St	26	0	0	0	0	0	0	0	0	0	3	7
8	Harrison St	36th St	Williamsburg Blvd	6	0	0	0	0	0	0	0	0	0	0	8
9	Williamsburg Blvd	Emerson St	Harrison St	39	1	3	1	1	2	2	3	4	7	6	9
10	Williamsburg Blvd	Harrison St	Kensington St	76	3	2	1	1	2	2	3	3	2	5	10
11	Kensington St	35th St	36th St	26	0	0	0	0	1	1	1	0	0	0	11
12	36th Rd	Kensington St	Lancaster St	34	5	8	9	9	8	9	8	11	13	12	12
13	37th St	Lancaster St	Kensington St	34	4	5	4	4	3	3	3	4	4	5	13
14	Kensington St	37th St	36th Rd	10	1	1	1	1	1	1	1	1	0	0	14
15	Kensington St	36th Rd	36th St	15	2	2	4	3	3	7	5	2	2	2	15
16	36th St	Kensington St	Jefferson St	60	7	8	8	6	5	4	15	16	31	14	16
17	Jefferson St	Cul-de-sac	36th St	12	3	2	2	2	2	3	3	2	3	4	17
18	36th St	Jefferson St	Harrison St	43	6	5	5	4	4	2	1	3	2	1	18
			Total	**591**	**62**	**59**	**65**	**66**	**62**	**59**	**65**	**64**	**156**	**159**	
				Shading Key:	<25%		25-50%		50-75%		75-100%				

Figure 10: Summary of On-Street Parking Counts, Weekday (5/10/2012)



Segment	Street	From	To	No. of Spaces	Occupancy 11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	Segment
1	Harrison St	Cul-de-sac	37th Rd	24	0	0	0	1	0	0	1	2	3	13	1
2	37th Rd	N Harrison St	5155/5150 Drwy	50	6	6	7	6	7	8	8	9	12	9	2
3	Harrison St	37th Rd	37th St	10	2	2	1	1	1	1	1	1	1	1	3
4	37th St	N Harrison St	5141 Drwy	36	6	4	4	5	5	4	4	4	5	4	4
5	Harrison St	37th St	West Lot Exit	45	6	9	9	4	6	9	6	5	3	5	5
6	Harrison St	West Lot Exit	West Lot Entrance	45	6	7	7	7	7	6	5	5	5	3	6
7	Harrison St	West Lot Entrance	36th St	26	3	5	5	2	3	3	3	4	7	9	7
8	Harrison St	36th St	Williamsburg Blvd	6	2	2	2	2	1	2	3	2	2	1	8
9	Williamsburg Blvd	Emerson St	Harrison St	39	3	4	4	5	4	3	3	3	4	4	9
10	Williamsburg Blvd	Harrison St	Kensington St	76	8	11	11	12	11	12	10	12	11	11	10
11	Kensington St	35th St	36th St	26	0	0	2	2	0	0	5	4	3	1	11
12	36th Rd	Kensington St	Lancaster St	34	10	8	8	7	7	5	6	7	7	11	12
13	37th St	Lancaster St	Kensington St	34	3	4	4	4	5	4	6	6	6	5	13
14	Kensington St	37th St	36th Rd	10	1	1	1	1	1	1	1	1	1	1	14
15	Kensington St	36th Rd	36th St	15	1	4	3	3	2	2	10	12	4	1	15
16	36th St	Kensington St	Jefferson St	60	38	29	43	34	50	44	43	59	53	11	16
17	Jefferson St	Cul-de-sac	36th St	12	6	5	6	6	6	5	11	11	8	5	17
18	36th St	Jefferson St	Harrison St	43	10	17	20	16	13	9	32	42	26	8	18
			Total	**591**	**111**	**118**	**137**	**118**	**129**	**118**	**158**	**189**	**161**	**103**	

Shading Key: <25% 25-50% 50-75% 75-100%

Figure 11: Summary of On-Street Parking Counts, Saturday (5/12/2012)

Traffic Capacity at Nearby Intersections

As part of this Transportation Assessment, traffic capacity at nearby intersections was examined to determine if any traffic concerns exist currently, and to help provide background information for determining if placing a new elementary school adjacent to Williamsburg Middle School would generate any capacity issues. The study area intersections were set to those intersections closest to the school driveways along N Harrison Street and three intersections along Williamsburg Boulevard. Details of the analysis area attached to this report. Although this section only reviews existing capacity, later sections examine potential future conditions.

In order to perform intersection capacity analyses, Gorove/Slade conducted turning movement counts of vehicular traffic between 7:00 and 9:30 am and 2:00 and 4:30 pm on Thursday, May 12, 2012. The traffic capacity analyses were performed for the peak half hour of highest traffic generated by the school in the morning and afternoon, and thus the count times were based on the first and last bell times at the Middle School. In addition, the analyses are based on information provided by Arlington County on their traffic network, including signal timings, and Gorove/Slade conducted fields visits to record observations and geometrical information. Figure 12 contains a map of the study area intersections, and a summary of Level of Service (LOS) results for each intersection. LOS is a measure of congestion ranging from LOS A (least congested) to LOS F (most congested). LOS is one of the most common terms used to describe how "good" or how "bad" traffic is, or is projected to be. The LOS grades are based on a calculation of the average delay drivers experience travelling through an intersection.

For signalized intersections, the LOS grades shown on Figure 12 are for the overall intersection (based on the average delay for all drivers passing through). LOS for a signalized intersection is based on the volume of vehicles traveling through the intersection, the capacity of the intersection (number and width of lanes, signal timing, etc.), and the average delay experienced by a driver at the intersection.

At a signalized intersection, LOS A, B, and C are the most favorable for vehicles, indicating that most vehicles arrive at the intersection during the green phase and do not have to stop at the intersection. LOS A, B, and C are frequently seen on roadways with favorable signal timings or low traffic volumes. LOS D indicates that the intersection experiences a noticeable amount of delay. This delay is seen by vehicles arriving during the red phase or sitting through a full signal cycle before being able to continue to the next intersection. LOS E indicates that the intersection has reached its theoretical capacity. Intersections that operate under LOS E typically have poor progression along a corridor (stopping at multiple red lights along a single stretch of roadway) and high traffic volumes. LOS F describes intersections that operate under conditions that are typically viewed as “unacceptable” to most drivers. This level of delay is typically seen when the volume on the roadway exceeds the capacity of the intersection, either due to the roadway configuration or signal timing and progression.

At signalized intersections, LOS grades of E or better are typically desired during peak times. Since LOS E is often used to denote when an intersection reaches its theoretical capacity, the most efficient use of a roadway may occur when all the movements at an intersection operate under LOS E. A well-designed intersection does not necessarily operate at LOS A at all times. Instead, the busiest intersections should reach LOS E during the highest times of use to ensure efficient use of public facilities. In practice, the most desirable LOS grades depend on location, time, and context.

The unsignalized intersections within the study area are all 2-way stop controlled intersections, which means that the main roadway flows through the intersection without stopping while the cross-street is controlled by stop signs. Since the main roadway does not have a stop sign, through traffic and right turns are assumed to be able to pass through the intersection without any delay. The only vehicles on the main roadway that theoretically experience delay are those executing left turns

because they must yield to through traffic. However, the vehicles on the cross-street, which are controlled by a stop sign, will experience delay and are given a corresponding LOS grade based on the level of delay. The LOS grade given to the stop-controlled cross-street is based on the volume of conflicting traffic (vehicles on the main roadway and vehicles on the opposite approach at a four-way intersection), the capacity of the approach (number and width of lanes), and the size and frequency of acceptable gaps in the main street traffic to complete a turn from the cross-street. In Figure 12, the intersection capacity is depicted through the largest delay to the cross-street traffic.

At an unsignalized intersection, LOS A on the cross-street indicates that there is very little conflicting traffic and vehicles are only briefly paused at the stop sign before continuing. LOS B, C, D, and E correspond to an increase in delay experienced by a driver waiting at a stop sign. LOS F describes an intersection that operates under conditions that are typically viewed as "unacceptable" to most drivers. LOS F typically exists when there are insufficient gaps for cross-street traffic to enter the intersection. While an unsignalized intersection may operate under LOS F conditions, the delay may not result in long queues and may only reflect a significant amount of wait-time experienced by a small volume of vehicles. A signal may not be warranted at an intersection operating at LOS F if the traffic volumes are low on the cross-street. The LOS F will likely just result in adjustments to driver behavior, either changing their travel routes, if available, or increasing their threshold for risk (decreasing the length of gap between vehicles they deem necessary to enter the intersection).

The existing capacity analysis shows the following:

- School morning and afternoon peak half hours show most intersections operate at LOS C or better. Exceptions include:
  - Overall LOS D at North Harrison Street and North Williamsburg Boulevard in the morning school peak half hour primarily due to the southbound movement which has an LOS F;
  - Southbound movement at North Williamsburg Boulevard and North Kensington Street operates at LOS D in the morning school peak half hour; and
  - Northbound movement at North Williamsburg Boulevard and Old Dominion Drive operates at LOS D in the morning school peak half hour.

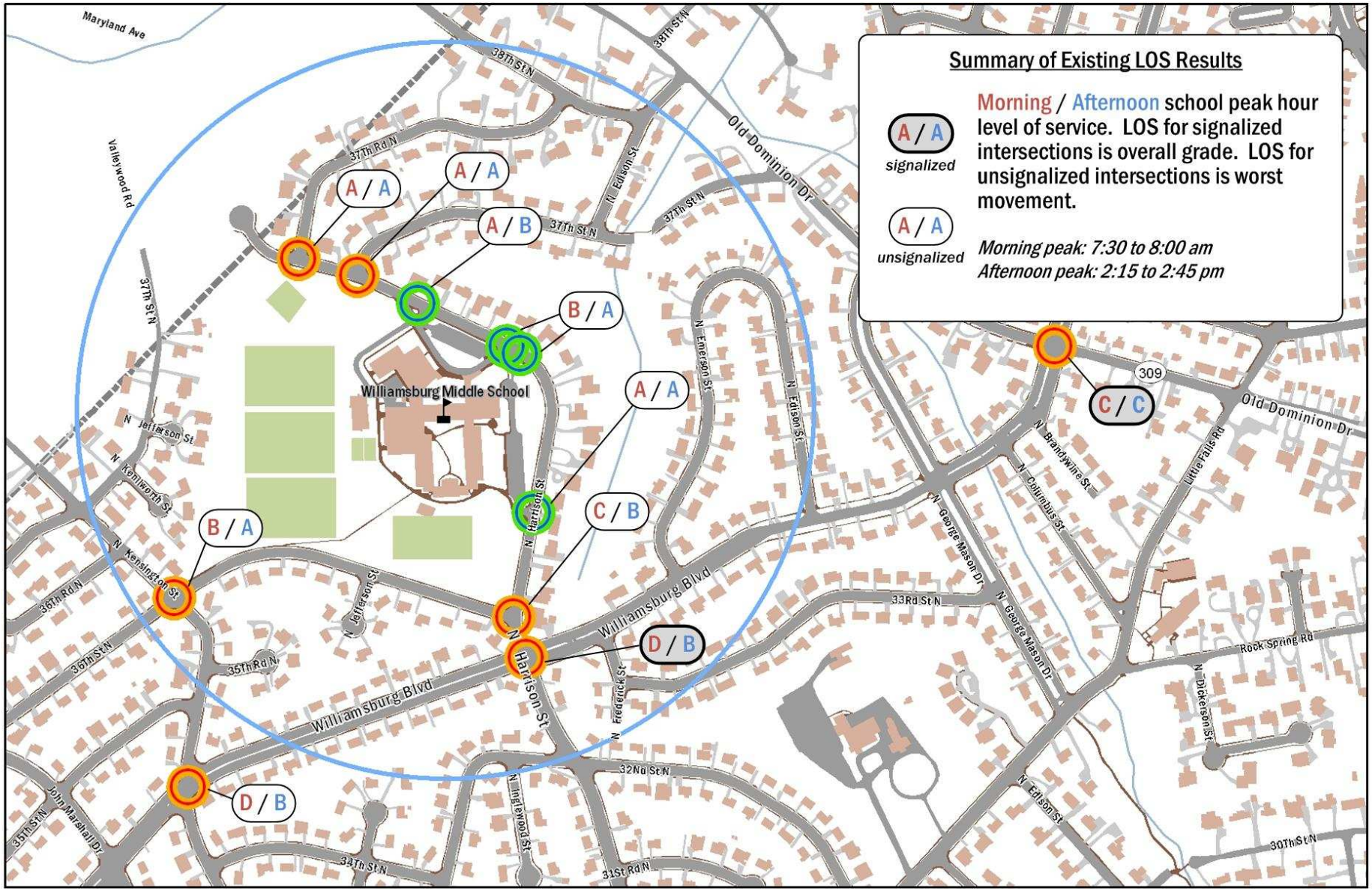


Figure 12: Summary of LOS Results

IMPACT OF EXPANSIONS AND NEW ELEMENTARY SCHOOL

As stated previously, Williamsburg Middle School has an existing student population of 903. Enrollment is expected to grow in the future, up to 1,135 by the year 2015. The school is currently approved to expand to as many as 1,300 students. In addition, Arlington Public School's current concept is for a new, neighborhood elementary school with 600 students to be constructed adjacent to Williamsburg Middle School. Elementary schools typically have bell times of 8:00 AM in the morning and 2:41 PM in the evening. These times are around 10 to 20 minutes later than Williamsburg Middle School. Thus, the majority of traffic between the schools would not overlap, except for around 10 minutes at the end of the Middle School and beginning of the elementary school arrivals.

Traffic Demand

Expansion of Williamsburg Middle School

In order to determine the impact of the future growth at the schools on the roadway network, the existing trip generation was examined for Williamsburg Middle School. The existing traffic demand of the middle school was determined by summing the traffic volumes entering and exiting the school driveways during the morning and afternoon peaks. As started previously, Gorove/Slade conducted these turning movement counts of vehicular traffic between 7:00 and 9:30 AM and 2:00 and 4:30 PM on Thursday, May 12, 2012. These counts included traffic volumes at all the site driveways for Williamsburg Middle School. Traffic volumes were counted and summed in 15-minute intervals for each of the peak periods. Figure 7 and Figure 8, shown previously, depicts the existing traffic volumes at the schools compared to the total network volumes on the surrounding roadway network.

Future traffic demand was estimated based on the existing traffic demand, increased by a growth factor based on the ratio of the future student population to the existing population at the middle school. Figure 13 and Figure 14 show the existing and projected future traffic demand for Williamsburg Middle School.

Construction of New ES

Based on data on file for other elementary schools the traffic that a new elementary school would generate was projected. The total trips generated by the school would be much larger in the morning, 410 total enters and exists, compared to the afternoon, which has 149 total enters and exits. Thus, it is likely that a new elementary school would mimic the transportation patterns of Williamsburg Middle School, notably the times of peak activity and how morning traffic is much higher than afternoon traffic.

Figure 16 shows the future traffic demand generated by the new ES and the total traffic demand for the middle school, assuming similar school start times. Comparing this amount of trip generation to the existing capacity analyses and LOS results indicates that the local roadways near the site could not handle this amount of traffic without generating unacceptable levels of congestion at some of the nearby intersections. Greater impact would occur in the morning, since the school generates more traffic and the school peak is closer to the commuter peak, with the greatest change occurring at the intersection of Williamsburg Boulevard and N Harrison Street. The southbound movement is already failing during the existing conditions and the addition of the new school exacerbates the congestion. The amount of impact could be lessened by offsetting the first bell from the elementary school more than 15 minutes, either through a later first bell, or an earlier one for the Middle School. A later first bell for the elementary school would push the peak traffic closer to the commuter peak so an earlier time may be preferable.

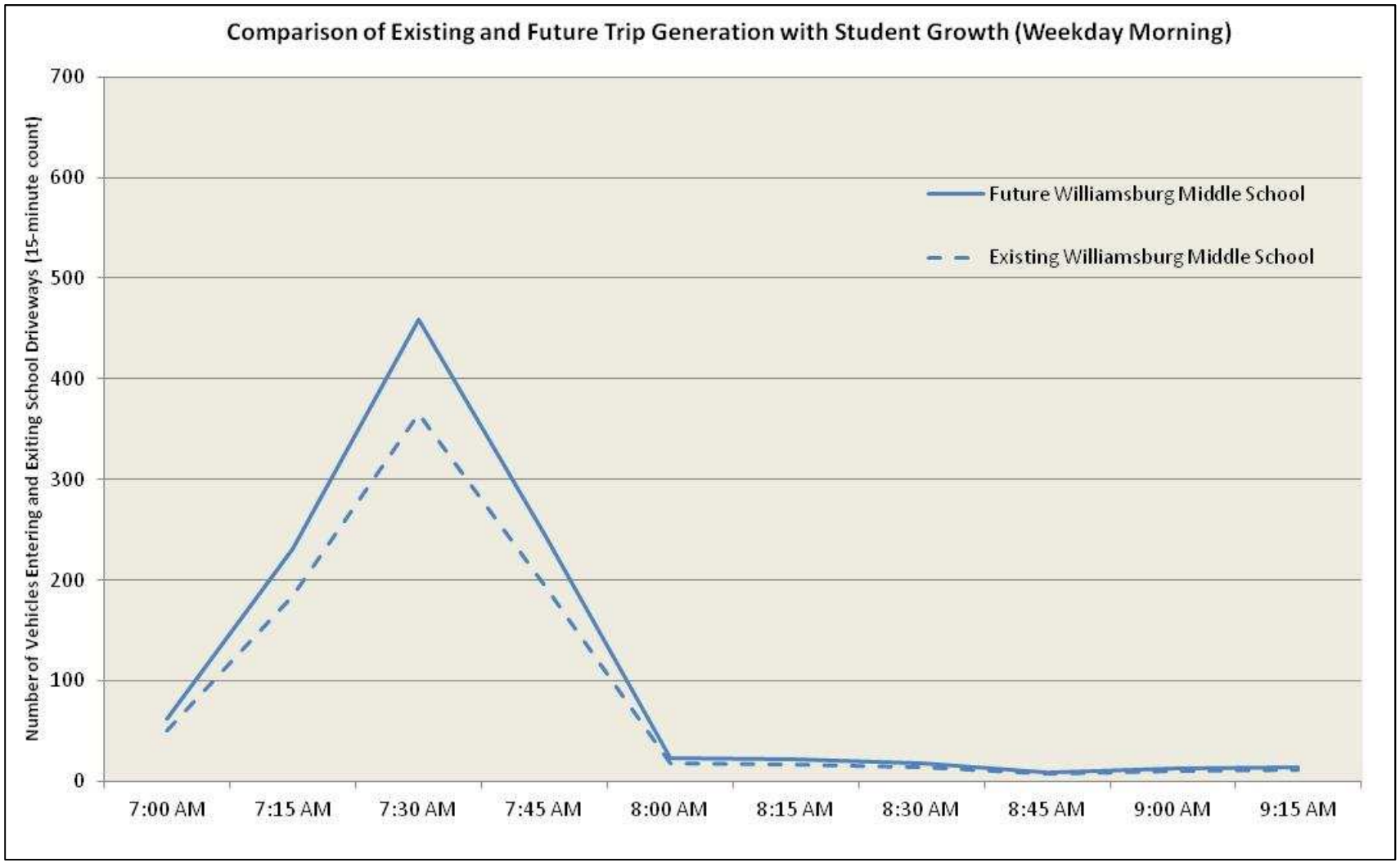


Figure 13: Comparison of Existing and Projected Trip Generation with Growth (Weekday Morning)

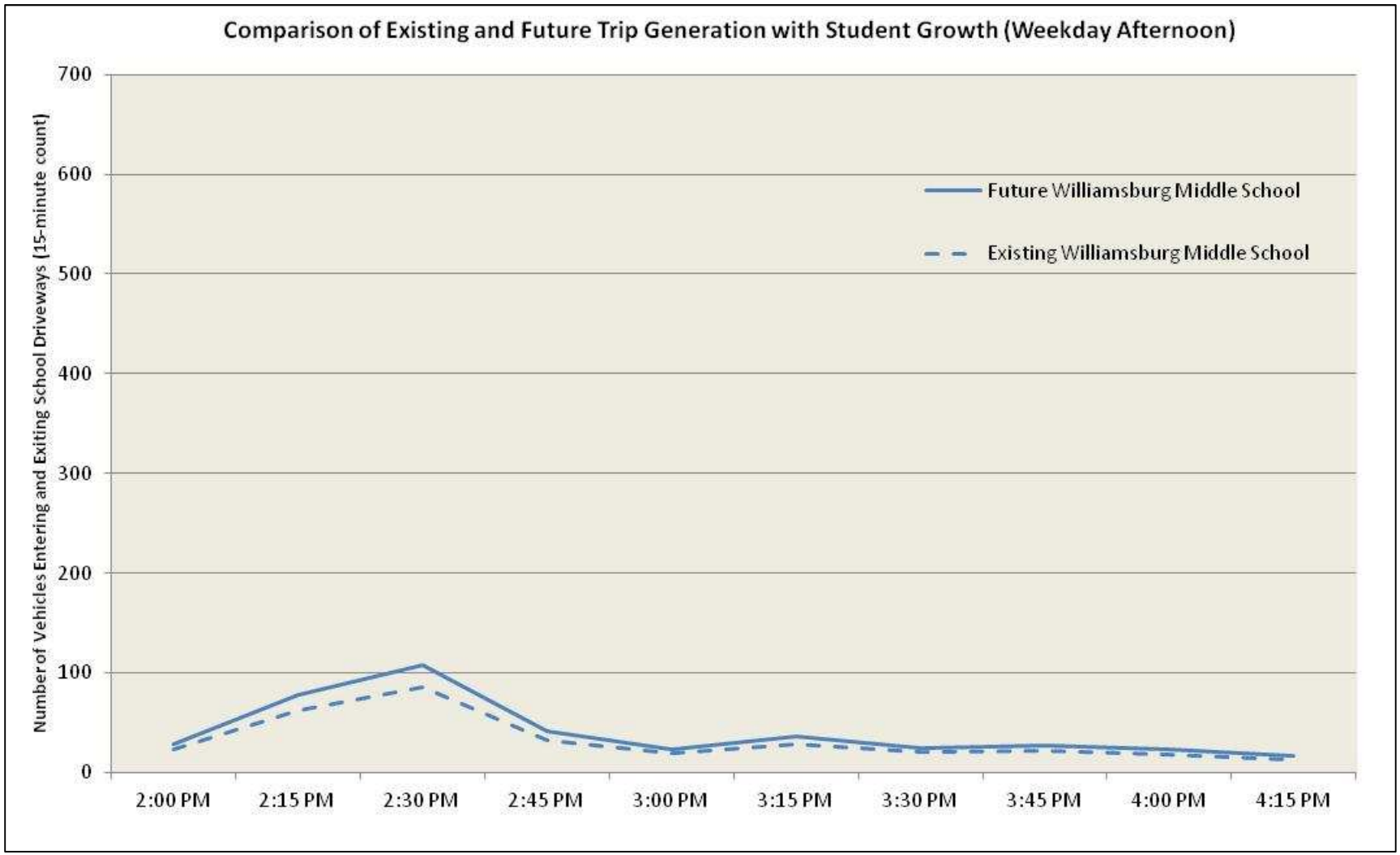


Figure 14: Comparison of Existing and Projected Trip Generation with Growth (Weekday Afternoon)

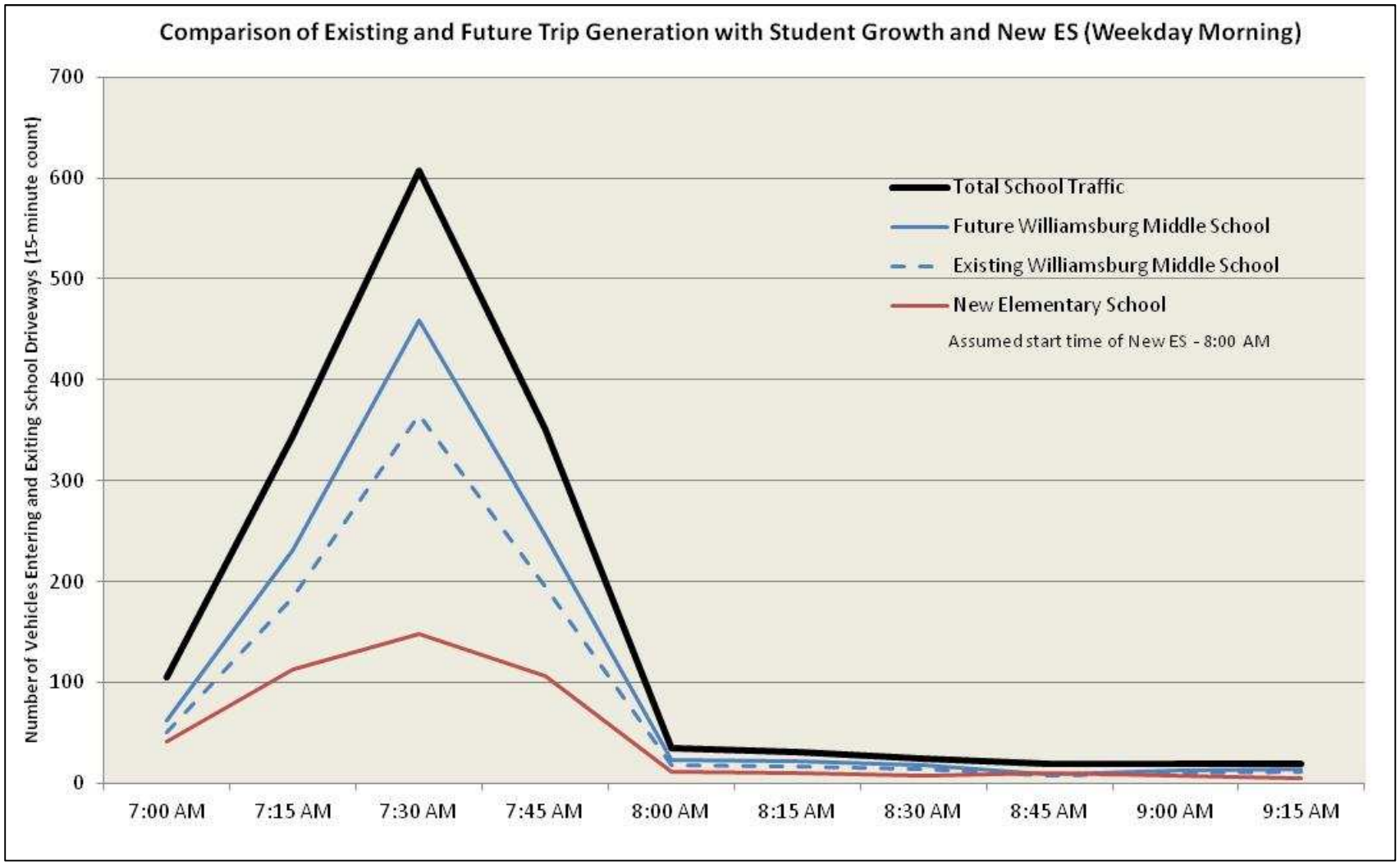


Figure 15: Comparison of Existing and Projected Future Traffic Demand with Growth and New ES (Weekday Morning)

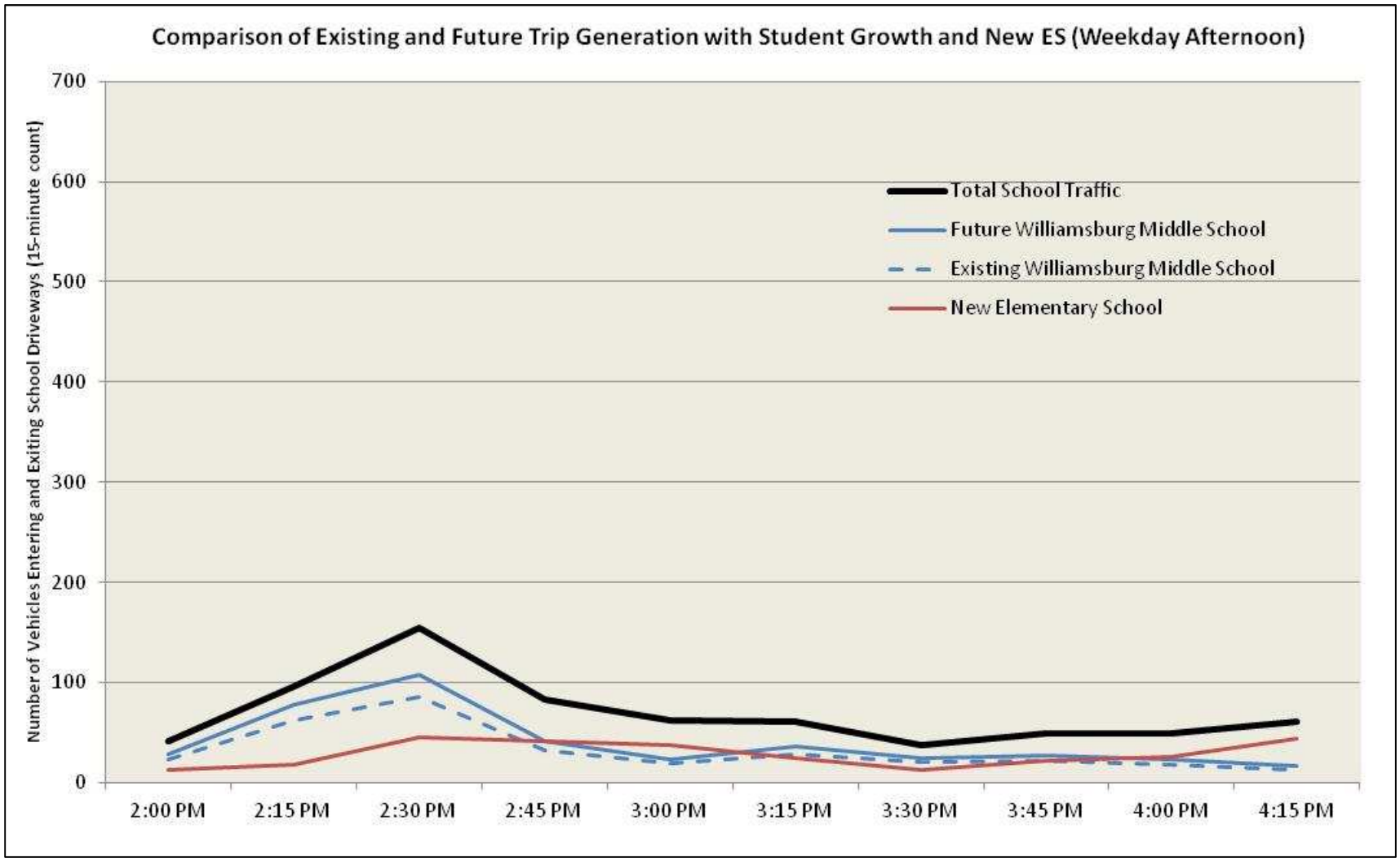


Figure 16: Comparison of Existing and Projected Future Traffic Demand with Growth and New ES (Weekday Afternoon)

Parking Demand

Future parking demand was predicted based on the population growth of Williamsburg Middle School. The existing demand in the school parking lots, as shown previously in Figure 9, was increased by a growth factor based on the ratio of the future student population to the existing population at each of the schools. The resulting projected parking for Williamsburg MS is 151 spaces. Based on a population of 600 students and utilizing data from other elementary schools in the area, the peak parking demand of the new elementary school should be approximately 98 parking spaces. Ideally, a parking lot has 10% additional supply over demand to account for circulation, so recommended supplies for the schools are 165 spaces for Williamsburg MS and 108 for the new ES, a total of 273 spaces.

According to the AZCO guidelines, elementary schools must provide one parking space per twenty (20) students of design capacity[3]. This equates to an existing minimum parking supply of 30 spaces for the new ES. Additionally, the AZCO requires that one parking space must be provided for each ten (10) seats in an auditorium or other facility for public assembly. If no fixed seating arrangement is specified, the requirement is one parking space per fifty (50) square feet of floor area. Given an estimate of 4,100 to 5,100 square feet for the new ES auditorium, 102 spaces are required.

Table 2 summarizes the peak existing demand and supply as well as the future demand and supply based on zoning requirements and recommendations. The recommended future parking supply of 273 spaces is 159 spaces more than the current parking supply. This report recommends that the two schools share as much parking supply as possible. Quality walking paths should be provided and walking distances kept to a minimum between the schools. This shared resource could help accommodate parking during events at either school. This would require coordination between the schools so events do not occur at the same time. Such an arrangement is already in place between Carlin Springs ES and Kenmore MS, which are adjacent to each other.

A factor in deciding how many spaces to construct is the presence of ample on-street parking. The existing parking counts show over 100 spaces available on weekdays adjacent to the school property (not counting the other side of the street). These spaces could be used to keep the amount of new construction to a minimum, reducing the amount of new spaces to construct from 159 to 59. The design should balance the zoning and practical parking needs, while also keeping the amount of new parking constructed at a minimum to preserve as many playing fields on site as possible.

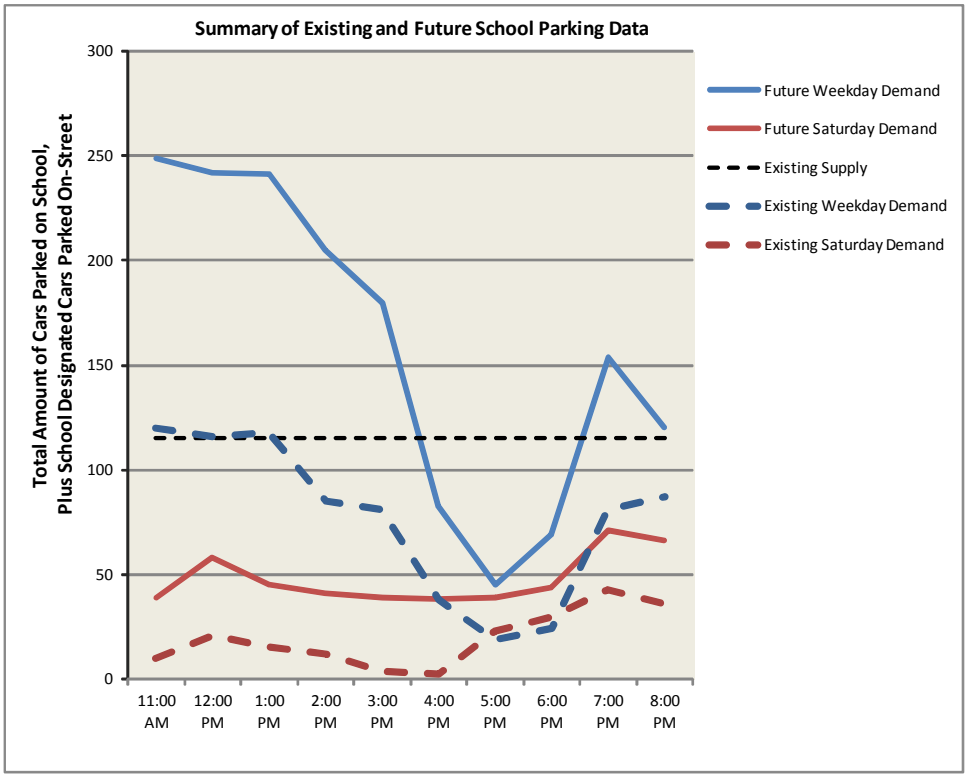
Table 2: Parking Demand Comparison

School	Existing Conditions			Future Conditions		
	Parking Demand[(1)]	*Zoning Req.*[(2)]	*Existing Parking Supply*	*Parking Demand*[(1)]	*Zoning Req.*[(2)]	*Recommended Parking Supply*[(3)]
Williamsburg MS	120	148	115	151	148	165
New ES	--	--	--	98	102	108
Total	**120**	**148**	**115**	**249**	**250**	**273**

1 – Demand based on observations and data collected by Gorove/Slade, future demand based on existing demand plus population growth
2 – Zoning requirements as stated in the Arlington County Zoning Ordinance. Zoning requirements shown based on student design capacity and public assembly space (students/assembly space).
3 – Recommended supply is equal to projected demand plus 10%

[3] Arlington County Zoning Ordinance, *Section 33: Automobile Parking, Standing and Loading Space*, page 8 of 11; April 27, 2010

Figure 17 shows the comparison of the existing and future parking demand. Using recommended number of parking spaces, the future parking demand peaks at 91% of the total supply during a typical weekday. On a Saturday, the future parking demand peaks at 28% of the total supply.



Weekday

Time	Existing Conditions			Future Conditions			
	Demand	Supply	Percent	Demand			Percent
	MS only	MS only		MS	ES	Total	
11:00 AM	120	115	104%	151	98	249	91%
12:00 PM	116	115	101%	146	96	242	89%
1:00 PM	118	115	103%	148	93	241	88%
2:00 PM	85	115	74%	107	98	205	75%
3:00 PM	81	115	70%	102	78	180	66%
4:00 PM	38	115	33%	48	35	83	30%
5:00 PM	19	115	17%	24	21	45	16%
6:00 PM	24	115	21%	30	39	69	25%
7:00 PM	81	115	70%	102	52	154	56%
8:00 PM	87	115	76%	109	11	120	44%

Saturday

Time	Existing Conditions			Future Conditions			
	Demand	Supply	Percent	Demand			Percent
	MS only	MS only		MS	ES	Total	
11:00 AM	10	115	9%	13	26	39	14%
12:00 PM	21	115	18%	26	32	58	21%
1:00 PM	15	115	13%	19	26	45	16%
2:00 PM	12	115	10%	15	26	41	15%
3:00 PM	4	115	3%	5	34	39	14%
4:00 PM	2	115	2%	3	36	39	14%
5:00 PM	23	115	20%	29	10	39	14%
6:00 PM	30	115	26%	38	6	44	16%
7:00 PM	43	115	37%	54	17	71	26%
8:00 PM	36	115	31%	45	21	66	24%

Figure 17: Existing vs. Future Parking Demand

SUMMARY OF CONCERNS & POTENTIAL IMPROVEMENTS

The following contains recommendations to mitigate concerns from the review of the existing facilities, as well as the future growth at Williamsburg Middle School:

- *Passenger Car Pick-up/Drop-off Layout and Congestion*

  Current passenger car pick-up/drop-off has several areas of concern, notably in the morning. Both pick-up/drop off areas have layout issues. The pick-up/drop-off area in the northern lot is within a drive aisle of the parking lot, not in a separate area. In addition, students need to cross the bus access lane to reach the school. The eastern pick-up/drop-off area also has issues, including how the pick-up/drop-off area is on the left side of the vehicle, which can lead to students getting in and out of cars in the middle of the travel lane. In response, the school has prohibited cars from passing each other in this area, which lead to frustration in the afternoon. Passenger pick-up in the afternoon is not done sequentially as passenger drop-off is in the morning, thus leading to driver frustration when they are ready to leave prior to cars in front of them.

  The amount of cars dropping-off students in the morning is much higher than national data would suggest for a school of this size, and the concentration of cars dropping-off students is significant over a 30 minute period. At times, congestion can back up onto North Harrison Street. Similar conditions in the afternoon do not exist, as student pick-ups seems to be much more spread out, or students get home a different way than they arrive to school.

  Potential Solutions: In the short-term, additional signs and markings could be used in the eastern parking lot in an attempt to reduce illegal turns and activities from drivers. In addition, it may be worth exploring changing the orientation of the eastern parking lot, so traffic enters at the north and exits at the south. This would create a situation where the passenger side of the car is facing the school, and limits the impact of congestion on North Harrison Street by moving the entrance further away from 36th Street. This would also allow vehicles to pass others in the designated pick-up/drop-off zone, which could help alleviate issues during the afternoon.

  Additional solutions could involve trying to reduce the amount of drop-off activity in the morning, through efforts to increase walking and cycling of students to school. The school can work with Arlington County's Safe Routes to School Program in an attempt to reduce vehicular traffic in the morning.

  Long-term solutions would include fixing the geometrical issues by redesigning and constructing new parking lots with specific pick-up/drop-off areas. This solution may be more viable in conjunction with construction of the new elementary school rather than by itself.

- *Pedestrian Facilities*

  As discussed above in the report, and detailed in the field review attached to the report, there are some gaps in the pedestrian facilities. Most roadways have sidewalks, but a few residential streets only have them on one side. More notably, crossings near the school do not have marked crosswalks, which may be beneficial on some intersections close to the school. Also, the unsignalized intersections along Williamsburg Boulevard do not have marked crosswalks. This is not a major concern as pedestrians can be routed through the intersection of Williamsburg Boulevard and North Harrison Street, which has signalized crossings

  Potential Solutions: The school can work with the County to provide additional sidewalks and marked crossings on nearby residential streets. Exact locations for improvement should be developed when a final school boundary is

known and walking routes are more final. Likely locations will be 36th St and North Kensington Street as well as Williamsburg Boulevard and North Harrison Street. This report does not recommend adding marked crossings to the unsignalized intersections of Williamsburg Boulevard, unless they were recommended as part of the larger study examining all users of the roadway and the impacts crossings would have on capacity and safety.

- *Speeding*

  As discussed above in the report, and detailed in the field review attached to the report, site observations indicated that speeding may be a problem in the residential streets surrounding the school. Although a speed study was not performed as part of this assessment, the speeds of vehicles on the residential streets appeared to be high and intimidating for pedestrians, especially when crossing the road. The natural topography of the roads leads to many cars speeding up going downhill, and although on-street parking is permitted on both sides of the residential streets, most homes have driveways and a lot of parking stays empty. This leads to very wide travel lanes for cars, which can in turn lead to increased speeds from drivers.

  Several speed bumps already exist on North Harrison Street, adjacent to the school, indicating that speeding has been an issue in the past. The placement of the speed humps does not cover all of the major walking routes to school, as they are located close to the school itself, sometimes where students would have already left the roadway to walk on a path to/from the school.

  Potential Solutions: The school can work with the County to explore if traffic calming would be the correct solution. This may include speed and cut-through studies, and examining a list of potential calming elements, such as signing and striping improvements, mini-traffic circles, and other traffic calming features. Similar to pedestrian improvements, solutions should be developed when the school boundary is final and walking routes are better known.

- *Parking*

  The parking demand observations performed as part of this assessment showed parking demand can exceed the supply provided on site. This leads to some on-street parking of school employees and visitors. During events held at the school, a larger amount of overspill parking can occur.

  Potential Solutions: Based on county of on-street parking occupancy, although overspill parking does occur on-street, a large amount of spaces were still available to residents and other drivers. County zoning code calls for all parking to be accommodated on site thus the amount of parking available to the school should be increased as part of construction of the new elementary school.

The following contains recommendations for the site design of the proposed new elementary school adjacent to Williamsburg Middle School:

- *Bus Loading/Unloading*

  Bus loading/unloading should occur separately from other activity and students should have a clear space to walk to and from the loading/unloading area and the school. Care should be taken when locating the vehicular access points for the bus, since they require larger turn radii and generally more room compared to other vehicles. This can create large gaps in sidewalks for pedestrians, and encourage high speeds in passenger cars. Ideally buses and passenger cars would have separate access points so as not to encourage cars making high speed turns in and out

of school driveways. Based on comparisons with other schools, it is likely that the school will have six to eight buses at peak times, and the bus area should be designed to hold at least that many buses.

- *Passenger Car Pick-up/Drop-off*

  Passenger car pick-up/drop-off should occur within its own separate area, but if located in a parking lot it should not take place within a drive aisle. Students should be discharged on the right side of the vehicle and have a direct path to the school. It can be useful to have some short-term parking spaces near the pick-up/drop-off area for drivers waiting to pick-up their students in the afternoon.

  Because Williamsburg Middle School generates a significant amount of pick-up/drop-off traffic the access pattern for the new school should avoid conflict with the Middle School. They should not share the same driveway.

- *Parking*

  The recommended future parking supply of 273 spaces is 159 spaces more than the current parking supply (total for both schools). This report recommends that the two schools share as much parking supply as possible. Quality walking paths should be provided and walking distances kept to a minimum between the schools. This shared resource could help accommodate parking during events at either school. This would require coordination between the schools so events do not occur at the same time. Such an arrangement is already in place between Carlin Springs ES and Kenmore MS, which are adjacent to each other.

  A factor in deciding how many spaces to construct is the presence of ample on-street parking. The existing parking counts show over 100 spaces available on weekdays adjacent to the school property (not counting the other side of the street). These spaces could be used to keep the amount of new construction to a minimum, reducing the amount of new spaces to construct from 159 to 59. The design should balance the zoning and practical parking needs, while also keeping the amount of new parking constructed at a minimum to preserve as many playing fields on site as possible.

- *Pedestrian Facilities*

  Paths to and from the school, from all directions, should be direct and not overlap parking lots and loading/unloading areas. When they do, they should have a dedicated and highly marked path with sidewalks. Potential upgrades to pedestrian facilities in the surrounding neighborhood may be needed to encourage students to walk to and from school. This could include filling in missing sidewalks, adding high-quality pedestrian signs and markings on major routes, and adding queuing spaces to curbs at the intersection of North Harrison Street and Williamsburg Boulevard. The school and County should coordinate efforts to review potential improvements.

- *Transportation Demand Management*

  Transportation Demand Management (TDM) programs at Williamsburg Middle School are very limited. TDM programs are initiatives to reduce vehicular traffic through promoting non-auto modes such as walking, bicycling and transit. A new elementary school would be a good impetus for pushing TDM programs at both schools. At minimum bicycle racks for employees and students should be incorporated into the new school design. The racks should be secure and covered. Initiatives for employees to use the nearby transit service should also be explored. The County already has programs for its employees and can help assemble a TDM plan.

COMPARISON OF ALTERNATIVES

Mitigation Strategies

There are several possible ways to minimize the impact of the new elementary school and to mitigate the impacts of the expansion of Williamsburg Middle School. This includes constructing additional driveways or reconfiguring existing driveways, staggering the school start-times, and implementing Transportation Demand Management (TDM) programs.

Access Strategies

The impact of the school expansion and new school on the surrounding roadway network could be lessened by spreading out the trips generated by the schools to more driveways. This involves both rerouting existing trips to other driveways and choosing the access point for the new school. In order to improve existing safety conditions some of the existing driveways were also reconfigured to create a safer environment for students.

The following four strategies were chosen for analysis:

a) Alternative A, as shown in Figure 18, involves constructing a new one-way access from 36th Street to Harrison Street to be used for the new elementary school. In addition a bus loop located at 36th Street is proposed for the new elementary school. The direction of traffic flow in the east lot will be reversed in this alternative in order to create a separate pick-up/drop-off for the middle school. This provides a much safer environment for students as students would no longer be dropped off on the traffic lane side.

b) Alternative B, as shown in Figure 19, involves the construction of a loop located on 36th Street that will provide access to the new elementary school pick-up/drop-off and the parking lot. The construction of a shared located on Harrison Street is also proposed. This allows for the current middle school bus access to be converted to a pick-up/drop-off. This allows for students to have direct access to the school without having to cross a bus lane. This alternative also involves reversing the direction of traffic flow in the east lot. The figure does not include an east lot pick-up/drop-off; however, this is something that can be added if desired.

c) Alternative C, as shown in Figure 20, includes the same new 36th Street loop as Alternative B. The main difference is that the elementary school and middle school will have separate bus loops. Thus a new bus loop for the elementary school would be constructed along 36th Street. This alternative also involves reversing the direction of traffic flow in the east lot with the additional pick-up/drop-off facility.

d) Alternative D, as shown in Figure 21, involves the construction of a two-way access road between 36th Street and North Harrison Street to be utilized by both the elementary school and the middle school. In this scenario it is assumed that all pick-up/drop-off activity for the middle school is rerouted to the new access and that the north and east lot are only to be used by people parking. Thus, the traffic flow in the east lot will not be reversed as there would no longer be a safety concern for students being picked up or dropped off. This alternative would also involve the construction of a new bus loop for the elementary school along 36th Street.

It should be noted that all access alternatives involve the expansion of the existing east lot parking facility.

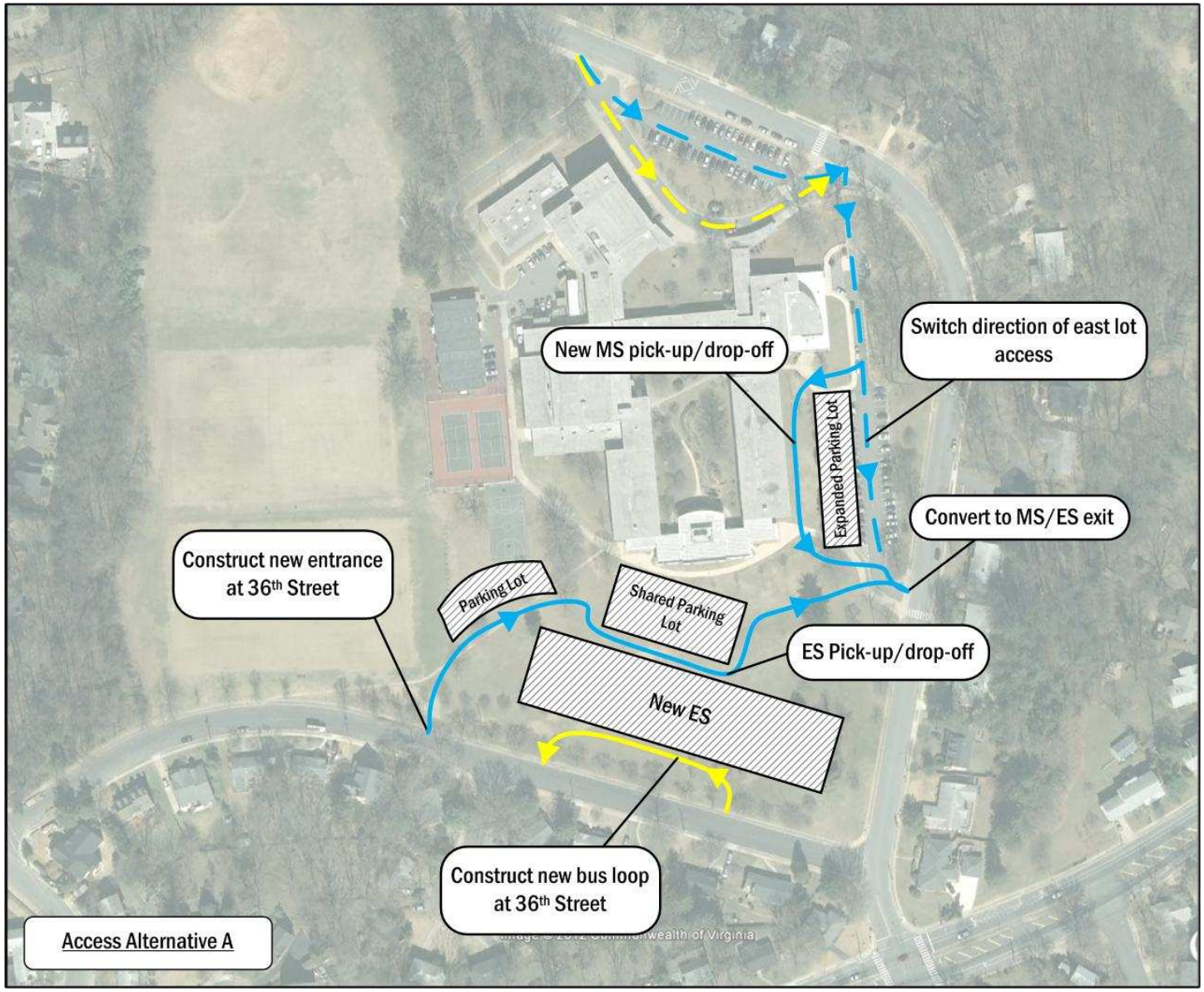


Figure 18: Access Alternative A

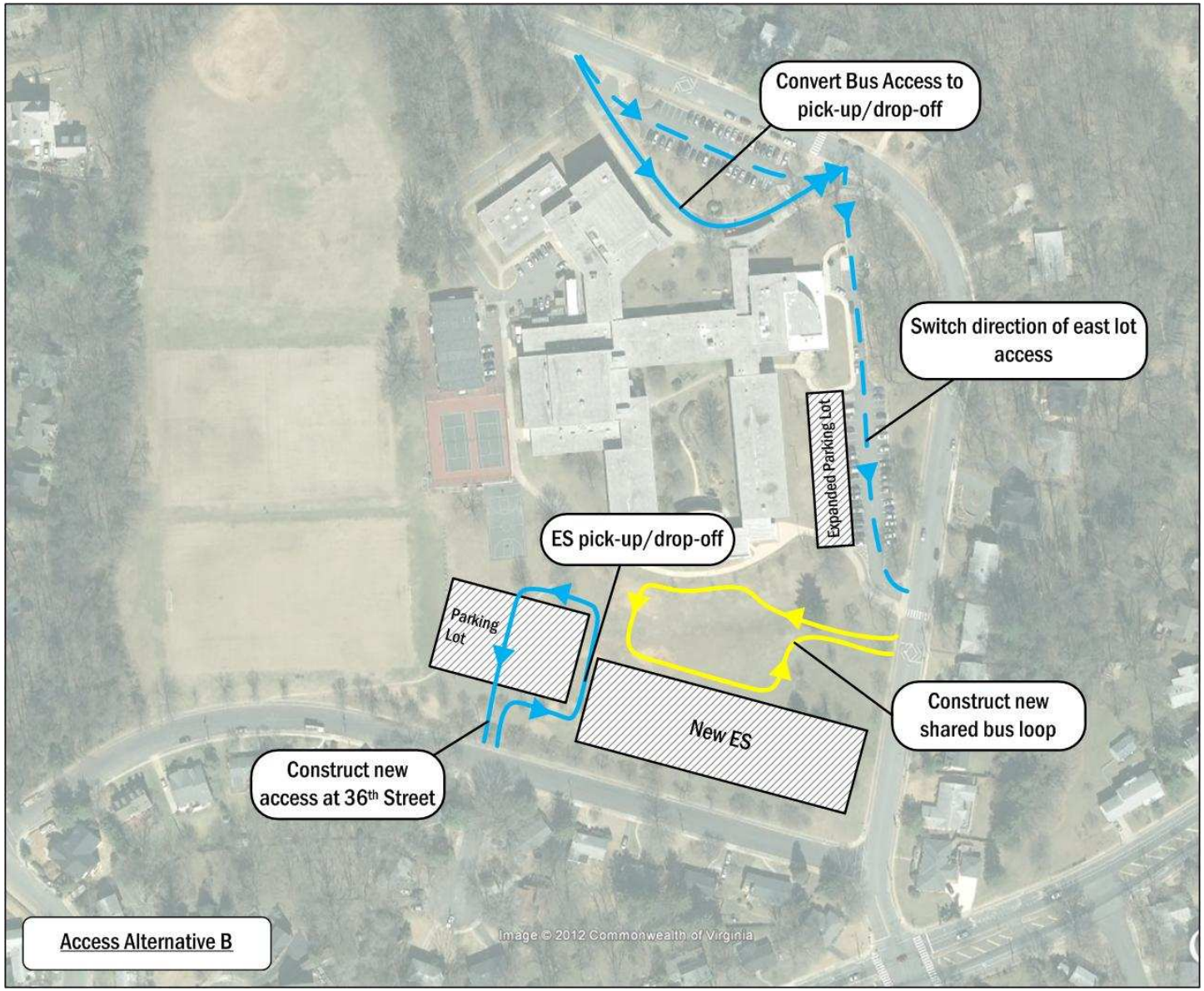


Figure 19: Access Alternative B

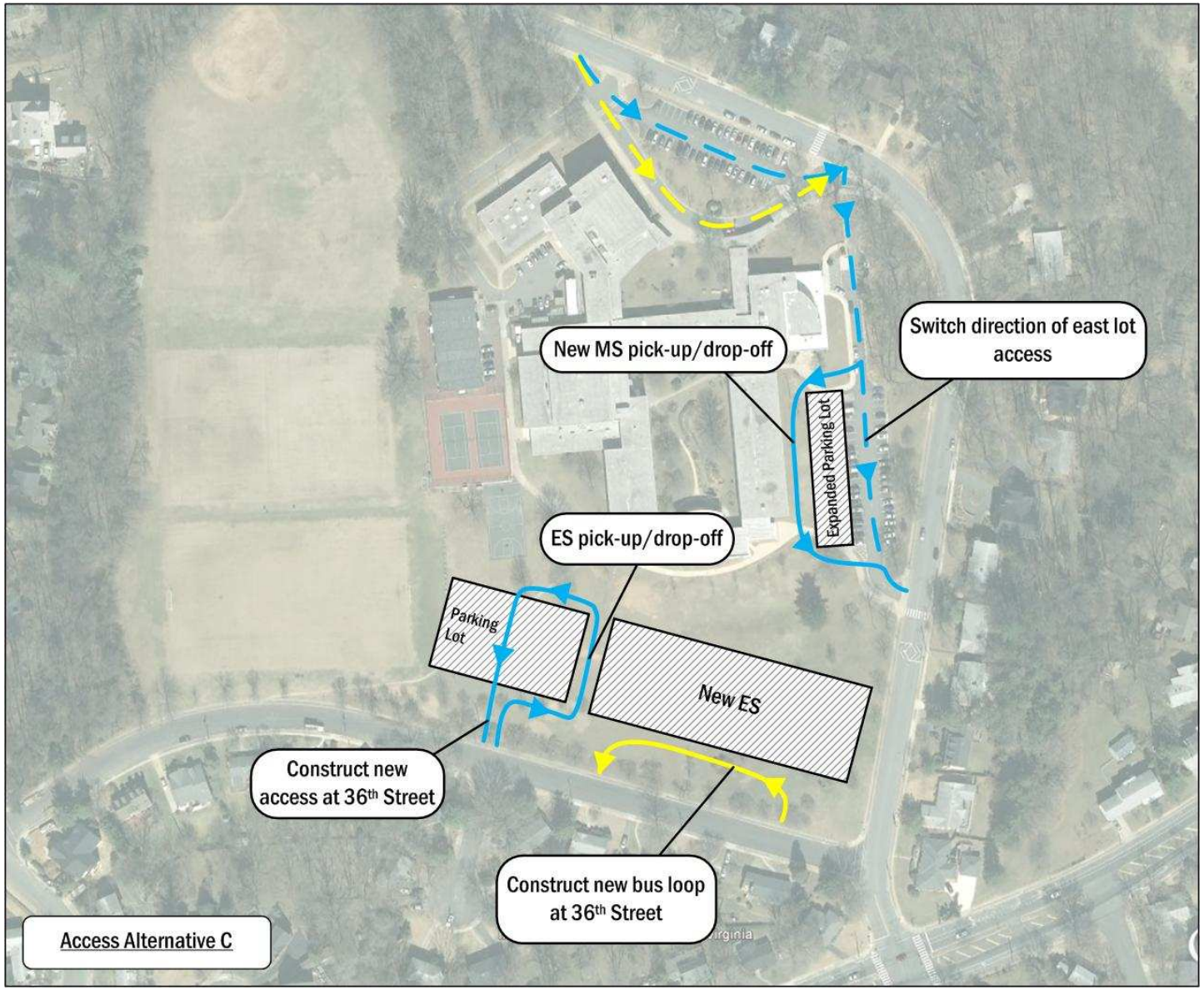


Figure 20: Access Alternative C

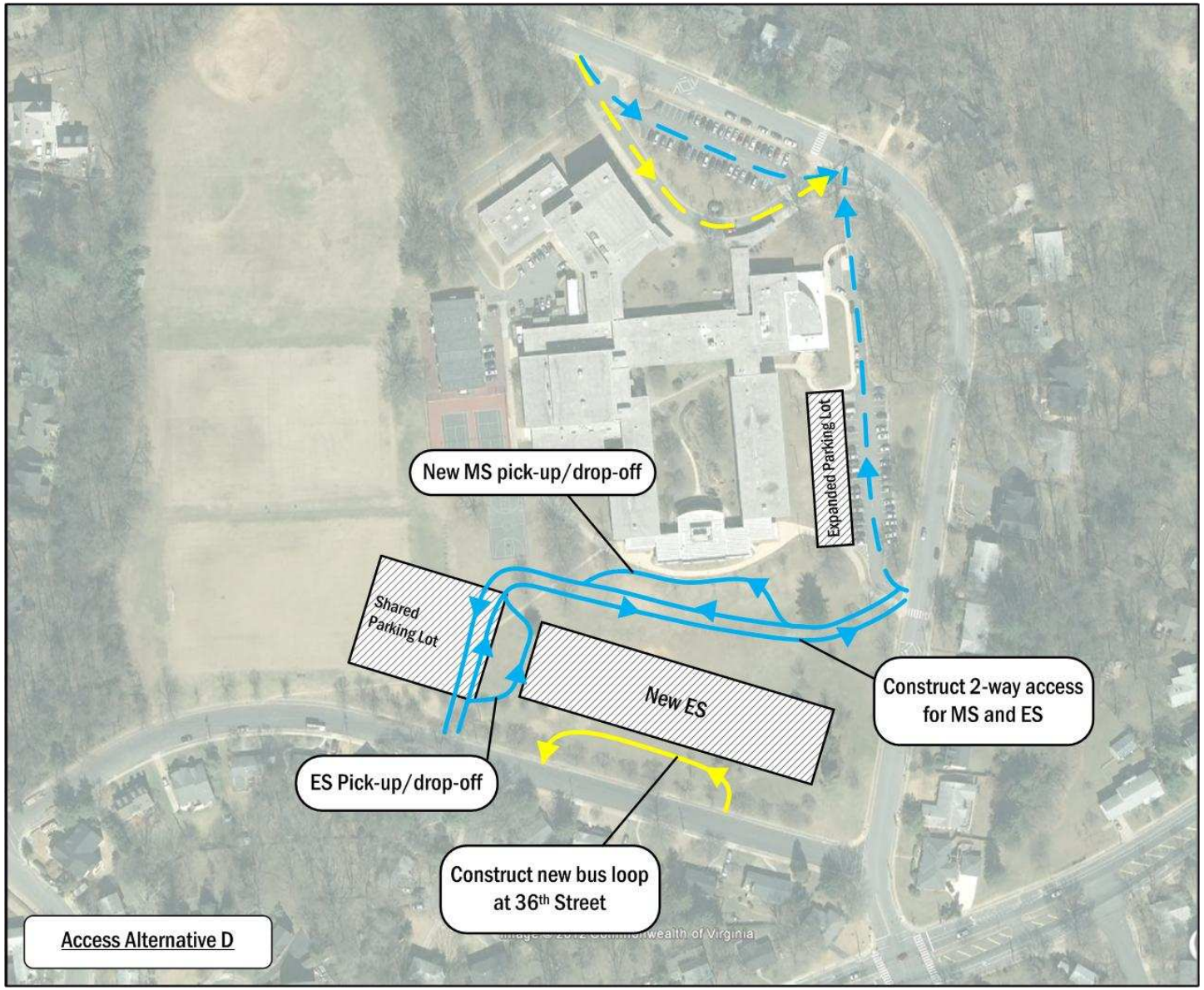


Figure 21: Access Alternative D

Staggering Strategies

The existing conditions show that the traffic volume for the network, excluding traffic generated by the school, peaks from 7:45 to 8:45 AM with the largest concentration of traffic occurring from 8:00 to 8:30 AM. Although the existing peak hours of the network and the middle school overlap, the peak half hours do not. There is however existing congestion at a few intersections in the surrounding area during the middle school peak. Therefore it is possible that the middle school growth and construction of the new school may exacerbate the delay and congestion on site.

In order to lessen the impacts of the added traffic, the start times for the schools may be shifted in order to create a situation in which the peak half hours for the network, the middle school, and the new elementary school conflict as little as possible.

Details for each of the analysis scenarios can be found in the following section.

Analysis Scenarios

With these strategies in mind, six scenarios were analyzed to help determine the relative merits of the strategies and develop conclusions and recommendations:

- Scenario #1 – Existing Conditions
- Scenario #2 – Growth of Existing School
- Scenario #3 – Growth of Existing School + New Elementary School
  - Access Alternative A
  - Access Alternative B/C
  - Access Alternative D
- Scenario #4 – Staggered School Start-Times (Option 1)
  - Access Alternative A
  - Access Alternative B/C
  - Access Alternative D
- Scenario #5 – Staggered School Start-Times (Option 2)
  - Access Alternative A
  - Access Alternative B/C
  - Access Alternative D
- Scenario #6 – Staggered School Start-Times (Option 3)
  - Access Alternative A
  - Access Alternative B/C
  - Access Alternative D

The difference in delay and LOS was negligible for Access Alternatives B and C. Therefore, for the purpose of analysis, they were combined to reduce redundancy.

The first two scenarios, which look at the existing conditions and projected future conditions with only growth at the existing middle school, are included for comparison purposes. The main evaluation takes place in the comparison of Scenarios #3, 4, 5, and 6. Scenario 3 investigates the merits of the four access alternative when the two schools have similar start times. Scenarios #4, 5, and 6 examine staggering and shifting the start times of the two schools in a manner to minimize impacts, while the sub-alternatives compare the various access alternatives combined with the staggering strategies.

For the purposes of the traffic analysis component of the evaluation, only the morning peak period of school traffic was evaluated. This was done because the morning trip generation of the school is much higher than the afternoon, and the morning peak school time coincides with higher volumes of commuter traffic compared to the afternoon. Thus, conclusions on traffic congestion are based on the worst case, the morning school peak period. Specifically, the time period analyzed was 7:30 am to 8:00 am. Traditionally, traffic analyses are performed over an hour-long period, but because the school traffic generation is so concentrated over a half hour, the smaller time period of analysis allows for more differentiation in results, and more clear conclusions, especially when examining the staggering strategies.

The following table summarizes the differences between alternatives.

Table 3: Summary of Scenarios Evaluated

Scenario	Access Scheme	School Start Times	Morning Peak Traffic Profile
1 - Existing	Existing	Williamsburg MS: 7:50 AM	Figure 7
2 - Growth at Existing School	Existing	Williamsburg MS: 7:50 AM	Figure 22
3a - Growth + New School	a: Figure 18	Williamsburg MS: 7:50 AM New ES: 8:00 AM	Figure 23
3b/c - Growth + New School	b/c: Figure 19 and Figure 20	Williamsburg MS: 7:50 AM New ES: 8:00 AM	Figure 23
3d - Growth + New School	d: Figure 21	Williamsburg MS: 7:50 AM New ES: 8:00 AM	Figure 23
4a - Staggering Start-Times (Option 1)	a: Figure 18	Williamsburg MS: 7:50 AM New ES: 7:30 AM	Figure 24
4b/c - Staggering Start-Times (Option 1)	b/c: Figure 19 and Figure 20	Williamsburg MS: 7:50 AM New ES: 7:30 AM	Figure 24
4d - Staggering Start-Times (Option 1)	d: Figure 21	Williamsburg MS: 7:50 AM New ES: 7:30 AM	Figure 24
5a - Staggering Start-Times (Option 2)	a: Figure 18	Williamsburg MS: 7:20 AM New ES: 8:00 AM	Figure 25
5b/c - Staggering Start-Times (Option 2)	b/c: Figure 19 and Figure 20	Williamsburg MS: 7:20 AM New ES: 8:00 AM	Figure 25
5d - Staggering Start-Times (Option 2)	d: Figure 21	Williamsburg MS: 7:20 AM New ES: 8:00 AM	Figure 25
6a – Staggering Start-Times (Option 3)	a: Figure 18	Williamsburg MS: 7:50 AM New ES: 9:00 AM	Figure 26
6b/c – Staggering Start-Times (Option 3)	b/c: Figure 19 and Figure 20	Williamsburg MS: 7:50 AM New ES: 9:00 AM	Figure 26
6d – Staggering Start-Times (Option 3)	d: Figure 21	Williamsburg MS: 7:50 AM New ES: 9:00 AM	Figure 26

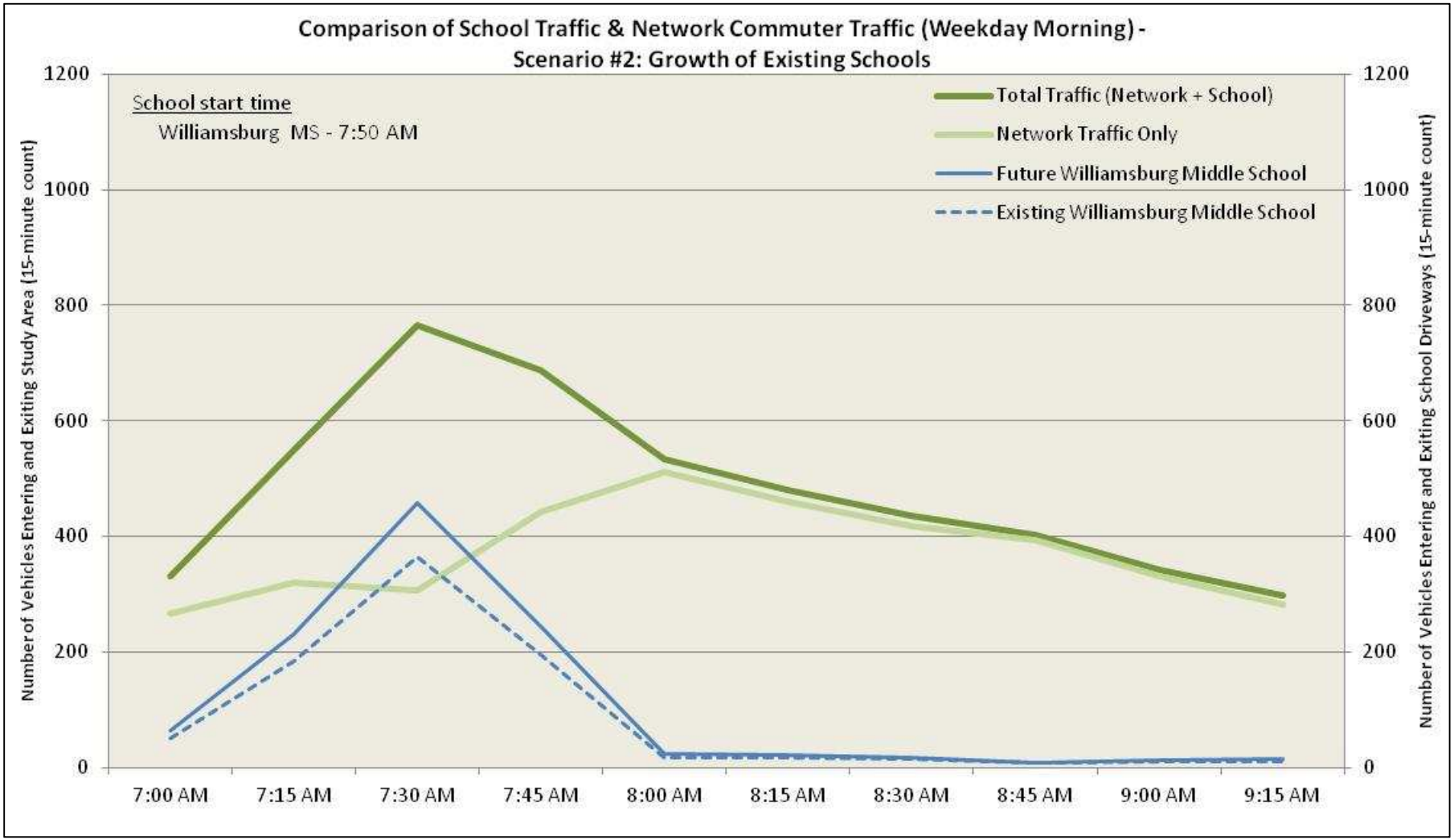


Figure 22: Scenario #2– Comparison of School Generated and Commuter Traffic (Weekday Morning)

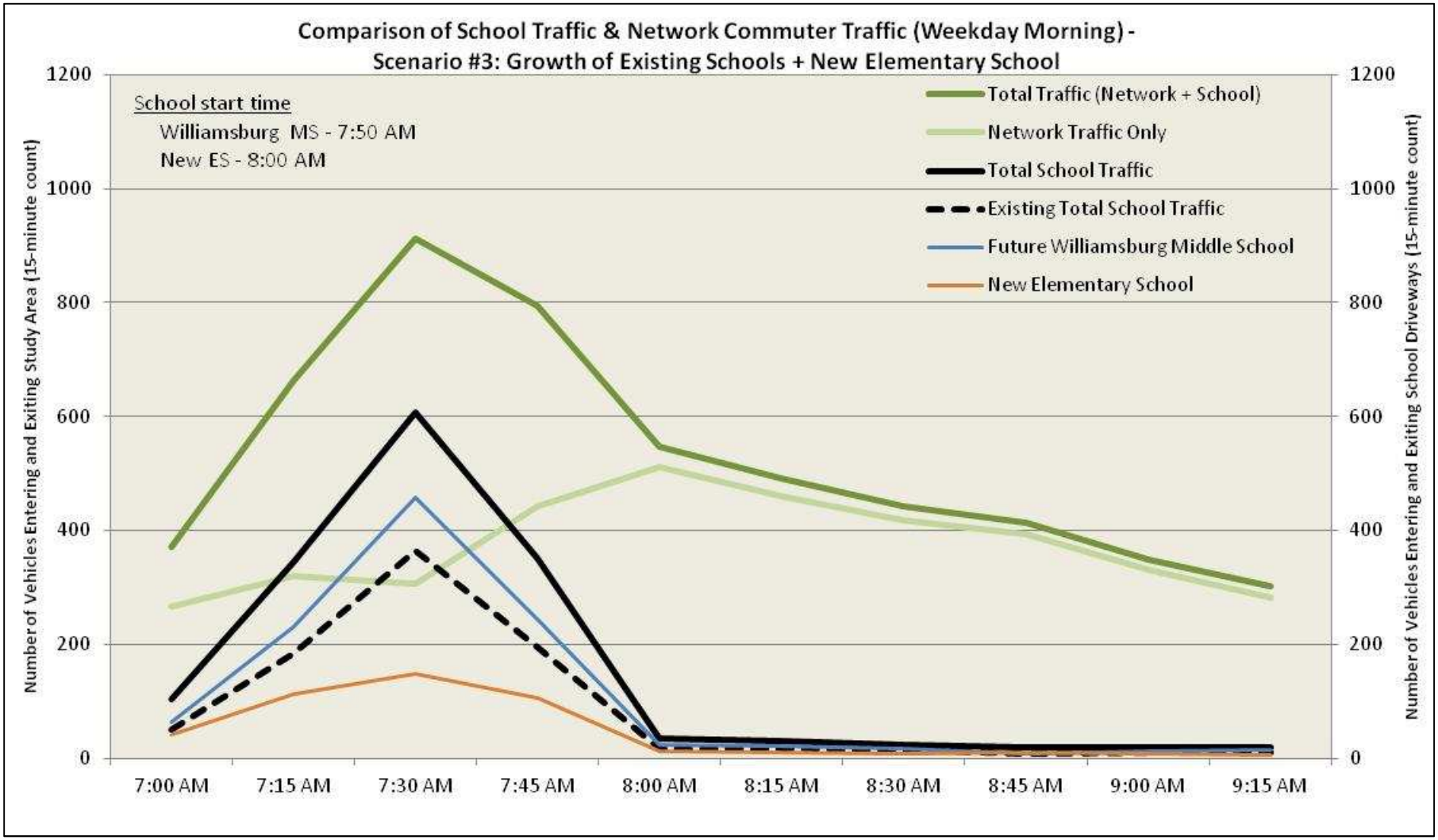


Figure 23: Scenario #3 – Comparison of School Generated and Commuter Traffic (Weekday Morning)

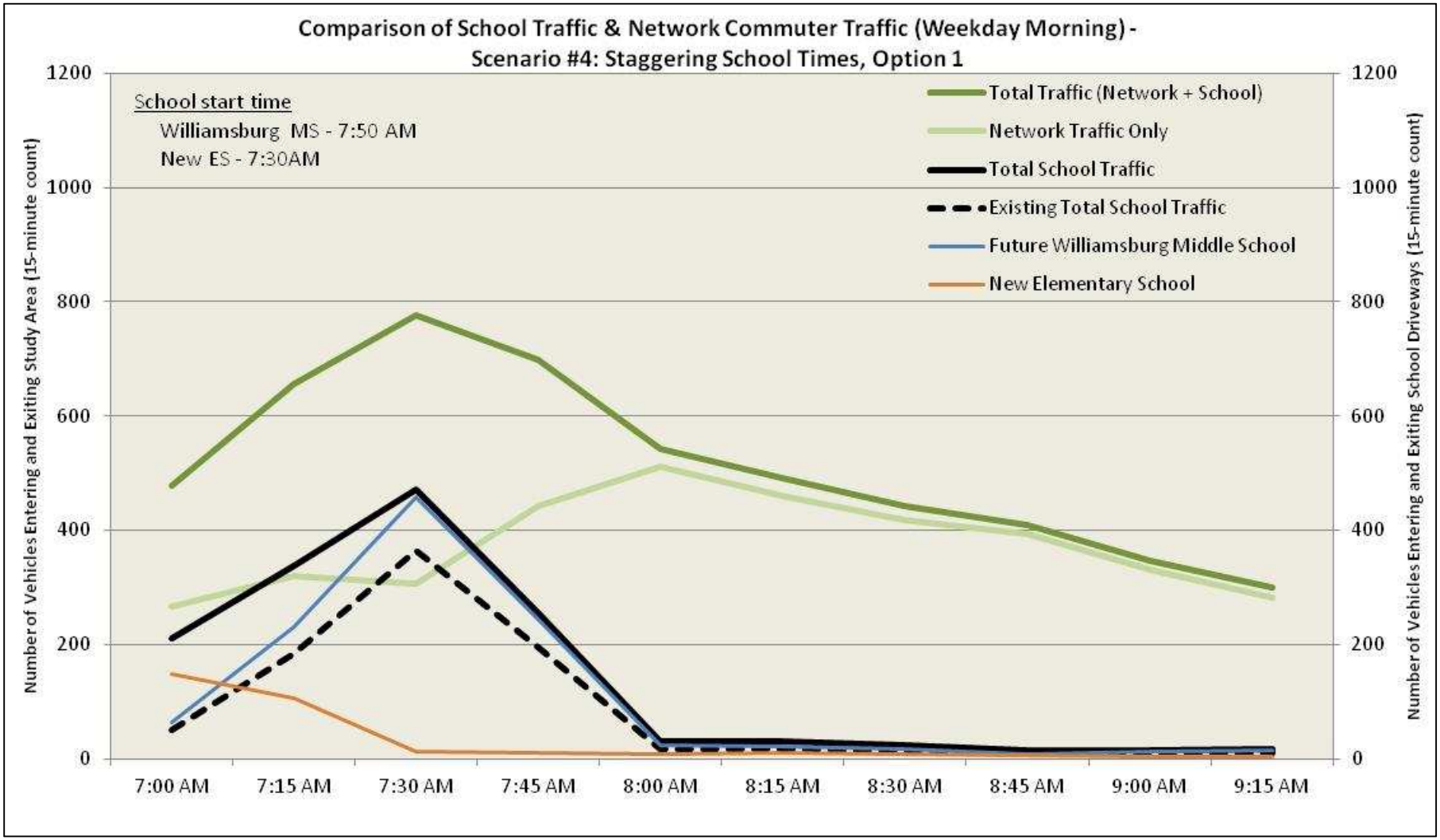


Figure 24: Scenario #4 – Comparison of School Generated and Commuter Traffic (Weekday Morning)

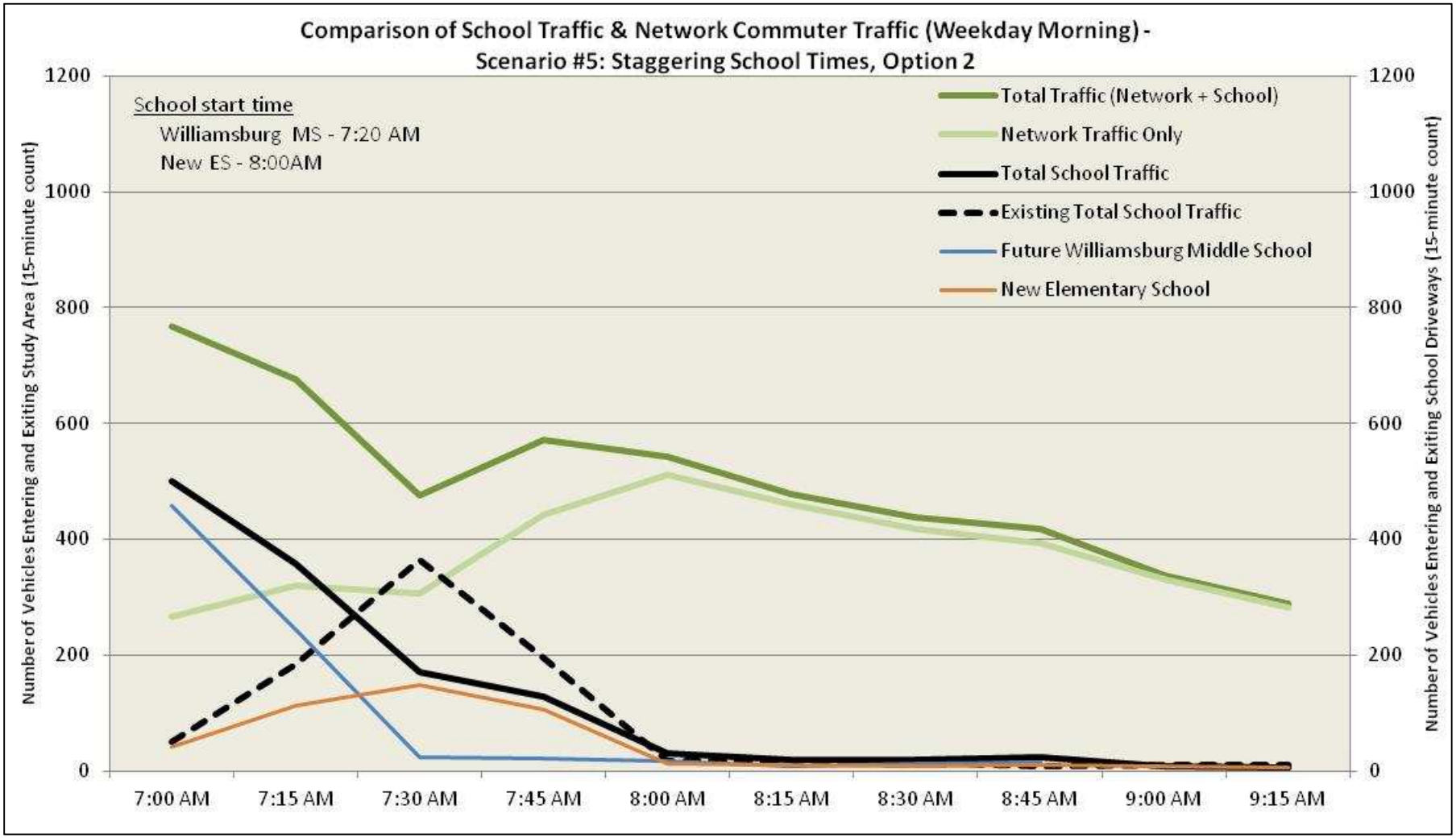


Figure 25: Scenario #5 – Comparison of School Generated and Commuter Traffic (Weekday Morning)

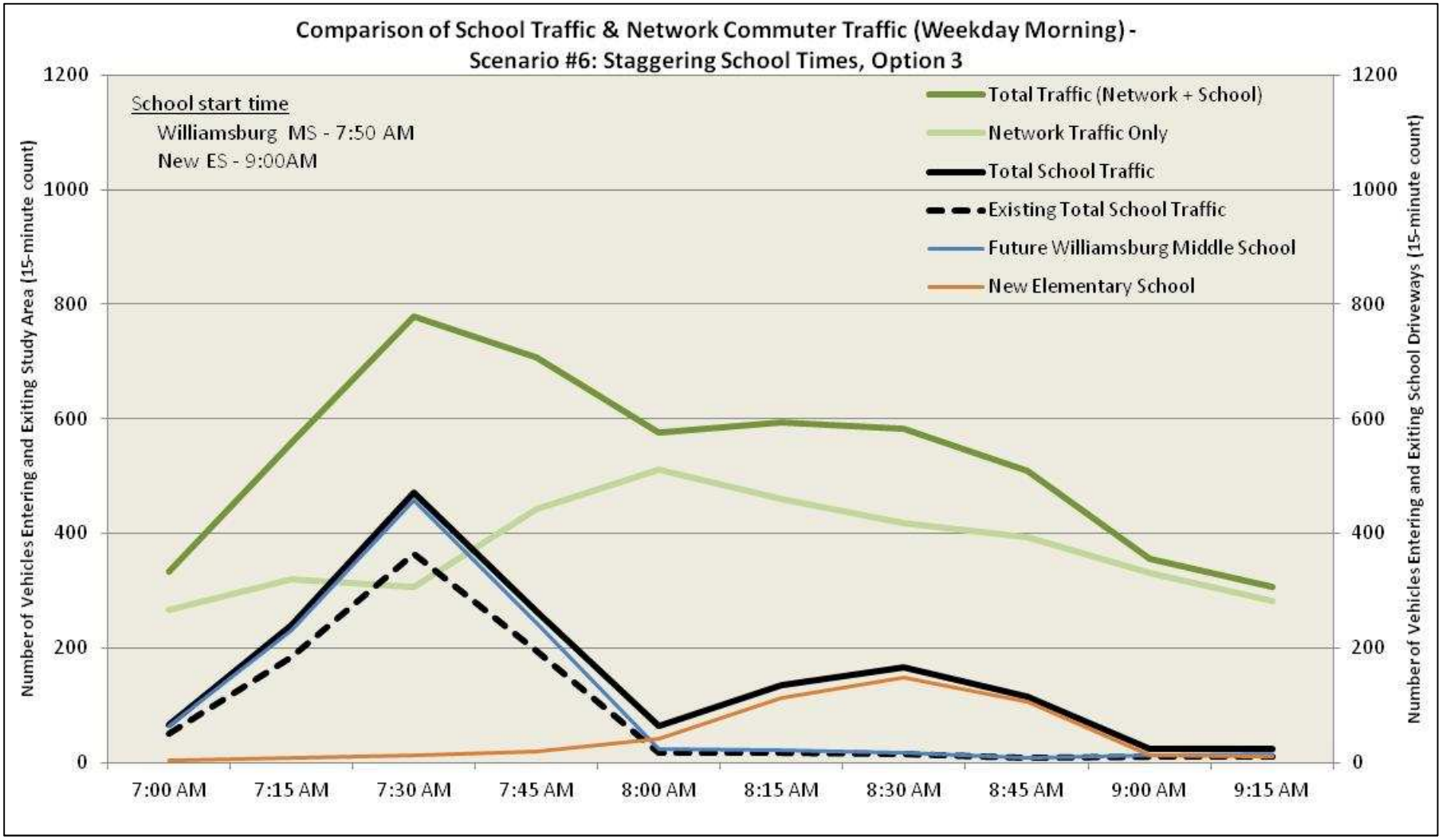


Figure 26: Scenario #6 – Comparison of School Generated and Commuter Traffic (Weekday Morning)

Evaluation and Recommendations

Several criteria were examined in order to evaluate the scenarios described above. The impacts to the following criteria were assessed:

- Parking – quality of access & accommodation of demand
- Bus access – quality of access & queuing
- Pick-up/drop-off – quality of access & queuing
- Pedestrian/bicycles – positive benefits of site design
- Internal roadway network – delays encountered entering or exiting school driveways
- External roadway network – delays generated to external traffic on surrounding roadways

The following section provides an overview of these criteria for each scenario. Afterwards, a table summarizing the relative difference between Scenarios #3, 4, 5, and 6 is presented.

Parking

All of the future scenarios will have the same impact on off-street parking because they will have similar parking demand, as outlined previously. As previously mentioned, Williamsburg Middle School currently has a slight parking shortage. Therefore all scenarios and access strategies address additional parking for the middle school and new parking lots to serve the elementary school.

While the six analysis scenarios will have relatively similar parking demand, the parking access will be modified in Scenario #3, 4, 5, and 6. The four Access Alternatives (A, B, C, and D) outline the parking lot access for the site. The following summarizes the impact of the Access Alternatives:

- *Scenario #3A, 4A, 5A, and 6A*
  In Alternative A, the east lot for the middle school has been expanded and the direction of traffic has been switched. A pick-up/drop-off will be constructed at the east lot which allows for the parking lot to be exclusively used for parking. Along the access road to the elementary school two parking lots are anticipated, one of which may be used as a shared parking lot if necessary. The exits from the east parking lot and new elementary school parking lots occur at the same location therefore this alternative may cause some congestion at the exit.
- *Scenario #3B, 4B, 5B, and 6B*
  In Alternative B, the east lot for the middle school has been expanded and the direction of traffic has been switched. A separate pick-up/drop-off will be employed at the north lot which allows for the parking lot to be exclusively used for parking. The parking lot for the new elementary school is accessible via a loop located on 36th Street North.
- *Scenario #3C, 4C, 5C, and 6C*
  In Alternative C, the east lot for the middle school has been expanded and the direction of traffic has been switched. The parking lot for the new elementary school is accessible via a loop located on 36th Street North. The bus access in the middle school's north parking lot has been converted to a pick-up/drop-off. This will create a better parking situation in the north lot as the pick-up/drop-off and parking will now occur in different places.

- *Scenario #3D, 4D, 5D, and 6D*
  In Alternative D, the east lot for the middle school has been expanded. A large shared parking lot will be constructed west of the new elementary school. It will be accessible via a two-way access road spanning from 36th Street North to North Harrison Street.

Overall, the four future scenarios do not greatly differ on their impact to parking. The additions to existing parking and new parking lots will adequately handle the future parking demand. Alternatives B and C are slightly more favorable as they separate the parking access for the two schools. This allows for fewer conflicts between vehicles due to the new access point.

Bus Access

The bus access will be impacted by the five future Scenarios outlined previously, as well as the three Access Alternatives. The following summarizes the impacts of each Scenario and Access Alternative:

- *Scenario #2*
  Scenario #2 will increase the volume of buses currently accessing the site due to the increase in student population at the existing middle school. Williamsburg Middle School is currently served by eight to nine buses. The existing bus facility is approximately 320 feet long (approximately 8 buses can queue at once). Based on the population growth, two or three additional buses will be needed. Assuming that all the buses do not come at one time, the growth will likely not cause buses to back up onto North Harrison Street.
- *Scenario #3A/C/D, 4A/C/D, 5A/C/D, and 6A/C/D*
  Access Alternatives A, C, and D all employ the same strategy for bus access of the existing middle school and the new elementary school. Scenario #3A, 4A, and 6A will increase the volume of buses currently accessing the Williamsburg Middle School bus facility; however, there will be no need to expand the existing bus facility. The new elementary school will have a separate bus access located on 36th Street.
- *Scenario #3B, 4B, 5B, and 6B*
  Alternative B converts the current middle school bus access to a pick-up/drop-off. A new shared bus loop located on North Harrison Street will be used instead. This bus loop will be designed such that buses queuing at the middle school will not block the elementary school buses and will provide the adequate amount of space to hold all buses. In Scenario #5 and 6 this will not be a concern as the school start times and end times do not conflict.

Overall, either of the bus access strategies can be viewed as an acceptable option as both allow for an adequate amount of bus storage space.

Pick-Up and Drop-Off

The pick-up/drop-off facilities will be impacted by the four future scenarios outlined previously, as well as the three access alternatives. The following summarized the impacts of each Scenario and Access Alternative:

- *Scenario #2*
  Scenario #2 will increase the pick-up and drop-off activity at the existing site due to the increase in student population at Williamsburg Middle School. This will likely exacerbate the existing issues outlined previously.

- *Scenario #3A, 4A, 5A, and 6A*

  Scenario #3A, 4A, 5A, and 6A will also increase the volume of pick-up and drop-off currently at the middle school. These scenarios also add the pick-up/drop-off activity generated by the new elementary school. In access alternative a, the east lot at the middle school is altered to improve the existing issues. The direction of traffic of the lot is switched such that a new pick-up/drop-off facility can be constructed directly next to the middle school. A pick-up/drop-off facility will be constructed on the north side of the new elementary school. In this alternative the pick-up/drop-off facilities for the east lot and the elementary school exit at the same access point along North Harrison Street.

- *Scenario #3B, 4B, 5B, and 6B*

  Scenario #3B, 4B, 5B, and 6B will also increase the volume of pick-up and drop-off currently at the middle school. These scenarios also add the pick-up/drop-off activity generated by the new elementary school. In access alternative b, the east lot at the middle school is altered to improve some of the existing issues. The direction of traffic is switched so that students do not have to enter and exit the vehicle in the middle of the traffic lane. In the north lot the bus lane is converted to a pick-up/drop-off facility in order for students to have direct access to the school. The vehicles no longer have to queue in the parking lane and instead have an exclusive lane. This also eliminates students crossing the bus lane to access the school. The new elementary school pick-up/drop-off is located at a separate facility than that of the middle school.

- *Scenario #3C, 4C, 5C, and 6C*

  Scenario #3C, 4C, 5C, and 6C will also increase the volume of pick-up and drop-off currently at the middle school. These scenarios also add the pick-up/drop-off activity generated by the new elementary school. In access alternative b, the east lot at the middle school is altered to improve the existing issues. The direction of traffic of the lot is switched such that a new pick-up/drop-off facility can be constructed directly next to the middle school. The new elementary school pick-up/drop-off is located at a separate facility than that of the middle school.

- *Scenario #3D, 4D, 5D, and 6D*

  Scenario #3D, 4D, 5D, and 6D will also increase the volume of pick-up and drop-off currently at the middle school. These scenarios also add the pick-up/drop-off activity generated by the new elementary school. A new two-way access is proposed that will allow for middle school and elementary school pick-up/drop-off. Ideally, the north and east lot of the existing middle school would only be used for vehicles parking and a separate bus lane, thus enforcement tactics would be implemented in order to deter people from continuing to use them as a pick-up/drop-off facility.

Overall, alternatives B and C are favorable as they provide solutions to existing problems and create completely separate facilities for the elementary school and middle school. Both alternatives provide an exclusive pick-up/drop-off facility from the parking facilities for the middle school. In alternative b the pick-up/drop-off is located in the north lot and in alternative c the pick-up/drop-off is located in the east lot. Both exclusive pick-up/drop-off facilities could be constructed if so desired. The new elementary school pick-up/drop-off is completely separate from that of the middle school and will successfully accommodate elementary school traffic.

Pedestrian/Bicycle

All of the future scenarios will increase the pedestrian and bicycle trips to the site. The growth of the existing Williamsburg Middle School will lead to more students walking or biking from the surrounding neighborhood. Faculty and staff may also be encouraged to bike or walk to the schools due to the increase in Transportation Demand Management. The construction of the new elementary school will also lead to an increase in faculty and staff bike/walk trips. An increase in student bike/walk trips due to the construction of the new elementary school is expected because it is a neighborhood school.

Growth of the existing schools and construction of the new school should not impact the existing pedestrian paths to and from the schools. Additionally, all of the scenarios include bus and pick-up/drop-off facilities that will be designed to provide clear space to walk between the loading/unloading area and the school. Design of new facilities could also include improvements to the existing pedestrian environment to encourage biking and walking to the school by both students and faculty/staff. The facility design, as well as the design of the new elementary school, should include bicycle facilities, such as bike racks, as explained previously.

Overall, the five future scenarios do not greatly differ on their impact to the bicycle and pedestrian environment.

Internal Roadway Network

The driveways and internal roadway network will be impacted by the five future Scenarios outlined previously, as well as the three Access Alternatives. Detailed capacity analyses of the driveways are attached to this report. The following summarizes the impacts of each Scenario and Access Alternative:

- *Scenario #2*
  The increase in traffic volumes due to the expansions of the existing middle school in Scenario #2 does not show a significant impact on the driveways. All access points continue to operate at an LOS C or better.

- *Scenario #3A, 3B, 3C, and 3D*
  In Scenario #3, the two schools start within 10 minutes of each other. This causes the majority of school generated traffic to occur within the same peak period. In Access Alternative b and c the driveways are not impacted significantly because separate driveways are used. However, in Access Alternatives A and D, some driveways are shared causing an LOS F at these locations.

- *Scenario #4A, 4B, 4C, and 4D*
  In Scenario #4, the elementary school starts at an earlier time than the middle school. With the staggered start times, most driveways operate at an adequate LOS with the exception of the new elementary school access at 36th Street in Access Alternative D. In this case all middle school traffic exits at the new access as opposed to the outbound trips being split between two exits in the existing conditions.

- *Scenario #5A, 5B, 5C, and 5D*
  In Scenario #5, the middle school starts at an earlier time than the elementary school. With the staggered start times, all driveways operate at an adequate LOS.

- *Scenario #6A, 6B, 6C, and 6D*

  In Scenario #6, the middle school starts at an earlier time than the elementary school. With the staggered start times, all driveways operate at an adequate LOS with the exception of the southbound movement at the new elementary school exit at 36th Street in Scenario #6D.

Overall, Scenario #5 has the most favorable impact on the internal roadway network as all driveways operate at an LOS C or better. Scenarios #4 and 6 would also be acceptable as long as Access Alternatives A, B, or C is employed. Scenario #3 is not advised as it causes existing driveways with acceptable levels of service to fail.

External Roadway Network

In addition to impact on the site driveways and internal roadway network, the growth of the existing middle school and the construction of the new elementary school will also have an impact on the surrounding roadway network. Table 4 shows the differences between network volumes and school traffic for each scenario in the morning peak half hour. The morning peak half hour (7:30 to 8:00 AM) for the school coincides with high network volumes of the surrounding area. Therefore it is beneficial to decrease the percentage of school traffic traveling during that time period. Scenarios #1, 2, 3, 4, and 6 yield percentages above 50%, but in Scenario #5 the amount of school traffic decreases below that of the existing conditions.

Table 4: Comparison of Network Volumes

Scenario	Time	Network Volumes	School Traffic	% School Traffic
Scenario #1	7:30 - 7:45 AM	671	365	54.4%
	7:45 - 8:00 AM	638	195	30.6%
Scenario #2	7:30 - 7:45 AM	765	459	60.0%
	7:45 - 8:00 AM	688	245	35.6%
Scenario #3	7:30 - 7:45 AM	913	607	66.5%
	7:45 - 8:00 AM	794	351	44.2%
Scenario #4	7:30 - 7:45 AM	777	471	60.6%
	7:45 - 8:00 AM	698	255	36.5%
Scenario #5	7:30 - 7:45 AM	477	171	35.8%
	7:45 - 8:00 AM	570	127	22.3%
Scenario #6	7:30 - 7:45 AM	778	472	60.7%
	7:45 - 8:00 AM	708	265	37.4%

The increase in traffic volumes will also impact the capacity of the intersection in the study area. Detailed capacity analyses of the study area intersections are attached to this report. The following summarizes the impacts of each Scenario and Access Alternative:

- *Scenario #2*

  The increase in traffic volumes due to the expansion of the existing middle school in Scenario #2 shows some significant impact to the roadway network. The addition of traffic volumes due to the population increase at the schools exacerbates the existing areas of congestion. The overall LOS at the intersection of North Harrison Street and North Williamsburg Boulevard changes from D to F. Additionally, a few individual movements show degradation in LOS and an increase in delay.

- *Scenario #3A, 3B, 3C, and 3D*

  In Scenario #3, the increase of traffic volumes due to the expansion of the existing middle school and the construction of the new elementary school show a significant impact on the surrounding network. The addition of traffic volumes due to the population increase and the new school construction exacerbates the existing areas of congestion. Many approaches operate at a LOS of D or worse in this scenario.

- *Scenario #4A, 4B, 4C, and 4D*

  Scenario #4 results in an improvement over Scenario #3. Although there are still a few approaches that operate at an inadequate LOS, these are areas that showed existing congestion. It should be noted that in Scenario #4 the end times of the two schools are within 15 minutes of each other. Therefore if this scenario is implemented, access alternatives b and c would be favorable as there are no shared driveways.

- *Scenario #5A, 5B, 5C, and 5D*

  The most significant impact on the surrounding roadway network is seen in Scenario #5. This scenario staggers the school start-times such that the middle school has a slightly earlier start time than the morning peak hour of the surrounding roadway network. This minimizes the overall impact of the school. Improvements in capacity are seen at several intersections, including North Harrison Street and Williamsburg Boulevard. There are also no significant differences in capacity at the surrounding intersections for the four Access Alternatives explained previously.

- *Scenario #6A, 6B, 6C, and 6D*

  Scenario #6 yields nearly identical capacity results as Scenario #4. Therefore this scenario is also an improvement over Scenario #3; however, it does not provide the improvements shown in Scenario #5. Unlike Scenario #4, the end times of the school differ such that there would be no significant difference in capacity at the surrounding intersections for the four Access Alternatives explained previously.

Overall, Scenario #5 has the most favorable impact on the external roadway network. It improves the overall network from the existing conditions due to the school peak half hour being shifted away from the overall network peak. Scenarios #4 and 6 do not show any significant impacts on the external network, but do show increases in delay at the existing areas of congestion. Scenario #3 shows very poor LOS at several intersections and it not advised to be used.

Table 5: Summary of Relative Differences between Scenarios 3, 4, 5 & 6

Scenario	Parking	Bus	Pick-up/Drop-off	Pedestrian/Bike	Internal Roads	External Roads
3A	Expansion to existing middle school east lot suggested	Current bus lane will be adequate for middle school growth	East lot altered to improve existing issues; Exclusive pick-up/drop-off implemented	No significant difference between scenarios	LOS F at east lot access	New traffic exacerbates existing problems; New congestion arises at 36th St N and N Harrison St
3B		Shared ES/MS facility provides adequate space for all buses	East lot altered to improve some existing issues; Exclusive pick-up/drop-off implemented in north lot		All driveways operate at acceptable conditions	
3C		Current bus lane will be adequate for middle school growth	East lot altered to improve existing issues; Exclusive pick-up/drop-off implemented in east lot			
3D	Expansion to existing middle school east lot suggested; North and east lot used exclusively for parking (no pick-up/drop-off)		New two-way access with exclusive pick-up/drop-off for both schools		LOS F at east lot access; LOS F at new ES access	
4A	Expansion to existing middle school east lot suggested	Current bus lane will be adequate for middle school growth	East lot altered to improve existing issues; Exclusive pick-up/drop-off implemented		All driveways operate at acceptable conditions	Overall school traffic peaks at a lower volume; however, new traffic continues to exacerbate existing problems and new congestion still arises at 36th St N and N Harrison St (more favorable conditions than
4B		Shared ES/MS facility provides adequate space for all buses	East lot altered to improve some existing issues; Exclusive pick-up/drop-off implemented in north lot			

Scenario	Parking	Bus	Pick-up/Drop-off	Pedestrian/Bike	Internal Roads	External Roads
4C		Current bus lane will be adequate for middle school growth	East lot altered to improve existing issues; Exclusive pick-up/drop-off implemented in east lot	No significant difference between scenarios		Scenario 3)
4D	Expansion to existing middle school east lot suggested; North and east lot used exclusively for parking (no pick-up/drop-off)		New two-way access with exclusive pick-up/drop-off for both schools		LOS D at new ES access	
5A	Expansion to existing middle school east lot suggested	Current bus lane will be adequate for middle school growth	East lot altered to improve existing issues; Exclusive pick-up/drop-off implemented		All driveways operate at acceptable conditions	Schools comprise a lower percentage of AM commuter peak hour than existing school traffic. Shifts school impacts to earlier in morning, providing slight improvements to AM commuter peak hour, but more congestion earlier (no single hour is worse than existing conditions)
5B		Shared ES/MS facility provides adequate space for all buses	East lot altered to improve some existing issues; Exclusive pick-up/drop-off implemented in north lot			
5C		Current bus lane will be adequate for middle school growth	East lot altered to improve existing issues; Exclusive pick-up/drop-off implemented in east lot			
5D	Expansion to existing middle school east lot suggested; North and east lot used exclusively for parking (no pick-up/drop-off)		New two-way access with exclusive pick-up/drop-off for both schools			

Scenario	Parking	Bus	Pick-up/Drop-off	Pedestrian/Bike	Internal Roads	External Roads
6A	Expansion to existing middle school east lot suggested	Current bus lane will be adequate for middle school growth	East lot altered to improve existing issues; Exclusive pick-up/drop-off implemented	No significant difference between scenarios	All driveways operate at acceptable conditions	Overall school traffic peaks at a lower volume; however, new traffic continues to exacerbate existing problems and new congestion still arises at 36th St N and N Harrison St (more favorable conditions than Scenario 3)
6B		Shared ES/MS facility provides adequate space for all buses	East lot altered to improve some existing issues; Exclusive pick-up/drop-off implemented in north lot			
6C		Current bus lane will be adequate for middle school growth	East lot altered to improve existing issues; Exclusive pick-up/drop-off implemented in east lot			
6D	Expansion to existing middle school east lot suggested; North and east lot used exclusively for parking (no pick-up/drop-off)		New two-way access with exclusive pick-up/drop-off for both schools		LOS D at new ES access	

Recommendations

The evaluation of the scenarios led to the following general conclusions:

- Staggering start times leads to a much greater reduction in impacts to external roadway traffic than the various access schemes that explored driveway locations. Through staggering start times, it is possible to minimize impacts in a manner that the weekday commuter peak hours are not impacted by the schools more than they are today.
- Although the four Access Alternatives examined did not show external impacts, they did show beneficial impacts to internal traffic. Access Alternatives with separate driveways for the two schools showed an improvement to the level of service of the driveways.
- None of the scenarios evaluated was clearly superior to the others, and the preferred design will include different elements from some of them.

With the evaluation completed, the following recommendations are made for the site design of the campus containing the existing schools and the new elementary school:

- School start times should be staggered similarly to how they are for Scenario #4, 5, or 6. Scenario #5 is a better of the three options; however, all are acceptable.
- The direction of traffic should be switched in the east lot. This will create a safer environment for students being picked up and dropped off. An exclusive pick-up/drop-off facility separate from the parking lot is also suggested to further improve the safety as well as allow vehicles parking to be unobstructed by pick-up/drop-off activity. The switch in traffic flow will not be possible if Access Alternative D is chosen. In this situation the objective is that pick-up/drop-off activity will no longer occur in the north and east lots. Realistically, some pick-up/drop-off activity will most likely continue at these locations, thus with Access Alternative D, some unsafe pick-up/drop-off activity will continue in the east lot.
- It is suggested that access to the new ES parking and pick-up/drop-off facilities should occur as a separate driveway such as Access Alternative B or C implement. This allows for less possibility of congestion at a shared access. Access alternative a will be sufficient as long as the start and end times of the schools are staggered. Access Alternative d does not allow for improved safety in the east lot therefore it is the least desirable option.
- Either bus access scenario is acceptable. Both will accommodate the new and existing bus traffic for the middle school and the elementary school.
- A Transportation Demand Management (TDM) plan should be developed in conjunction with the County's DES to help reduce overall trip generation at the existing middle school and new elementary school.

The following list contains the next steps to be taken to move forward on this project.

- Improving access to Williamsburg Middle School
  - Perform a travel survey of students and parents to learn more about school transportation use and concerns;
  - Examine crash data at nearby intersections to help provide more information on pedestrian and vehicular safety; and

- Discuss potential solutions with school staff, community and Arlington County Department of Environmental Services staff.

- Planning and designing a new elementary school on the site
  - Scope and complete a full Transportation Impact Study in coordination with Arlington County Department of Environmental Services staff;
  - Work with design team to implement recommendations contained within this report; and
  - Design the access and circulation of the new school in a manner that best fits with the characteristics of the surrounding transportation network.

FIELD REVIEW: WILLIAMSBURG MS

Observations taken in May/June 2012 and focused on school grounds and the area within an approximate 0.25 mile radius from the site within school boundaries.

Guidelines based on Safe Routes to School program documentation and the Federal Highway Administration's *Pedestrian Road Safety Audit.*

Guideline	Existing Condition
Pedestrian	
Sidewalks should be provided along the street. If no sidewalk is present, a walkable shoulder (e.g. wide enough to accommodate cyclists/ pedestrians) or alternative path/trail should exist. Sidewalks should be continuous and on both sides of the street.	This field review examined sidewalks within an approximate 0.25 mile radius from the school. Within the area surveyed, the majority of roadways had sidewalks on both sides of the street. The exceptions are: The east side of N Kensington St between 36th Rd and 36th St The north side of 37th St between N Kensington St and the County line The north side of 37th St between N Edison St and Old Dominion Dr (portion) At all of these locations, sidewalks are available on the opposite side of the street.  *N Kensington St between 36th Rd and 36th St*
Sidewalks should be wide enough to handle peak pedestrian traffic.	The predominant sidewalk width appears to be 4' throughout the field review area. Observations showed that peak volumes were easily accommodated on the existing sidewalks. Some curbs at signalized intersections appeared to have limited space for queuing (while waiting for walk signs), but volumes observed where not significant enough to generate queuing problems.

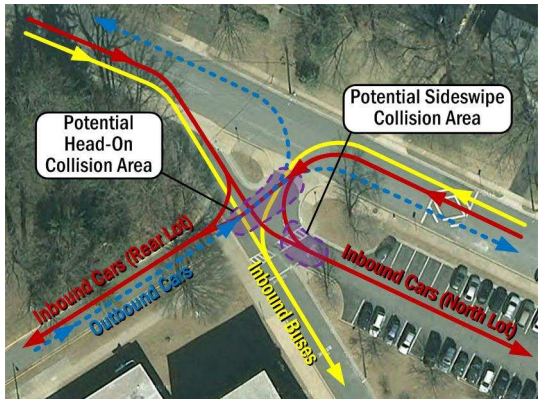
Guideline	Existing Condition
	 *Limited space at corner for pedestrians – N Harrison & Williamsburg Blvd*
Sidewalks should have a buffer between them and moving traffic.	The majority of sidewalks within the field review area had buffers. Notably, the parking and bicycle lane along Williamsburg Boulevard separates pedestrians from moving traffic by a substantial amount, aiding in creating a pedestrian friendly environment that might not otherwise exist on such a wide roadway.  *Parking and bicycle lane supplement landscaped buffer on Williamsburg Blvd*
Sidewalks should be well maintained and not in poor condition.	The majority of pedestrian facilities in the field review area were in good condition.
Pedestrian paths and sidewalks should be clear of obstructions. Crossings should be clear of obstructions that could lead to pedestrians being	The majority of pedestrian facilities in the field review area were in good condition. Some vegetation blocked the sidewalks along the north side of 36th Street between the fields and N Kensington St.

Guideline	Existing Condition
difficult to see while waiting to cross.	There are two mid-block crossings of N Harrison St adjacent to the school. Cars parked on street can block visibility between pedestrians and drivers, depending on how close they are parked to the crosswalk. On-street parking should be restricted near the crosswalks to ensure proper sight distance between pedestrians and drivers.  *Mid-block crossing adjacent to school*
Sidewalks and pedestrian pathways should not have steep grades. If stairs are provided, ramps should also be available.	There are some steep grades on Williamsburg Boulevard and surrounding streets, which follow the natural hills in the area. These grades could be intimidating for disabled pedestrians. A pathway leading from N Harrison Street to the northern portion of the eastern school parking lot contains stairs without a ramp alternative. This pathway does not appear to be used by students as a path to and from the school, and is not a significant link within the school's pedestrian network.
School doors/gates should be appropriately located to provide convenient and direct access for pedestrians. Walking & cycling paths should have dedicated facilities on school grounds, so they do not overlap bus or passenger car pick-up/drop off areas. Paths through or around parking lots should have dedicated sidewalks and marked crossings.	Pathways leading to doors are available on all approaches to the school. None of the paths require crossing parking lots or traffic lanes, and pathways around parking lots are provided.
Pedestrians should easily be able to locate sidewalks, crossings and pedestrian facilities though either an intuitive design or wayfinding signage.	During the field review no issues with locating pathways and sidewalks were observed.

Guideline	Existing Condition
All nearby residential areas and transit stops should have high quality connections to the school. Non-connective roadway designs, such cul-de-sacs and dead-end roads should be avoided to allow for the most pedestrian/cyclist porosity on surrounding streets. Paths should be provided when roadways do not connect	Transit stops along Williamsburg Boulevard are connected well to the school with sidewalks along the entire route. The majority of homes within the field review area had direct routes to the school, or semi-direct given the hilly nature of the streets. N Emerson and N Edison streets only connect to Williamsburg Boulevard, requiring circuitous walking routes to reach the school. Creating a pathway would be a difficult task given the natural topography and the existing building separating N Emerson and N Harrison streets.
The number of driveways crossing a sidewalk should be kept to a minimum.	The vast majority of homes within the field review area have driveways, which cross sidewalks. The nature of the residential streets and the very low amount of traffic using these driveways significantly limits their negative impact to the pedestrian environment.
Sidewalks, paths, and crosswalks should be adequately lit.	A lighting analysis was not performed as part of this field review.
Pedestrian travel zones should be clearly delineated from other modes of traffic through the use of striping, colored and/or textured pavement, signing, and other methods.	Within the field review area, although sidewalks were easily identifiable, not all crosswalks were. Some highly visible crossings were noted, such as the N-S crossings of 36th St at its intersection with N Kensington, and at the intersection of N Harrison St and Williamsburg Boulevard. Most crosswalks were not marked at all, including the majority of all crossings within the residential areas, and at the intersections of Williamsburg Boulevard with N Kensington St and Williamsburg Boulevard and George Mason Dr.
Crosswalks should be sufficiently wide to accommodate peak demand	Where provided, crosswalks were observed to be wide enough to accommodate demand.
Pedestrians and cyclists should not conflict each other on common areas, such as trails and sidewalks.	No pedestrian and cyclist conflicts were observed within the field review area. Bicycle activity was minimal during the site visit. Despite the bicycle facilities provided (signs, marking and bike lanes), the grades within the area likely create undesirable bicycling conditions.
Signs warning drivers to pedestrian activity should be used when appropriate.	A signing inventory was not performed as part of this field review, but warning signs were observed in the area.

Guideline	Existing Condition
	 *Pedestrian warning sign on N Harrison St*
Curb radii at intersections should not be overly wide as to encourage high speed turns and lengthen crosswalk distances. Channelized rights turns need to be designed in manner that minimizes conflicts with pedestrians.	Within residential areas, when the on-street parking is not occupied it creates a condition where where wide cross-sections and large curb radii make high speed turns possible. Traffic calming may be desirable along significant student walking routes. The intersection of Williamsburg Boulevard and N Kensington St has a large skew, creating some large curb radii and high speed turns, notably the left turn from Williamsburg to northbound N Kensington and the corresponding southbound right turn. The general lack of on-street parked vehicles only exacerbates the condition by creating unusually large traffic lanes. Crosswalks are not provided at this intersection, which appears very intimidating to pedestrians crossing in any direction.
Raised medians should be located to provide a safe waiting area (refuge) for pedestrians.	The crosswalks provided over Williamsburg Boulevard at N Harrison Street crossed over medians, but refuge islands were not provided, although the median can provide refuge for non-disabled pedestrians. If crossings were provided at other locations along Williamsburg Boulevard, median refuges could be incorporated into the design.

Guideline	Existing Condition
	 *Williamsburg Boulevard at N Harrison Street*
Crossing guards should be employed where appropriate.	Crossing guards are stationed at the intersection of Williamsburg Boulevard and N Harrison St
Signalized crossings should provide enough time for pedestrians. Pedestrian heads and countdown timers should be used.	The only traffic signal in the field review area is the intersection of Williamsburg Boulevard and N Harrison St. Timings appeared adequate, and pedestrian heads with countdown timers were installed. The pedestrian actuation buttons were slightly confusing, as it was difficult to tell which button to push for which crosswalk. The nearby traffic signal at the intersection of Williamsburg Boulevard and Old Dominion Drive also has crosswalks with pedestrian heads with countdown timers. Pedestrian actuation buttons are provided, but some were not labeled as to which crossing they were provided for.
The speed of adjacent traffic should not be high enough to intimidate pedestrians and cyclists.	A speed study was not performed as part of this field review, but during the site visits speeding appeared to be an issue within the residential streets adjacent to the school. Many vehicles were observed travelling at high speeds, most likely due to grades, wide lanes, low traffic volumes, and minimal traffic controls. Since the vast majority of residences have driveways, most of the on-street parking is empty. When cars are not parking along a street, the travel lanes appear to be very wide, which can lead to high speeds. Traffic calming may be desirable on significant student walking routes.

Guideline	Existing Condition
Pick-up/Drop-off	
Pick-up/drop-off lanes should be separated from bus lanes to minimize confusion and conflicts	Bus loading/unloading is separate from passenger car pick-up/drop-off. A potential conflict point does exist at the entrance to the northern parking lot. In this location, two entrances with large turning radii are provided to allow both right- and left-turning buses to access the bus loading/unloading area. However, these ramps are also used by drivers to enter the northern parking lot as well as to enter and exit the rear parking lot. Therefore, in addition to serving bus traffic these entrances serve two separate inbound movements to the northern lot as well as two-way traffic accessing the rear lot. These conflicting traffic streams cross in an area without traffic controls, creating a chaotic and potentially unsafe condition when multiple vehicles arrive at this intersection simultaneously.  *Potential conflict points at entrance to north parking lot*
The bus loading/unloading area should have adequate storage so buses do not queue onto roadways or other space not designated for buses.	Bus queuing was not observed to be a problem.
Students should have sidewalks and direct access from the bus loading/unloading & the passenger car pick-up/drop-off areas to the school, without crossing parking lots and traffic lanes.	Sidewalks and paths are provided between the bus loading/unloading area and passenger car pick-up/drop-off within the eastern parking lot. Students must cross the bus travel lane to get to and from the passenger car pick-up/drop-off that occurs within the northern parking lot.
Passenger car pick-up/drop-off should occur on the right side of the vehicle so students do not have to enter the vehicular travel path.	Pick-up/drop-off occurs on the left side in the eastern parking lot, and on the right side in the northern parking lot.

Guideline	Existing Condition
Cars should not be double-parking or performing illegal turns in the designated pick-up/drop-off area.	Parents often do not move up in the eastern parking lot to the official pick-up/drop-off zone and instead pick-up/drop-off near the southern end of the parking lot. This can create queuing and vehicle back-ups onto N Harrison St. Some vehicles were observed performing pick-up/drop-off operations in this location and then turning around and exiting out the southern driveway entrance, which is signed and marked for one-way inbound traffic. Since this driveway is not wide enough to support two-way traffic and because inbound drivers will not be expecting outbound traffic, this practice could lead to unsafe conditions.
On-street pick-up/drop-off activities on adjacent streets should be limited and should not impede the flow of local traffic.	On-street pick-up and drop-off activity was observed occurring in 3 primary locations: along N Harrison St adjacent to the northern parking lot, along N Harrison St adjacent to the south driveway of the eastern parking lot, and along 36th Street at its intersection with N Harrison St. While parents performing pick-up maneuvers along 36th Street are able to access this location from N Williamsburg Rd via N Kensington St, those vehicles making pick-ups and drop-offs along N Harrison St must perform a 3-point turn to exit back to N Harrison St. A high number of 3-point turns were observed during the school dismissal period, especially around the departure of the buses, contributing to delays and potential vehicular conflicts along N Harrison St. Any reconstructed pick-up/drop-off areas should be designed in such a way as to facilitate efficient pick-up/drop-off activity to discourage on-street pick-ups and drop-offs.
Queuing for passenger cars should be adequate for cars waiting in the pick-up/drop-off area.	Queuing at the pick-up/drop-off areas was observed to be adequate as long as drivers followed instructions.
Traffic Capacity & Operations	
The school zone should be identified with signs and pavement marking. School speed limit signs should be properly posted where appropriate.	A signing inventory was not performed as part of this field review, but speed limit signs were observed in the area. 

Guideline	Existing Condition
	School speed limit sign on N Harrison St
Directional signs should be used to ensure traffic to/from the school uses the correct access points	Signing was not observed during the site visit. School staff sends instructions for school access to parents directly.
Driveways should not be too closely placed near intersections	School driveways are located mid-block on N Harrison St, no issues with intersection spacing were observed in the field.
There should be sufficient gaps in traffic at unsignalized crossings for pedestrians to safely cross	Gaps in traffic were observed to be adequate at the mid-block crossings on N Harrison Street, and within the residential neighborhood.
Congestion along roadways and at intersections near the school should not be so severe to delay student and employee arrivals and departures.	Capacity analyses and field observations noted no issues resulting from intersection capacity.
Congestion and queuing in streets surrounding the school should not block crosswalk or pedestrian facility access.	No issues were noted during the field visits. The queues noted during the morning generated from the pick-up/drop-off rush did not block pedestrian routes to school.

DETAILED IMPACTS REVIEW

This section details the vehicular trips generated in the study area along the vehicular access routes, defines the analysis assumptions, analyzes the vehicular impacts of the proposed development, and makes recommendations for improvements where needed.

Scope of Analysis

The purpose of this study is to determine the impacts of the new elementary school and the growth of the existing school on the overall transportation network. All surrounding intersections and direct school access points were chosen for analysis as shown in Figure 27: Study Intersections. Intersection capacity analyses were performed for the existing conditions at each intersection with the study area during the schools morning and afternoon peak hours, as well as for future growth conditions with and without the new elementary school. The selected study scenarios are as follows:

- Scenario #1 – 2012 Existing Conditions
- Scenario #2 – 2015 Future Conditions with Existing School Growth
- Scenario #3 – 2015 Future Conditions with Existing School Growth + New Elementary School
- Scenario #4 – 2015 Future Conditions with Staggered School Start-Times (Option 1)
- Scenario #5 – 2015 Future Conditions with Staggered School Start-Times (Option 2)
- Scenario #6 – 2015 Future Conditions with Staggered School Start-Times (Option 3)

Scenarios #3, 4, 5, and 6 are further broken down to include the access management strategies described previously. These include:

a) Access Alternative A

b) Access Alternative B

c) Access Alternative C

d) Access Alternative D

The capacity analyses consisted of planning-level analysis in order to determine the potential impact of the growth and new school. Before the new school is constructed, a full Transportation Impact Study should be scoped and completed in coordination with Arlington County Department of Environmental Services staff.

The *Synchro, Version 7.0* software package was used to analyze the network based on the Highway Capacity Manual (HCM) methodology. The *Synchro* model was compiled using signal timings provided by Arlington County and with lane configurations and traffic volumes collected by Gorove/Slade. The following sections review the assumptions made for the technical analyses.

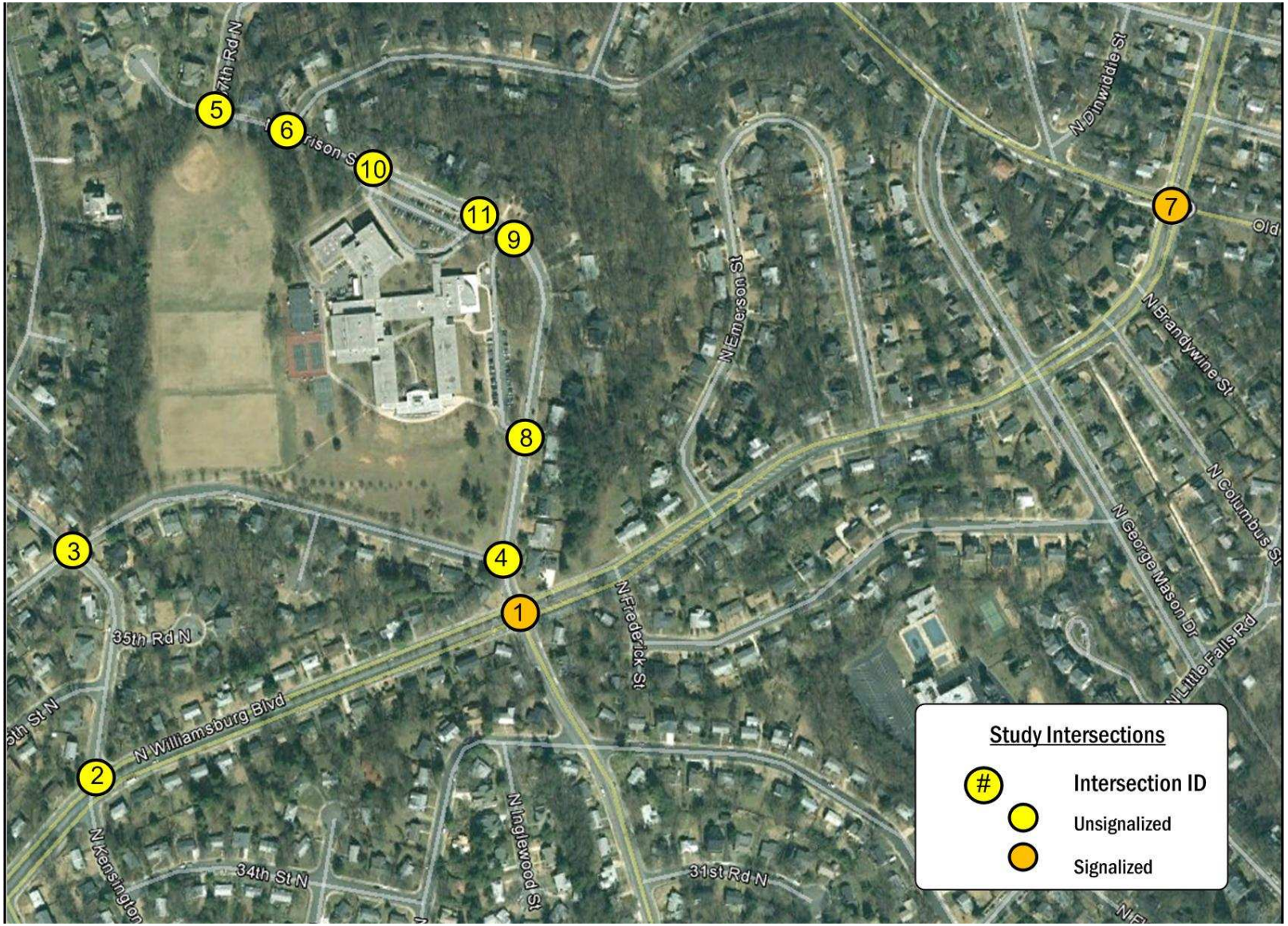


Figure 27: Study Intersections

Traffic Volume Assumptions

The following section reviews the traffic volume assumptions made and methodologies used in the roadway capacity analyses.

2012 Existing Conditions

The overall purpose of this study is to show what effect the proposed development will have on the transportation system in the study area. The existing conditions in and around the site are characterized in order to provide a foundation for assessing the transportation implications of the proposed development.

Arlington County and National standards require that traffic counts be conducted on a weekday, not including Monday or Friday, when traffic conditions can be described as "typical". This includes the consideration for adjacent uses, such as retail, special events, and recreation facilities and for major traffic generators.

In a full Transportation Impact Study, traffic counts are conducted on a "typical" day and are used to determine the morning and afternoon "peak hour" of traffic within the study area. According to the Highway Capacity Manual (HCM) methodologies, a one-hour analysis period is preferred. The "peak hour" represents the worst-case scenario, when the system traffic volumes are the highest. The use of a "typical" weekday morning and afternoon peak hours are used to ensure that conclusions regarding adverse impacts and their respective mitigation measures would apply to the vast majority of time roadways are used in the study area.

In order to ensure that the data collected contains the peak hour, traffic counts are taken for a period of several hours during the morning and afternoon peak periods. From these peak periods, a peak hour is derived for both the morning and the afternoon time periods. According to the Transportation Impact Analyses for Site Development Manual published by the Institute of Transportation Engineers (ITE), data is generally collected during the weekday morning (7:00 to 9:00 AM) and afternoon (4:00 to 6:00 PM) peak hours.

However, in this analysis, the peak hours for the schools were analyzed in order to determine the impact of the schools when their trip generation is the highest. Generally, the morning peak hour of the schools coincides with the morning peak commuter period. While the peak hours may not be exactly the same, they will likely overlap. However, the afternoon peak hour of the schools generally occurs before the afternoon peak commuter period. This is due to the dismissal time of the school occurring significantly before the commuter peak period. Therefore, for the purpose of this analysis of the school peak periods, the morning traffic count was performed from 7:00 to 9:30 AM and the afternoon traffic count was performed from 2:00 to 4:30 PM on Thursday, May 19, 2012.

The peak period counts are analyzed to determine the one hour during the morning and afternoon periods that contains the highest cumulative directional traffic demands. Generally "peak hours" for the morning and afternoon are determined; however, based on the rapid stream of traffic generated by the start and end of a school day, "peak half-hours" were used in this analysis. The "peak half-hours" are determined by summing up the two fifteen-minute consecutive time periods in the study area that experience the highest cumulative traffic volumes. The hourly traffic volumes are determined by extrapolating the volume of the peak half-hour to an hourly flow rate (doubling the half-hour peak traffic volumes to determine the hourly traffic volumes).

2015 Future Conditions with Existing School Growth

Williamsburg Middle School is anticipated to expand by the year 2015. Trip generation for the additional school population was calculated based on the existing trip generation as shown below:

$$New\ Trips = Existing\ Trips\ x\ \frac{New\ Population}{Existing\ population}$$

The new trips were calculated for each 15 minute count interval and the trips for the "peak half-hour" were used in the analysis. The peak half-hour traffic volumes were doubled to determine the hourly traffic volumes. These trips were then distributed and assigned to the network. The distribution was based upon the existing patterns of vehicles entering and exiting both the school access points as well as the overall network.

The traffic volumes generated by the school population growth were added to the 2012 Existing network in order to establish the 2015 future conditions with the existing school growth only. No background growth or development was assumed for the purpose of this analysis. As stated previously, before the new school is constructed, a full Transportation Impact Study should be scoped and completed in coordination with Arlington County Department of Environmental Services staff. This study will include background growth due to inherent growth on the roadways, as well as background developments located in the study area.

2015 Future Conditions with Existing School Growth + New Elementary School

The new elementary school is anticipated to be complete in 2015. Trip generation for the new school was determined based on an average of trip generation for existing elementary schools within the surrounding area obtained from the files of Gorove/Slade. In this scenario, four different access alternatives were analyzed. In the first and fourth alternative, the new school is accessible via a one-way access road with the entrance at 36th Street and the exit at Harrison Street. The trip distribution of the exiting traffic was based off the exiting traffic of the middle school. The trip distribution at the 36th Street entrance was based upon where middle school traffic enters and exits the system. From there the elementary school trips were distributed based upon overall traffic patterns in the network. In the second and third alternative, the new school is accessible via a loop located on 36th Street. The trip distribution at this access point was based upon where middle school traffic enters and exits the system. From there the elementary school trips were distributed based upon overall traffic patterns in the network.

The traffic volumes generated by the new school were added to the 2015 Future Conditions with Existing School Growth in order to establish the 2015 future conditions with the addition of the new elementary school. Thus this scenario includes both the new traffic generated by the expansion of the existing middle school and the traffic generated by the new elementary school.

2015 Future Conditions with Staggered School Start-Times (Option 1)

Staggering the start times of the middle school and the elementary school allows for the school traffic to be more evenly distributed throughout the network. As can be seen in Figure 24, the school peak still occurs at the same time as in the existing condition; however the amount of trips at this peak time is much less than if the schools were to start around the same time. It should also be noted that this scenario results in a similar end time for both schools. Although there is a much lower traffic volume at this time, it would be beneficial to employ an access alternative that does not utilize a shared access for the middle school and elementary school.

The trips generated by each school were determined based on the original calculations of new trips for the second scenario. In that stage, the trips for each 15 minute interval were determined. These values were shifted to align with the new start times of each school. The trips entering and exiting each access point were then determined. For some school access points the amount of "new" trips was a negative number due to the half hour analysis volumes being lower than the existing volumes. The trip distribution was performed in the same way as the previous scenarios, but instead of adding trips to the network, trips were removed from the network where necessary.

The traffic volumes generated by the staggered start times were added to the 2015 Future Conditions with Existing School Growth in order to establish the 2015 Future Conditions with Staggered Start Times (Option 1). Thus this scenario includes both the new traffic generated by the expansion of the existing schools and the new traffic generated by the new elementary school with staggered start times.

2015 Future Conditions with Staggered School Start-Times (Option 2)

Staggering the start times of the middle school and the elementary school allows for the school traffic to be more evenly distributed throughout the network. In Figure 25, shown previously, the peak of the school traffic is shifted earlier so that it is further away from the peak of the overall network. It should also be noted that this scenario results in a significant separation between the last bells of the day for both schools.

The trip generation and trip distribution was determined using the same methodology as the previous scenario. The traffic volumes generated by the staggered start times were added to the 2015 Future Conditions with Existing School Growth in order to establish the 2015 Future Conditions with Staggered Start Times (Option 2). Thus this scenario includes both the new traffic generated by the expansion of the existing schools and the new traffic generated by the new elementary school with staggered start times, leading to an earlier overall school peak.

2015 Future Conditions with Staggered School Start-Times (Option 3)

Staggering the start times of the middle school and the elementary school allows for the school traffic to be more evenly distributed throughout the network. In Figure 26, shown previously, the school peak still occurs at the same time as in the existing condition; however the amount of trips at this peak time is much less than if the schools were to start around the same time. It should also be noted that this scenario results in a significant separation between the last bells of the day for both schools.

The trip generation and trip distribution was determined using the same methodology as the previous two scenarios. The traffic volumes generated by the staggered start times were added to the 2015 Future Conditions with Existing School Growth in order to establish the 2015 Future Conditions with Staggered Start Times (Option 2). Thus this scenario includes both the new traffic generated by the expansion of the existing schools and the new traffic generated by the new elementary school with staggered start times, leading to an earlier overall school peak.

Table 6: Summary of Analysis Assumptions

2011 Existing Conditions
• Dates of data collection: Thursday, May 19, 2012 o Counts taken from 7:00 – 9:30 AM and 2:00 – 4:30 PM o Count sheets in Technical Appendix • System Peak: 7:00 – 8:00 AM, 2:15 – 3:15 PM • Half Hour Peak: 7:30 – 8:00 AM, 2:15 – 2:45 PM
2015 Future Conditions with Existing School Growth
• Volumes added: o Expansion to middle school population will occur by 2015 o Trips generated for middle school based on population growth o No background growth or development assumed • Trip distribution for vehicles based on existing traffic volumes and travel patterns at school access points and in the study area.
2015 Future Conditions with Existing School Growth + New Elementary School
• Volumes added: o Expansion to middle school population will occur by 2015 o Completion of new elementary school assumed to be complete by 2015 o Trips generated based on average of similar elementary schools in the area o No background growth or development assumed • Trip distribution for vehicles based on existing traffic volumes and travel patterns at school access points and in the study area.
2015 Future Conditions with Staggered School Start-Times (Option 1)
• Volumes added: o Expansion to existing schools population will occur by 2015 o Completion of new school assumed to be complete by 2015 o Trips generated shifted based on new coordination of start times with the elementary school starting before the middle school • Trip distribution for vehicles based on existing traffic volumes and travel patterns at school access points and in the study area.
2015 Future Conditions with Staggered School Start-Times (Option 2)
• Volumes added: o Expansion to existing schools population will occur by 2015 o Completion of new school assumed to be complete by 2015 o Trips generated shifted based on new coordination of start times with the middle school starting before the elementary school • Trip distribution for vehicles based on existing traffic volumes and travel patterns at school access points and in the study area.
2015 Future Conditions with Staggered School Start-Times (Option 3)
• Volumes added: o Expansion to existing schools population will occur by 2015 o Completion of new school assumed to be complete by 2015 o Trips generated shifted based on new coordination of start times with the elementary school starting before the middle school • Trip distribution for vehicles based on existing traffic volumes and travel patterns at school access points and in the study area.

Vehicular Analysis Results

Intersection capacity analyses were performed for the six outlined scenarios at the study intersections shown in Figure 27. Given that the school peak and network peak are very similar in the morning, it is important to minimize the impact in this condition. Therefore, only the AM peak half-hour was thoroughly analyzed as it is the controlling condition within the analysis. The school peak and network peak in the PM are far enough apart that the changes in the school population and staggering of start times will create a less significant overall impact.

Synchro, Version 7.0 was used to analyze the study intersections based on the Highway Capacity Manual (HCM) methodology. The results of the capacity analyses are expressed in level of service (LOS) for each approach. Levels of service (LOS) range from A to F. A brief description of each level of service for signalized and unsignalized intersections is provided below.

For signalized intersections, LOS is based upon the traffic volume present in each lane on the roadway, the capacity of each lane at the intersection and the delay associated with each directional movement. The LOS criteria for signalized intersections are summarized in Table 7. Full LOS descriptions are included in the Technical Appendix.

Table 7: LOS Criteria for Signalized Intersections

LOS	Delay/vehicle (sec)	Progression Type	Comments
A	< 10	Favorable	
B	10.1 to 20	Good	
C	20.1 to 35	Fair	Generally considered the lower end of the range of the acceptable level of service in rural areas.
D	35.1 to 55	Unfavorable	Generally considered the lower end of the range of the acceptable level of service in urban areas.
E	55.1 to 80	Poor	Limit of acceptable conditions for the purpose of this analysis.
F	> 80	Poor	

At an unsignalized intersection, the major street through traffic and right turns are assumed to operate unimpeded and therefore receive no level of service rating. The level of service for the minor street is dependent on the volume and capacity of the available lanes. The level of service for the major street left turn traffic is dependent on the number and frequency of acceptable gaps in the major street traffic to make a conflicting turn. The level of service grade is provided for each conflicting movement at an unsignalized intersection and is based on the total average delay experienced by each vehicle. The delay includes the time it takes a vehicle to move from the back of a queue through the intersection. The unsignalized intersection levels of service are summarized in
Table **8**. Full LOS descriptions are included in the Technical Appendix.

The LOS capacity analyses were based on: (1) the peak half-hour traffic volumes for the four scenarios; (2) the lane use and traffic controls in the existing network; and (3) the Highway Capacity Manual (HCM) methodologies (using *Synchro 7* software). Table 9 shows the results of the capacity analyses for the existing and growth conditions, as well as access-specific analyses of both scenarios involving the implementation of the new school. The LOS for each approach and the overall intersection is shown for the signalized intersections, and the LOS for each appropriate approach and movement is shown for the unsignalized intersections. The intersection ID numbers correspond with those shown in Figure 27.

Table 8: LOS Criteria for Unsignalized Intersections

LOS	Delay/vehicle (sec)	Comments
A	< 10	
B	10.1 to 15	
C	15.1 to 25	
D	25.1 to 35	
E	35.1 to 50	
F	> 50	LOS F may not always result in long queues but may result in adjustments to normal driver behavior

The analysis results for the show the following:

- 2015 Future Conditions with Existing School Growth
  - Impact to surrounding intersections
    - Decrease in overall LOS at North Harrison Street and North Williamsburg Boulevard
    - Decrease in eastbound LOS at 36th Street North and North Harrison Street
    - Decrease in northbound LOS at North Williamsburg Boulevard and Old Dominion Drive
  - No significant decrease in LOS at any school access points
- 2015 Future Conditions with Existing School Growth + New Elementary School
  - Impact to surrounding intersections
    - All results given in 2015 Future Conditions with Existing School Growth
    - Decrease in overall LOS at North Williamsburg Boulevard and Old Dominion Drive
    - Decrease in northbound LOS at North Harrison Street and North Williamsburg Boulevard
    - Decrease in northbound and southbound LOS at North Williamsburg Boulevard and North Kensington Street
    - Further Decrease in eastbound LOS at 36th Street and North Harrison Street
  - Impact to school access points
    - Decrease in eastbound LOS at east lot exit
    - New elementary school access at 36th Street North operates at an LOS F with Access Alternative d
- 2015 Future Conditions with Staggered School Start-Times (Option 1)
  - LOS improved from 2015 Future Conditions with Existing School Growth + New Elementary School
  - In comparison to existing conditions
    - Impact to surrounding intersections
      - Decrease in overall LOS at North Harrison Street and North Williamsburg Boulevard

        - Decrease in eastbound LOS at 36th Street North and North Harrison Street
        - Decrease in northbound LOS at North Williamsburg Boulevard and Old Dominion Drive
    - Impact to school access points
        - New elementary school access at 36th Street North operates at an LOS D with Access Alternative d
- 2015 Future Conditions with Staggered School Start-Times (Option 2)
    - LOS improved from all previous future conditions scenarios
    - In comparison to existing conditions
        - Impact to surrounding intersections
            - Significant increase in overall LOS at North Harrison Street and North Williamsburg Boulevard with a particular improvement to the southbound movement
            - Increase in southbound LOS at North Williamsburg Boulevard and North Kensington Street
        - No significant change in LOS at any school access point
- 2015 Future Conditions with Staggered School Start-Times (Option 3)
    - Yields nearly identical traffic capacity results as 2015 Future Conditions with Staggered School Start-Times (Option 1) with one exception:
        - Overall LOS at North Harrison Street at North Williamsburg Boulevard improves from F to E (Southbound movement continues to operate at LOS F).

Table 9: LOS Summary

ID	Intersection	Approach	LOS during AM peak half hour (7:30 - 8:00 AM)														
			Scenario #1	Scenario #2	Scenario #3			Scenario #4			Scenario #5			Scenario #6		
					A	B/C	D	A	B/C	D	A	B/C	D	A	B/C	D
1	**North Harrison Street at North Williamsburg Boulevard**	**Overall**	D	F	F	F	F	F	F	F	B	B	B	F	F	E
		Eastbound	B	B	B	B	B	B	B	B	B	B	B	B	B	B
		Westbound	B	B	B	B	B	B	B	B	B	B	B	B	B	B
		Northbound	C	C	D	D	D	C	C	C	B	B	B	C	C	C
		Southbound	F	F	F	F	F	F	F	F	C	C	C	F	F	F
2	**North Williamsburg Boulevard at North Kensington Street**	Eastbound Left	A	A	A	A	A	A	A	A	A	A	A	A	A	A
		Westbound Left	A	A	A	A	A	A	A	A	A	A	A	A	A	A
		Northbound	C	C	D	D	D	C	C	C	C	C	C	C	C	C
		Southbound	D	D	E	F	F	D	D	E	C	C	C	D	D	E
3	**North Kensington Street at 36th Street North**	Southeastbound Left	A	A	A	A	A	A	A	A	A	A	A	A	A	A
		Northwestbound Left	A	A	A	A	A	A	A	A	A	A	A	A	A	A
		Northeastbound	B	B	B	B	B	B	B	B	B	B	B	B	B	B
		Southwestbound	B	B	B	B	B	B	B	B	B	B	B	B	B	B
4	**36th Street North at North Harrison Street**	Eastbound	C	D	F	F	F	E	E	E	B	B	B	E	E	E
		Northbound Left	A	A	A	A	A	A	A	A	A	A	A	A	A	A
5	**37th Road North at North Harrison Street**	Eastbound Left	A	A	A	A	A	A	A	A	A	A	A	A	A	A
		Southbound	A	A	A	A	A	A	A	A	A	A	A	A	A	A
6	**37th Street North at North Harrison Street**	Eastbound Left	A	A	A	A	A	A	A	A	A	A	A	A	A	A
		Southbound	A	A	B	B	B	A	A	A	A	A	A	A	A	A
7	**North Williamsburg Boulevard at Old Dominion Drive**	**Overall**	C	C	D	D	D	C	C	C	C	C	C	C	C	C
		Eastbound	C	C	C	C	C	C	C	C	C	C	C	C	C	C
		Westbound	B	B	B	B	B	B	B	B	B	B	B	B	B	B
		Northbound	D	E	E	E	E	E	E	D	D	D	D	E	E	D
		Southbound	C	C	C	C	C	C	C	C	C	C	C	C	C	C

ID	Intersection	Approach	LOS during AM peak half hour (7:30 - 8:00 AM)													
			Scenario #1	Scenario #2	Scenario #3			Scenario #4			Scenario #5			Scenario #6		
					A	B/C	D	A	B/C	D	A	B/C	D	A	B/C	D
8	**School East Lot Entrance at North Harrison Street**	Eastbound*	A	A	F	C	F	C	C	C	B	A	B	C	C	A
		Northbound Left	A	A	--	--	C	--	--	A	--	--	A	--	--	A
9	**School East Lot Exit at North Harrison Street**	Northbound	B	C	--	--	A	--	--	A	--	--	A	--	--	A
		Westbound Left	--	--	A	A	--	A	A	--	A	A	--	A	A	--
10	**School North Lot Entrance at North Harrison Street**	Westbound Left	A	A	A	A	A	A	A	A	A	A	A	A	A	A
11	**School North Lot Exit at North Harrison Street**	Northbound	B	B	B	B	A	B	B	A	A	A	A	B	B	A
12	**New ES Exit at 36th Street North**	Eastbound Left	--	--	A	A	A	A	A	A	A	A	A	A	A	A
		Southbound	--	--	--	C	F	--	A	D	--	B	B	--	A	D

* In all future scenarios, the east lot entrance becomes either the exit, or a two-way entrance/exit thus it is necessary to evaluate the eastbound movement in those scenarios.